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Complications of vertebral metastasis surgery

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Abstract The authors report their experience concerning complications of spinal metastasis surgery. The purpose of this study was to assess the frequency of such complications and analyse the factors influencing their occurrence. The records of 145 patients treated between 1982 and 1991 for metastatic disease of the spine were retrospectively reviewed for intra- and postoperative complications. Other factors such as radiation therapy, emergent nature of surgery, and neurologic deficits were analysed for potential correlations with the frequency of complications. Twenty-seven (18.6%) patients developed

postoperative complications. Wound dehiscence and infection (11%) were the most frequent complications. Statistical analysis showed a significant influence of three factors: preoperative radiation therapy, paraplegia before surgery, and surgery under emergency conditions. The rate of complications in this surgery is lower than might be expected and can be significantly reduced. Surgery should be performed before radiation therapy and before appearance of substantial neurologic deficits.

Key words Vertebral metastases · Complications · MRI

Introduction

The principal drawback of surgery for bony metastatic locations, particularly vertebral metastases (VM), is, for many surgeons, the relative frequency of complications due to the procedures themselves. We decided to verify whether this fear is well founded by determining the frequency of immediate and secondary complications of such surgery, and to look for causes or predisposing factors that might point to means for reducing the frequency of these complications.

Materials and methods

We carried out a retrospective study of 145 patients operated in our unit between 1982 and 1991 for vertebral metastasis of malignant tumours. The surgery was indicated to reduce pain, prevent onset or aggravation of neural deficits, and to improve the quality of life of the patients. Primary vertebral tumours were excluded from this

series. Vertebral locations of haematological malignancies, which involve problems similar to those encountered in solid tumour metastases, were, on the other hand, included.

Epidemiology

Primary tumor (Table 1)

The 145 patients operated were among 155 patients hospitalized between 1982 and 1991 in our unit, for secondary locations of malignant tumours. Among these 155 patients, the primary tumour had already been diagnosed in 103 patients at the time that one or more metastases were detected. Vertebral metastasis was the inaugural manifestation of cancer in the other 52 patients (33.5%).

In the majority of cases in which the primary tumour was already known at diagnosis of vertebral metastasis, either breast cancer ($n = 39$, 37.8%), lung cancer ($n = 13$, 12.6%) or colon cancer ($n = 8$, 7.7%, all colic locations combined) was involved.

Among the rarer locations were noted tumours of the kidney, prostate, uterus (neck or body), oesophagus and bladder. We classed the even rarer tumours into the category "others" (synoviosarcoma, neuroendocrine carcinoma, leiomyosarcoma, malignant melanoma, malignant fibrous histiocytoma, tumour of the pancreas, tumour of the pharynx), when they were already diagnosed at the time of discovery of VM.

Table 1 Detection of the primary tumour prior to the diagnosis of metastasis, by primary tumour location

Location	Primary tumour unknown		Primary tumour known	
Breast	2	3.8%	39	37.8%
Lung	3	5.7%	13	12.6%
Colon	2	3.8%	8	7.7%
Kidney	1	1.9%	6	5.8%
Prostate	3	5.7%	6	5.8%
Uterus	1	1.9%	5	4.8%
Myeloma	10	19.2%	5	4.8%
Bladder	0		4	3.9%
Lymphoma	1	1.9%	3	2.9%
Oesophagus + cardia	0		2 + 2	3.9%
Cavum	1	1.9%	2	1.9%
Thyroid	2	3.8%	1	0.9%
Other	26	unknown 50%	7	6.8%
Total	52	100%	103	100%

When metastasis was the initial manifestation of the cancer, the primary tumour remained undiagnosed in 50% of patients (26/52), despite thorough work-ups we also classed these cases as others. Overall, the primary tumour remained undetermined in 16.7% (26/155). The incidence of myeloma discovered after vertebral symptoms was particularly high (10/52 = 19%).

At the time of discovery of VM, the primary tumour, when known, had been diagnosed an average of 42.5 months earlier (between 15 days and 250 months earlier).

The vertebral metastasis (VM)

There were 56 cases of VM (28.3%) involving the cervical level, 89 (44.9%) the thoracic (of which 24 were associated with cervical locations and 7 associated with both cervical and lumbar locations), and 53 (26.7%) lumbar (of which 23 were associated with thoracic locations).

The radiological work-up revealed from one to nine VM per patient (two or three locations in most cases).

Other locations and general status of the patients

Eighty patients had at least one other metastasis elsewhere than in the spine. Sixty-five had only vertebral metastasis. The patients with nonspinal metastasis generally had more than two lesions that had been discovered an average of 7 months before the spinal operation. The most frequent locations were in bones (62.5%), the lungs (24.5%), the liver (17%), and the brain (2%).

On the scale of 1–5 of the American society of Anesthesiology (ASA), the average general status of the patients was 3.

Presentation of the series

Among the 155 patients hospitalized for VM, 145 underwent surgery. Among the remaining ten patients, five were managed using vertebral reconstruction by injection of acrylic cement (vertebroplasty), and five could not be operated due to respiratory difficulties (pleural effusion), cardiac conditions (ventricular tachycardia, auricular fibrillation) or cerebral metastatic locations that would have exposed the patient to the risk of postoperative cerebral oedema.

Vertebroplasty was indicated for patients with pain resistant to opioid analgesics and without vertebral instability (the posterior aspect of the vertebral body had to be preserved to avoid cement penetration into the spinal canal). Twenty-nine of the patients received corticosteroids, most often as a preventative measure against neurologic compromise, before their transfer to our surgical unit. In six cases, preoperative embolization was performed for hypervascularized VM, most of which were renal in origin.

A postoperative evaluation was performed at 1, 3 and 6 months and 1 year. Late follow-up was continued by the oncologists. The mean survival rate was 14.9 months (depending mainly on the nature of the primary tumour).

Surgical treatment

Emergent surgery was performed in 43 cases (29.6%), because of onset of neural deficit. In the other 102 cases, surgery was carried out an average of 7.3 days after referral to our unit.

The surgical approach was anterior in 32 patients (22%), posterior in 97 (66.9%) and combined anterior and posterior in 16 (11%).

Anterior approach. As stated above, anterior exposure was used in 48 patients (33% of the surgical interventions), in 16 of them as the first stage of a combined anterior-posterior approach. The anterior approach was preferred for the cervical spine, being used in more than 85% of the cervical locations. Among the 48 anterior exposures, 37 involved corpectomy at one level, 9 at two levels, and 2 at three levels. An autograft (corticocancellous iliac graft) was associated 16 times, and an allograft twice. Currently, we tend to use acrylic cement. In this series it was used 30 times. Stabilization was reinforced by osteosynthesis in most cases. In 26, a Senegas screw-plate system [23] was employed and, in 13, pins were used with cement. In the remaining cases, posterior osteosynthesis was applied during a double approach.

Posterior approach. The posterior approach was used in 113 patients (78%). Among these, it was performed 16 times as the second stage of a combined anterior-posterior procedure. Laminectomy was carried out in 109 of these cases. In two of them, no decompression was necessary. Such surgery was performed most often in the thoracic spine (more than 60% of the posterior procedures).

The following techniques of osteosynthesis were used: Harrington rods (2 cases); Hartshill rectangle (89 cases); Randsford instrumentation (9 cases); and pedicle screws and rods (7 cases).

In six cases, when the patient's condition was particularly fragile, or because of an intraoperative incident (e.g. cardiac rhythm problem), no osteosynthesis was performed. In these cases, the intervention was limited to decompression alone or associated with posterolateral grafting.

On average, 8 levels were bridged by the osteosynthesis, ranging from a minimum of 3 to a maximum of 19 levels. Osteosynthesis was reinforced by grafting in ten of these patients.

Results

Intraoperative complications

We noted ten intraoperative complications as follows: two cases of radicular lesion; two cases of violation of the dura mater, which was repaired during the intervention; six general complications (excessive bleeding, cardiac arrhythmia). There were no intraoperative deaths.

Postoperative complications

Twenty-seven of the 145 patients (18.6%) presented postoperative complications. Some patients presented more than one complication.

Local complications

Local complications were those involving the operative wound. These were six infectious complications of the wound (4.1%), eight cases of wound dehiscence (5.5%) necessitating revision surgery, and six cases of delay or difficulties in healing (4.1%).

Haemorrhagic complications

Two subarachnoid haemorrhages with secondary neurologic deterioration occurred. In these two patients, substantial intraoperative bleeding was noted by the surgeon. There were also two cases of haematoma.

Thrombo-embolic complications

Thrombo-embolic complications occurred in 11% of the paraplegic patients who were not treated by low-molecular-weight heparin, whereas no deep venous thrombosis was noted in the patients treated preventatively. This accords with the findings of O'Neil et al. [18].

Neurologic complications

There were five cases of neurologic deterioration, of which three were due to cord lesions (among them, the two cases of subarachnoid haemorrhage) and two involved radicular damage.

Respiratory complications

Four patients suffered respiratory insufficiency. Among these, three recovered after treatment, whereas the respiratory failure of the fourth subject, presenting a neoplastic pleural effusion necessitating repeated drainages, persisted.

Confusion

The frequency of postoperative confusion was surprising. These episodes of confusion with no precise etiological factor were noted in 10% of the series. They occurred the day following intervention, most often in men

(16.9% vs 1.7% in women). These episodes regressed within 72 h, with treatment.

Early death

Three of the patients (2.07%) died less than 1 month after surgery: one of haemorrhaging from ruptured oesophageal varices before discharge from the hospital, one of acute kidney failure and one of acute respiratory failure.

Instrumentation failure

No loosening of instrumentation was observed.

Overall complication rates

Overall there were 16 local complications (sepsis and wound-related problems) giving a complication rate of 11.03%; three deaths within 1 month (2.06%), one of which occurred very early; five neurologic deteriorations (3.4%), three of which (2.06%) involved the cord (including two by subarachnoid bleeding) and 2 of which radicular (1.3%).

Factors influencing complications (Table 2)

Emergent surgery

Although the frequency of intraoperative complications during emergent surgery was comparable to that during planned surgery (respectively 9.5% and 11.7%), a significant difference ($P = 0.05$) was noted in their respective postoperative complications. Among the postoperative complications recorded, 11 occurred in the 42 patients operated under emergent conditions, compared to only 15 such complications during or after the 103 planned operations:

Complications after emergent surgery: 11/42 (26.1%) of which 8/42 (19.04%) involved the operative wound.

Table 2 Factors influencing complications

	Complication rate	P-value
Surgery		0.05
Emergent	19.04%	
Scheduled	7.76%	
Preop radiotherapy		< 0.005
Yes	12%	
No	1.1%	
Neurologic deficit		< 0.004
Yes	14.3%	
No	2.2%	

Complications following delayed surgery: 15/103 (14.1%), of which 8/103 (7.7%) involved the operative wound.

Operating under emergent conditions significantly increased the rate of skin complications involving the operative wound. This is probably due to the neurologic state of these patients and their poor state of health at the time of the emergent surgery. Scheduled surgery permits a better preparation of the patient (correction of metabolic disorders and proteic deficiency).

Radiotherapy and wound-healing problems

Among the six patients who presented infectious local complications, four had undergone preoperative radiation therapy. Likewise, among the eight patients who presented wound dehiscence, seven had undergone preoperative radiotherapy. There was superinfection of only one wound dehiscence. Among the six delays in healing, four presented in patients to whom radiation therapy had been administered preoperatively and one in a patient who had received corticosteroids. All these local cutaneous complications resolved with treatment.

The incidence of such complications in the population of patients that underwent preoperative radiation therapy (12%) was significantly higher than that (1.1%) in the patients that underwent postoperative or no radiation therapy ($P < 0.005$).

Complications and preoperative neurologic deficits

Among the 15 patients that presented local complications involving the wound (sepsis, dehiscence or delay in healing), 13 presented medullar neurologic deficits preoperatively, and among the latter patients, 8 could no longer walk (Frankel grade A or B). Thus, among the 56 patients with complete or incomplete para- or tetraplegia, local complications arose in 8 (14.3%), whereas only two local complications occurred in the 89 other patients (2.2%) of this series.

New locations and recurrences

New locations

Among the 98 patients not lost to follow-up, a new vertebral metastatic location was found in 21 (21.4%) between 1 and 60 months after surgery for the initial VM (mean: 9 months). These new VM were most often multiple. There were 10 cervical, 18 thoracic and 12 lumbar sites of new VM.

In this subgroup of 98 patients, only 20 had undergone MR imaging of the entire spine. Among these 20 patients, an new VM arose in only 1 (5%). The other 20 patients in

whom new metastatic sites were later found were among the 78 patients (25.6%) for whom MR images of the entire spine were not made initially.

This difference was significant ($P < 0.03$), signifying that most of these new VM sites were probably pre-existing asymptomatic lesions that would have been detected if they had been included in the initial MR examinations.

Recurrence

In 95 patients that were not lost to follow-up, there were ten recurrences at the site of the initial operation (10.5%). These recurrences were detected an average of 24.6 months after surgery (range: 1–63 months). They involved various types of primary cancer, including four breast cancers, two kidney cancers (note that two of five VM known to be of renal origin recurred), one fibrous histiocytoma, one synoviosarcoma, and two of unknown origin. Recurrence appeared to be independent of the surgical approach used. It occurred five times after posterior surgery, twice after anterior surgery and three times after a combined surgical approach.

Discussion

The treatment of VM must be integrated into the overall management of the cancer patient. This imposes interdisciplinary co-ordination involving close collaboration among oncologists, radiotherapists, neuroradiologists, and surgeons.

The efficacy of surgery in alleviating pain, reducing and preventing neural deficits, and improving the quality of the months of life that remain to the patient amply justify its use [12, 14, 22]. Such procedures most often serve the double purpose of decompression (for neurologic deficits) and stabilization. Decompression, indicated for both threat of compromise to the neural contents of the spinal canal and deficits already present, can be carried out through an anterior or posterior approach. Stabilization is obtained by osteosynthesis, entailing methods that vary according to the vertebral segment and number of levels involved. It greatly contributes to the analgesic action of these operations [24, 28].

It is important to monitor the morbidity and mortality of this surgery to seek means of lowering them as much as possible in these fragile patients. Asdourian [1], in a review of the literature, found the values reported in Table 3.

The reported death rates during surgery (zero in our series) and in the early postoperative period are relatively low in view of the risks presented by such patients, essentially involving anaesthesia (more than 71% of the patients in our study were ASA grade III or higher). Death during the 1st postoperative month may be linked to either surgery or the course of the cancer itself. In Harrington's

Table 3 Review of the literature (Asdourian [1])

Author	Year	No. of cases	Mortality	Morbidity
Sundaresan	1985	101	8%	10%
Siegal	1985	78	7%	21%
Onimus	1986	57	4%	–
Perrin	1987	200	8%	–
O'Neil	1988	33	3%	15%
Harrington	1988	77	10%	10%

series of 77 operated patients, four of the eight early deaths were attributed to the course of the primary tumour. This raises the issue of preoperative assessment of the vital prognosis of these patients. In our opinion, surgical interventions should not be included in the therapeutic arsenal for patients whose life expectancy is 3 months or less, as the average length of hospitalization for such surgery is 14 days.

Roughly half of the postoperative complications in this type of surgery involve the wound (dehiscence, delay in healing, local infection). In our series, 15 of 27 complications (55.5%) were of this nature. We found three factors significantly associated with their occurrence: preoperative radiation therapy, neurologic status at referral, and operating under emergent conditions. The negative influence of radiotherapy on wound healing has been observed by numerous authors [8, 11, 16, 27]. Harrington [11] noted three problems of wound healing associated with secondary local infection in his patients operated through a posterior approach. All three of these patients had undergone preoperative radiation therapy. Incidentally, he considered such complications to be an argument in favour of anterior surgery. In Sundaresan and co-workers' series of 19 patients operated for VM [27], 4 present wound healing problems, all of whom had been irradiated before surgery. Black [4] has also underscored the increase in risk of infection in patients that undergo radiotherapy before surgery.

The presence of a neurologic deficit due to VM is an indication for emergency salvaging surgery, which cannot be performed under the same favourable conditions as those pertaining in scheduled operations. This results in a higher risk of morbidity after emergent surgery. Furthermore, the risk of complications attending the decubitus position are greatly increased in patients with neurologic deficits. More meticulous nursing care and extreme vigilance concerning the state of the skin are required, as patients, having lost the sensation of pain, cannot alert the paramedical personnel. Efforts must be made to reduce this type of surgery by operating earlier in the course of these affections to prevent onset of neurologic deficits. Occurrence of neurologic deficits may even be considered as the result of an error in management, because neurologic recovery is uncertain and rehabilitation, often under-

taken concomitantly with complementary therapy, is difficult to implement in such fragile patients whose life expectancy is often short. Furthermore, patients able to walk before treatment (surgical or not) survive longer than non-ambulatory patients and those with sphincter incontinence [15, 25]. Constans et al. [6] have already stressed the importance of early surgical intervention. We wholly agree with Dewald et al. [7], that surgery for vertebral metastases should be preventative in the same manner as pinning for metastasis of the femur.

More than half of the complications of vertebral metastasis surgery could be avoided by applying simple preventative measures:

1. Do not wait for the onset of neurologic deficits before considering surgery.
2. When surgery and radiation therapy are associated to treat VM, surgery should be performed before radiotherapy.

This second point is essential, because postradiation osteonecrosis, which may be difficult to distinguish from a renewed flare-up of the tumour, presents substantial obstacles to achievement of the desired surgical results. Bony necrosis of the hip after radiotherapy has been described [8, 16]. We observed this complication in the spine in five patients of our series. Certain authors have also reported the absence of fusion of corticocancellous autologous grafts after radiation therapy [24]. We did not encounter this problem, but we preferred using acrylic cement in most of these patients [10, 19, 20, 26], as advocated by Harrington and Onimus. Roy-Camille et al. [21] and Emery et al. [9] demonstrated that radiation therapy administered in doses of less than 40 Gy does not prevent incorporation of corticocancellous grafts within the usual length of time. In contrast, irradiation levels above 60 Gy compromise the consolidation of such grafts.

The absence of mechanical complications observed in our series is not common in the literature. This was probably related to progress afforded by MRI in the preoperative work-up of these patients. Advances in the understanding of metastatic spread to the vertebra [3, 29] and the observation of the low percentage of patients presenting only one metastasis [7% in our study] have prompted us to consider vertebral metastases as an affection of the entire spinal column. In preoperative planning, every vertebra that presented pathological MR aspects was taken into account, leading to the use of long arthrodeses, the stability of which is obviously greater than that of short constructs.

The occurrence of new vertebral metastatic locations appears to be inevitable if survival is sufficiently long. However, there exists a problem concerning the detection of subclinical vertebral metastases, which should be integrated into the overall therapeutic strategy. While radionuclide bone scanning provided a considerable step forward in the past, MRI appears to be the most reliable

examination currently available for the detection of VM [2, 5]. This is why we now systematically request sagittal T1-weighted sequences of the entire spine in the preoperative work-up of such patients.

Tumoural recurrences remain real therapeutic problems (their frequency was 10.5% in our series), as the patients involved have generally exhausted a large part of the therapeutic arsenal (radiation therapy, surgery, chemotherapy). Posterior revision surgery gave very poor results in our series. Perhaps, the systematic use of the anterior surgical approach should be considered in such cases [13, 17].

Conclusion

The high frequency of spinal metastatic lesions calls for specific means of detection and management. In the

work-up of patients presenting a vertebral metastatic location, MRI is indispensable and, in particular, T1-weighted sagittal sequences of the entire spine are called for to avoid overlooking subclinical locations elsewhere in the column.

Surgery has proven its efficacy against pain and in improving the quality of life of patients with vertebral metastases. It should no longer be considered as a means of salvage to be used only when neurologic deficits appear and/or after the failure of radiation therapy, because these are the two main sources of operative failure and complications. The frequency of these complications can be significantly reduced by the application of simple rules. This type of surgery should be used for the prevention of neurologic deficits by vertebral stabilization. It should also precede adjuvant radiation therapy.

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