Spinal metastases: treatment evaluation algorithm

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Abstract. - Spinal metastases are only apparently similar lesions, considering the large varieties of isotypes and the spread of the primary tumour. These metastases develop early and are not terminal events, they have to be considered as severe complications because, when possible, surgical treatment can improve the history of the patient in terms of life expectancy and quality of life. The approach to these lesions should be multidisciplinary in collaboration with oncologists and radiotherapists, in fact the average of survival of these patients has increased in recent years. The evolution of anaesthesiological techniques that permit surgical treatments that were once considered prohibitive. The application of new adjuvant therapy increases the effectiveness for surgical treatment. Controversy exist over the most appropriate treatment for patients with metastatic disease of the vertebral column. The purpose of this article was to determine the best sequential process to arrive at the most appropriate treatment considering the individual general conditions and the parameters of the metastases.

As the number of treatment options for metastatic spinal disease has grown, it has become clear that effective implementation of these treatments can only be achieved by multidisciplinary approach.

Key Words: Spinal compression, Metastasis, Cancer, Radiation therapy.

Introduction

The incidence of skeletal metastases carcinoma is second only to pulmonary and hepatic metastases. The most frequently affected segment of the skeleton is the vertebral column. It is estimated that more than 10% of tumour patients develop symptomatic spinal metastases. The vertebral bodies are reached largely via the bloodstream and neoplastic substitution of the bone tissue causes progressive structural destruction leading to loss of stability and compression of the intracanal nerve structures.

Refinement of the protocols for treating tumour patients has led to a progressive improvement in the prognosis for many tumour histotypes in terms of an increase in mean survival time. As a consequence, the increase of symptomatic spinal metastases in patients without other evidence of disease severely affects the patient’s quality of life. The choice of the most suitable treatment is of crucial importance for the patient who may be severely disabled by the presence of untreated spinal metastases. These spinal metastases may not only be the cause of severe deterioration in the quality of life, but also the direct or indirect cause of death. On the other hand, although there is widespread agreement in literature regarding the need to treat symptomatic metastases, the best treatment protocol to adopt is still a matter of discussion.

It is commonly accepted that bone metastases are an expression of a systemic disease, and therefore require multi-disciplinary treatment, integrating radiotherapy, chemotherapy and surgery.

The indications for surgical treatment of spinal metastases are intractable pain, the onset of neurological deficit (caused by compression of the myelorradiacular structures by the tumour mass or by pathological fracture of the vertebra) and instability of the spinal segment affected causing ingraevcent mechanical pain and/or neurological deficit.
The first and most serious symptom affecting patients with spinal tumour is, in fact, pain. This is extremely frequent, non-specific and easily undervalued. Many tumours of the spinal column may be asymptomatic for long periods and a number of factors influence the onset of pain:

- the tumour occupying the vertebral body expands and breaks the cortex, stretching the periosteum stimulating the pain receptors and invading the paravertebral tissues;
- the tumour tissue may compress and invade the spinal cord and/or nerve roots;
- tumour erosion may weaken the vertebra and cause pathological fracture resulting in acute pain in every way similar to that caused by traumatic fracture. The resulting structural alteration may lead to spinal instability and/or compression of the spinal cord.

The pain associated with a tumour is not associated with activity, but infiltrative, it is continuous, sharp, progressive and frequently worsening during the night.

The aim of surgery is to relieve the pain, improve neurological functions and stabilise the spinal column. The local control of the disease and the reduction of the tumour mass (debulking) are also important targets.

Decompressive laminectomy alone is no longer performed as it has been found that the clinical improvement obtained using this technique is comparable with radiotherapy alone. Furthermore, the operation may itself cause or worsen segmental instability. The surgical techniques used today are extremely varied: decompression and stabilisation, intralesional resection or en bloc resection, followed by various reconstruction procedures. All these operations can be performed by either the anterior, posterior or combined approach.

**Materials and Methods**

Between September 1996 and December 2002, 182 patients suffering from spinal metastases from a solid tumour were treated (a total of 269 metamasers) at the orthopaedic and traumatology department at the Ospedale Maggiore, Bologna. Patients suffering from plasmacytoma and lymphoma were excluded from the study as the therapeutic approach and prognostic evaluation are, in our experience, different.

There were 116 males and 66 females (ratio 2:1) with an age range of between 14 and 89 (mean 56).

We identified 46 metastases located in the cervical section, 141 in the thoracic section and 82 in the lumbar section. The most frequently affected metamasers were L1 and L2 affected 20 and 19 times (Figure 1).

In 132 cases the lesion affected only one vertebra. In 25 patients, 2 vertebrae were affected simultaneously, in 16 cases the tumour affected 3 vertebrae, in six cases 4 metamasers were affected and in 3 patients 5 vertebrae were affected.

The anatomical location of the primary tumour is reported in Figure 2. The most frequent locations were kidney, lung, breast and thyroid. In 17% of the cases the original tumour was not known at the onset of the vertebral symptoms (Figure 2).

The Frankel score was used to assess neurological impairment; 101 patients had no neurological impairment (Frankel E), 14 patients were Frankel D3, 17 cases were D2, 14 cases were D1, 25 cases were C, 9 cases were B and 2 cases A.

On admission, there was pathological fracture of the vertebra concerned in 67 cases (37%).

All patients underwent the diagnostic workup for local and systemic oncological staging. Diagnosis was performed after decompression in 44 cases only (24%), when emergency surgery was needed. A CT-guided needle biopsy was performed for diagnostic purposes in 29 cases, while in 3 cases an incision biopsy was performed. At the end of the diagnostic process, 13 patients (6.6%) were found to be suffering from non-spinal bone metastases, while in 11 patients (5.5%) we found visceral metastases affecting various organs.

Of the 182 patients included in the study, 170 were treated surgically. Out of 12 patients, 9 were inoperable due to their poor general conditions, 3 cases were metastases from breast cancer sensitive to hormonal treatment. It should be kept in mind that the
patients referred to us had already been selected by the oncologists and this explains the high number of surgical operations.

The following surgical techniques were used:

**Decompression and stabilisation** in 79 cases (46%): this is the quickest and least aggressive of the surgical procedures and does not necessarily involve a direct approach to the tumour. The aim is to circumferentially decompress the spinal cord and stabilise the spinal column. It was chosen for patients with short-term prognosis in cases of neurological damage as a result of pathological fracture, but also in conditions of very high sensitivity to radiotherapy or hormonal treatment. In 10 cases, preoperative embolisation of blood vessels leading to the tumour was performed (Figure 3).

This surgical procedure was adopted in the majority of cases requiring emergency surgery. **Intralesional resection** “debulking” in 64 cases (38%): the tumour was attacked directly and removed as far as possible not only in order to achieve circumferential decompression of the spinal cord but also to reduce the mass of the tumour. This procedure was performed as part of a multi-disciplinary approach to treating the metastases and was preceded by appropriate surgical planning including selective preoperative arterial embolisation (performed in 18 cases). We chose this operation in the presence of metastases not sensitive to radiotherapy, with pathological fracture and/or signs of spinal cord compression, or when the oncologist considered it necessary to remove the tumour to enable adjuvant treatments to act more effectively on the remaining cells. Surgical access was posterior in 40 cases, anterior in 15 cases and combined anterior plus posterior in the remaining 9 cases (Figure 4).

**En bloc resection** in 27 cases (16%): this was performed on patients suffering from a single spinal metastasis deriving from the primary tumour, with a long life expectancy and already treated. The operation was performed with a double approach in 14 cases, a posterior approach alone in 10 cases and an anterior approach alone in 3 cases (Figure 5).

The criteria making this operation possible include: tumour size, volume, location. Three possible en bloc resections have been described according to the WBB system:

- resection of the vertebral body (17 cases) (14 vertebrectomy & 3 corporectomy)
- sagittal resection (4 cases)
- posterior resection (6 cases).

## Results

All patients underwent periodic out-patient check-ups in which a clinical examination was combined with X-ray examination of the spinal column, CT and/or MRI of the operated segment and any other examinations indicated in the individual case. The main elements recorded for each patient were functional assessment of the neurological conditions according to the Frankel scale, complications associated with the operation, local recurrence or local progression of the disease and general clinical status.

The 182 patients included in our study were followed up for a mean of 57.7 months (min: 5 days – max: 81 months). No patient dropped out of the follow-up. At the end of the study, 99 patients had died [(a mean distance of 11 months after admission to hospital (min: 5 days – max: 50 months)], 41 are still alive with the disease still active [operated a mean of 12 months previously (min:1.6 months – max: 53 months)] and 42 are alive without clinically evident disease 17 months after the operation (min: 1.8 months – max: 81 months).

In total, there were 11 (6.5%) surgical complications [dehiscence of the wound (4), haemorrhage (1 due to rupture of the aorta and 1 due to cardiac tamponade), respiratory problems (2), distal screw too long (1), radiation dermatitis treated with plastic surgery (1) and intestinal perforation and infection (1)] and three (1.7%) mechanical complications caused by failure of the implants (1 breakage, 2 implant loosening).

In 20 cases, the disease progressed and in 8 cases a second operation (curettage) was required.

As regards variations in the neurological profile, there was a worsening in one patient out of five at final follow-up.
More specifically, it was noted that in patients undergoing palliative decompression and stabilisation surgery, the neurological conditions improved in 38%, were unchanged in 40% and worsened in 22%.

In 81 patients in whom curettage was performed, there was an improvement in 20%, the neurological conditions were unchanged in 54% and they worsened in 26%.

En bloc resection was performed in 20 patients. In two cases only neurological conditions worsened (10%), in one case they improved (5%) and in the remaining patients (85%) they remained unchanged.

As stated above, these figures refer to follow-up. Obviously the longer the follow-up period, the greater the possibility that the disease will relapse with possible compression of the spinal cord and/or pathological fracture which could worsen the clinical neurological conditions. In the same way, the best results are obviously obtained in cases of en bloc re-

Figure 1. Distribution of the vertebral sites.
section where local recurrence of the disease is less likely.

The most interesting result from a surgical point of view is, on the other hand, the variation in the preoperative and postoperative Frankel score. During the early postoperative period, neurological conditions worsened in one case only. This involved a Frankel D1 patient undergoing emergency surgery with posterior decompression and stabilisation. During the operation there was profuse bleeding and two serious hypotensive crises. On coming out of the anaesthetic, the patient was Frankel B and died after a week in intensive care.

Figure 4. Intralesional excision or “debulking”: more or less complete removal of the tumour “piece by piece”. This is the procedure of choice in metastases of the cervical spine, with an anterior approach, but it is also used with success in the thoracic and lumbar sections where the approach can be anterior or posterior.

Figure 3. Decompression and stabilisation; palliative surgery aimed at decompression of the spinal bone marrow and stabilisation of the thoracic and lumbar sections of the spinal column, and which does not necessarily foresee a direct approach to the tumour. For emergency surgery and cases with a severe prognosis, this is the elective procedure.

Figure 5. En bloc resection; removal of the tumour in a single piece; resection can be along the outer surface of the pseudocapsule (marginal resection) or further out, removing a continuous layer of healthy tissue (wide resection). It is rarely indicated in vertebral metastases, but can be considered for single lesions, with a good prognosis or for hypervascularised lesions.
Pain improved in almost all patients. As can be seen from Table I, we divided the patients according to the primary tumour and the type of operation performed. For each tumour type, the number of patients treated, mean follow-up, total follow-up and number of patients deceased were considered for each surgical technique. Patients not surgically treated were specifically excluded as they were given oncologic treatments and/or radiotherapy not directly under our competence and were too few to be valid from a statistical point of view.

### Table III. Survival and follow-up according to histotype and type of operation.

<table>
<thead>
<tr>
<th>Primary tumour</th>
<th>No. of patients</th>
<th>Palliative surgery</th>
<th>Curettage</th>
<th>En bloc resection</th>
<th>F.U. total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N.</td>
<td>F. U.</td>
<td>Dead</td>
<td>N.</td>
</tr>
<tr>
<td>Thyroid</td>
<td>15</td>
<td>4</td>
<td>17.0</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Kidney</td>
<td>44</td>
<td>18</td>
<td>18.5</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Melanoma</td>
<td>4</td>
<td>1</td>
<td>40.3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Breast</td>
<td>19</td>
<td>10</td>
<td>16.0</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Resp. tract</td>
<td>35</td>
<td>18</td>
<td>15.2</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Unknown</td>
<td>22</td>
<td>15</td>
<td>13.5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>G.U. tract</td>
<td>13</td>
<td>11</td>
<td>8.8</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>G.I. tract</td>
<td>12</td>
<td>8</td>
<td>7.2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Sarcoma</td>
<td>15</td>
<td>2</td>
<td>2.5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Liver</td>
<td>4</td>
<td>1</td>
<td>13.8</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

In the spine, a CT-guided trocar biopsy performed through the pedicle without invading the epidural space seems to be the best way to reduce the spread of the tumour cells.

While for the treatment of primary tumours a systematic approach has been selected ever since the studies by Enneking, there are no accepted guidelines in the treatment of spinal metastases.

Protocols of chemotherapy, hormone therapy, immunotherapy and radiotherapy exist and are progressively increasing survival for the majority of solid and haematologic tumours.

However, vertebral collapse causes pain and severe functional limitations, particularly if it causes compression of the spinal cord, which cannot be controlled by drugs.

Despite these proven facts, the erroneous conviction of certain physicians that a patient with secondary skeletal localisations should be considered terminal, and therefore not of orthopaedic interest, often makes urgent surgery indispensable (anaesthesiological evaluation...
permitting), with evident problems for the patient, the relatives and the surgeon.

The development of aggressive surgical techniques, made possible by progress in anaesthesiology, enables complete decompression and adequate stabilisation at all levels of the vertebral column to be performed. In addition, “curettage” (“debulking”) or en bloc resection can be performed with significant results on the local control of the tumour.

Many factors must be taken into account when choosing the most appropriate surgical technique: the patient’s general conditions, the histotype of the primary tumour and its sensitivity to adjuvant treatments, the spread of the disease and the current neurological conditions.

Briefly, it can be said that a patient with diffuse neoplastic disease, generally impaired conditions and incipient neurological deficit should be treated with palliative decompression and stabilisation followed by radiotherapy which may noticeably improve the quality of life. On the other hand, in a patient in good general conditions suffering from a primary tumour with a relatively positive prognosis and a symptomatic isolated spinal metastasis, more aggressive treatment similar to that for a primary tumour is justified.

Sioutos et al. statistically analysed the factors influencing the incidence of complications and length of survival after surgical treatment of spinal metastases and showed that this is influenced by preoperative neurological conditions, the histotype of the primary tumour and the number of vertebrae involved, but not by the degree of diffusion of the disease or the age of the patient. On the basis of these observations, the authors recommend careful patient selection.

The literature proposes many preoperative scoring systems to classify patients by creating repeatable treatment protocols. These systems are characterised by the fact that each parameter is attributed a score and the sum of these scores suggests the appropriate treatment. Equal importance is therefore attached to the various parameters considered in individual cases. For example, the histotype of the primary tumour and general conditions of the patient have the same influence on the final score and therefore the choice of type of treatment.

We have built up an algorithm for treating spinal metastases in which the importance of the parameters considered varies according to when they are considered. Each patient follows his or her “personal” sequential process which does not necessarily consider all the parameters every time as some may be irrelevant for the purposes of choosing the type of treatment. For example, a patient in poor general conditions with a high “ASA” score is usually not a candidate for surgery, irrespective of the histotype of the primary tumour or the number of secondary localisations. For this patient, the most important parameter will therefore be the sensitivity of the tumour histotype to adjuvant treatment. In the same way, a patient with acute and in-gravescent spinal cord damage will undergo emergency palliative decompression and stabilisation surgery without considering a more demanding operation.

Finally, we consider the patient not just in terms of the disease, reducing the choice of treatment to an overly simplistic mathematical score. Instead, we analyse the case holistically, firstly considering the individual and his or her general conditions and only subsequently the parameters of the metastases.

In conclusion, appropriate surgical treatment of bone metastases and tumours in general has now become an integral part of the correct approach to the tumour patient.

The evolution of anaesthetic techniques now allows correct treatment of spinal metastases, both dramatically improving the quality of life and also prolonging the patient’s life expectancy, protecting him or her from the complications of these lesions, often either directly or indirectly fatal.

In the majority of cases, it is therefore possible to restore or maintain movement, sensitivity, dignity and hope, as well as controlling pain, reducing the use of adjuvant and analgesic treatments.

The surgical indication for spinal metastases must consider:

- the life expectancy of the patient;
- the need to improve function and to limit pain;
- the need for complete local control;
- the possibility of associating adjuvant treatments to improve the efficacy of the treatment, reducing morbidity.
Figure 6. A algorithm.
Without considering all the clinical and instrumental examinations which the patient undergoes on admission and forming part of preoperative staging, our treatment algorithm begins with diagnosis of spinal metastases. The first assessment must be performed by the anaesthetist who must say whether the patient is operable or not. If the patient is not operable due to a high ASA score, non-surgical options are considered. Next, the sensitivity of the tumour histotype to adjuvant therapies (CHT, RX, ...) is considered. If the tumour does not respond to any form of treatment, the only option for the patient is pain relief.
If the patient is operable, the severity of spinal cord compression and neurological damage is evaluated by means of the Frankel score. If there is neurological deficit or paralysis, the possibility of recovery is evaluated on the basis of time from symptom onset. Finally, if in our opinion neurological recovery of the patient is not possible, sensitivity to adjuvant treatments is re-evaluated. If, on the other hand, the patient has acute and ingravescent spinal cord damage, emergency surgery is performed.
If there is no deficit or the damage is recoverable and stable, sensitivity to adjuvant treatments is evaluated. If the tumour histotype is not sensitive and there is a single metastasis only, resection of the lesion is chosen. If, on the other hand, there are multiple metastases and they are treatable, the choice is decompression and stabilisation. When there is no deficit or the damage is recoverable and not ingravescent and the tumour is sensitive to some form of adjuvant treatment, pathological fracture (actual or impending) is evaluated. This parameter is, in fact, decisive in orienting the choice towards either surgical treatment with compression and stabilisation or adjuvant treatment only. Resection of the tumour may be performed en bloc with a wide margin or through debulking. Generally speaking en bloc removal is suggested for hypervascularised tumours, metastases from renal cell carcinoma and from sarcoma and the cases in which this type of operation is easy to perform.

References


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