PATHOLOGICAL FRACTURES OF THE CERVICAL SPINE

PALLIATIVE SURGICAL TREATMENT

MALCOLM W. FIDLER

From the Slotervaart Hospital, Amsterdam

Eleven patients with metastases in the cervical spine had operations for severe pain due to a pathological fracture which, in eight of the cases, was unstable. Conservative treatment had either failed or was unsuitable.

In the first five patients internal fixation with tension band wires and bone grafts was supported by a halo-brace. The method has evolved to the use of posterior instrumentation with laminar wires from two levels above the lesion to two levels below. Stability is increased by the use of bone cement with or without bone autografts applied to one side of the spine. This technique enables the patient to get up within a few days of operation—a great advantage when life expectancy is limited. The operations were successful in all except one case.

Most metastases and minor pathological fractures of the cervical spine can be treated with radiotherapy and cytotoxic agents, while the neck is supported in a collar or simple brace to relieve pain and muscle spasm. When conservative treatment is no longer possible or effective, then operation must be considered. A patient with a spinal metastasis has a limited life expectancy; treatment should ideally relieve pain, prevent or remove compression of the cord or roots, and provide immediate and permanent stability so that the patient can get up and go home as soon as possible.

Eleven patients with cervical spine metastases have had operative treatment during the past five years. At first minimal internal fixation and bone grafts were used, with tension band wires around the laminae and spinous processes and external support from a halo-shoulder brace (van Kempen de Witte 1980). This method has now been superseded by improved internal fixation.

MATERIAL AND METHODS

Details of the 11 patients are given in Table I. Indications for operation. All patients had pain in the neck; this was the main indication for operation. Pathological fractures were present in all 11 patients; in eight cases they were unstable. In one patient (Case 6) the pathological fracture was not only causing severe pain but had also led to a retropharyngeal haematoma which made swallowing difficult. Another patient (Case 5) had a kyphosis such that her chin rested on her manubrium sterni.

Three patients (Cases 1, 5 and 8) had nerve root irritation causing pain to radiate into the shoulder or arm. In all cases either radiotherapy and chemotherapy had failed to control the tumour or the pathological fracture was not suitable for conservative treatment. In order to relieve symptoms before operation, halo traction was provided for patients who had severe pain, marked kyphosis or nerve root compression.

Investigations before operation. Plain radiographs reveal all serious bony lesions (Fig. 1). However, it is essential that the full extent of disease should be known, so that internal fixation can be planned to span all involved vertebrae, including those with normal radiographs. A technetium scan is invaluable in assessing the cervical spine, and also helps detect metastases in the pelvis, at possible donor sites for bone grafts. Unsuspected metastases in the appendicular skeleton may also be identified so that prophylactic internal fixation can be advised (Fidler 1981). However, even a bone scan probably fails to detect lesions under 3 mm in diameter (Galasko 1981).

Computerised tomography (Fig. 2) including sagittal reconstruction, or tomograms in anteroposterior and lateral planes, helps provide a clear three-dimensional understanding of the diseased area. Cervical myelography delineates the extent of cord or nerve root compression, and if this is done before CT scanning, such compression is even more obvious. CT scans also indicate how much room is available for laminar wires at relevant levels in the spine.

If the cause of the defect in a vertebral body is in any doubt, a diagnostic puncture is needed; this is done by a lateral approach for C4 to C7 and by a transoral approach for C1 to C3 (Craig 1956; Ottolenghi 1967). Rarely, a lesion may be localised to a lamina; if so, needle puncture may be dangerous and open biopsy should be combined with the definitive posterior operation (Verbiest 1983).
Prophylactic antibiotics. At operation a metal and cement foreign-body is inserted into a patient who may have a low white blood cell count as one result of chemotherapy. Furthermore, it is possible that cement monomer inhibits leucocyte metabolism (Panush and Petty 1978), making these patients more susceptible to infection. For these reasons cement containing antibiotic is used in addition to prophylactic intravenous antibiotic.

Table 1. Details of 11 patients treated by operation for metastatic tumours of the cervical spine

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Site of primary tumour</th>
<th>Vertebrae involved</th>
<th>Symptoms</th>
<th>Operation</th>
<th>Cement</th>
<th>Autograft</th>
<th>Decompression</th>
<th>Post-operative support</th>
<th>Radiotherapy (rad)</th>
<th>Result</th>
<th>Post-operative survival (months)</th>
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<tbody>
<tr>
<td>1</td>
<td>48</td>
<td>F</td>
<td>Breast</td>
<td>C4-5-6</td>
<td>Neck and right arm pain</td>
<td>Wire C2-7</td>
<td>Bilateral</td>
<td>Right C5</td>
<td>Halo-brace 6 weeks</td>
<td>Pre-operative 4000</td>
<td>Pain relieved</td>
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<td>2</td>
<td>50</td>
<td>F</td>
<td>Breast</td>
<td>C1</td>
<td>Neck pain</td>
<td>Wire C1-5</td>
<td>Bilateral</td>
<td>Right C1-3</td>
<td>Halo-brace 6 weeks</td>
<td>Pre-operative 1500</td>
<td>Pain relieved</td>
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<td>3</td>
<td>59</td>
<td>F</td>
<td>Breast</td>
<td>C2-3</td>
<td>Neck pain</td>
<td>Wire C1-5</td>
<td>Bilateral</td>
<td>Right C2-T2</td>
<td>Halo-brace 8 weeks</td>
<td>Pre-operative 3500</td>
<td>Pain relieved</td>
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<td>F</td>
<td>Breast</td>
<td>C2</td>
<td>Neck pain</td>
<td>Wire C2-7</td>
<td>Bilateral</td>
<td>Right C2-3</td>
<td>Halo-brace 6 weeks</td>
<td>Pre-operative 2000</td>
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<td>5</td>
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<td>Breast</td>
<td>C3-6 T1</td>
<td>Neck and right arm pain</td>
<td>Wire C2-7</td>
<td>Bilateral</td>
<td>Right C4-5</td>
<td>Halo-brace 8 weeks</td>
<td>Pre-operative 2000</td>
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<td>52</td>
<td>M</td>
<td>Stomach</td>
<td>C2</td>
<td>Neck pain</td>
<td>Wire and rods C3-6</td>
<td>Bilateral</td>
<td>Occ-C4</td>
<td>Halo-brace</td>
<td>1 week</td>
<td>Pre-operative 2000</td>
<td>Pain relieved Immediate stability</td>
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<td>56</td>
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<td>Breast</td>
<td>C4-5</td>
<td>Neck pain</td>
<td>Wire and rods C3-6</td>
<td>Bilateral</td>
<td>Occ-C4</td>
<td>Halo-brace</td>
<td>2 weeks</td>
<td>Pre-operative 2000</td>
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<td>C6-7 T1</td>
<td>Neck pain</td>
<td>Wire and rods C6-T3</td>
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<td>Occ-C4</td>
<td>Cervical brace</td>
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<td>9</td>
<td>39</td>
<td>F</td>
<td>Breast</td>
<td>C2</td>
<td>Neck pain</td>
<td>Plate and wire C5-3</td>
<td>Left Occ-C4</td>
<td>Right C5 T3</td>
<td>Cervical brace 3 months</td>
<td>Pre-operative 4200</td>
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<td>Left Occ-C4</td>
<td>Right C5 T3</td>
<td>Cervical brace 3 months</td>
<td>Pre-operative 2400</td>
<td>Pain relieved</td>
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<td>Pain relieved</td>
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Occ. occiput
* Still alive, fusion intact, painfree.
(usually flucloxacillin), beginning just before operation and continuing until the drains have been removed after 24 to 48 hours. Using this regime, there were no infections in this series.

**Technique of operation.** If halo traction had not been necessary beforehand, a halo is applied to the skull once anaesthesia has been induced. This helps to control the head while the patient is turned and also during the operation; it is removed at the end of the procedure.

The patient is placed in a prone position, with the head on a rest extended from the end of the operating table; the position of the cervical spine is checked with an image intensifier. Traction of about 2 kg is maintained on the halo during the operation.

A longitudinal incision in the posterior midline allows muscles and ligaments to be cleared from the spinous processes and the laminae laterally to beyond the posterior facet joints. In the upper cervical spine, the massive spinous process of the axis is an unmistakable reference point. If the posterior arch of the atlas has to be exposed, great care is needed when working above it since the vertebral artery curves forwards around the medial side of the superior articular process, about 1.5 cm from the midline.

Any nerve root which is involved by tumour or fracture is decompressed by removal of the appropriate facet joint and nearby parts of the laminae. If the myelogram and CT scan have shown posterior compression of the cord, then the relevant laminae and metastatic tissue at posterior epidural level are removed: this is unlikely to be needed since most metastases lie anterior to the cord. Any dura or nerve root exposed by decompression is covered with a free fat graft; if either is near bone cement, additional protection is provided by a layer of Sterispon.

The principle of internal fixation for a pathological fracture is to immobilise two vertebrae above and two below the diseased level, using steel supports and laminar wires (Luque 1982). Bone cement is used to supplement the fixation on one or both sides of the spine. When the occiput needs to be included in the fixation, it requires exposure from the posterior margin of the foramen magnum to the inferior nuchal line and for 3 cm on each side of the midline. Fixation of the occiput has recently been facilitated by the use of a specially developed plate (Fig. 3), similar to that described by Vlahovitch and Fuentès (1975). This plate is screwed to the midline of the occiput and fixed to the laminae by wires (Figs 4 and 5). It is essential that the AO screws are placed in the midline, where the bone is about 14 mm thick, rather than in the very thin occipital plates. The screws are inserted using the standard AO technique.

When the patient's life expectancy is short (less than six months) or there is no tumour-free donor area from which autograft can be taken, the metal fixation is reinforced with methyl methacrylate bone cement on both sides of the spine. When life expectancy is better and tumour-free autograft is available, cement is used on one side and cancellous bone strips and chips are applied on the other side after partial decortication of the bed with a powered burr. Radio-opaque cement containing antibiotic (Simplex or Allofix G) is poured into a gutter which is formed by the spinous processes medially, the laminae in front and a strip of moist Sterispon placed laterally which effectively prevents the cement escaping into the muscles. If tumour tissue has been exposed during decompression, the cement is used on this side and a graft, when indicated, on the intact side, so reducing the chance of tumour invading the graft.

**Postoperative care.** Patients are usually allowed up within a day or two of the operation. The new method of internal fixation provides such rigid support that external fixation is usually unnecessary, but despite this a mandibular shoulder brace (van Kempen de Witte 1980) is worn for three months when a graft has been used on one side, in order to minimise the chance of loosening before the autograft is incorporated. After this the brace...
is worn only when the patient is riding in a car; it is a safeguard in case of accident, not only protecting the fusion but also the adjacent mobile segments. **Ancillary treatment.** Unless the patient has already received a maximum dose of radiation, the metastasis should be irradiated. When bone grafting is planned as part of the operation, radiotherapy should preferably be given pre-operatively; during this period the neck, if unstable, can be supported in a halo–cuiass. If grafting is not to be used, postoperative radiation is more convenient, beginning when the wound is satisfactory on about the fifth day. Chemotherapy is added, when this is indicated, but is postponed for six weeks if bone grafts have been used.

**RESULTS**

Details of the patients are given in Table I. They all had complete or almost complete relief of pain after operation. Pain recurred in Case 2 after 11 months and in Case 8 after three months. In Case 2 there was local tumour progression after five months and in Case 7 after two months.

All the spines with metal constructions which incorporated cement were immediately stable and remained so, except in one patient. In this patient (Case 8) one of the affected vertebrae had been destroyed both anteriorly and posteriorly. At operation posterior instrumentation from one level above this lesion to one level below had been combined with anterior resection and cement replacement of the involved vertebral bodies. After three months, uncontrollable progression of the tumour caused collapse, which was not prevented by the minimal posterior fixation, from only one segment above and below the lesion. Another patient developed paraplegia from another metastasis at T1 level 28 months after fixation; her general condition was terminal so no further operation was advised.

**DISCUSSION**

Patients suffering from malignant disease are now surviving longer because of better management, and an aggressive approach to metastases in the cervical spine is becoming more realistic once conservative therapy has nothing more to offer. All of the patients reported here presented with intractable pain and a potentially dangerous fracture of the cervical spine. Only three had symptoms of nerve root compression and none had evidence of anterior cord compression. The major requirement was therefore stabilisation, sometimes with root decompression, rather than anterior decompression of the cord.

The cervical spine may be approached and stabilised from the front or the back. The anterior approach (Robinson and Riley 1975) for the treatment of metastases is only really applicable below C3. Anterior stabilisation has been achieved by replacing the diseased vertebral bodies with methylmethacrylate bone cement (Scoville et al. 1967; Dunn 1977; Harrington 1981), or by a prosthesis (Ono and Tada 1975). Although anterior stabilisation is effective in preventing flexion-compression when the posterior elements are intact (White and Panjabi 1978a), it offers poor resistance to hyperextension and rotation; this may lead to loosening and displacement of anterior cement, as in three of the 10 patients reported by Dunn (1977) and one of the six reported by Harrington (1981).

The posterior approach (Murphy and Southwick 1983) is simple at all levels and much easier than the anterior approach above C3, though special care is needed when passing laminar wires, drilling the occiput or working near the vertebral artery. In this series nine of the 11 patients had metastatic involvement at or above the level of C3.

Posterior stabilisation with bone cement, wires and on occasion plates has been described by Scoville et al. (1967), Dunn (1977), Dunn, Davidson and Anas (1983) and Clark, Keggi and Panjabi (1984). In the early cases of the present series, autografts were used, either alone (Newman and Sweetnam 1969) or combined with wiring of laminae and spinous processes; but external splintage was then essential until the graft had consolidated. To achieve immediate rigidity, bone cement secured to the spine by wires was necessary. Biomechanical testing (Panjabi et al. 1977) and canine experiments (Whitehill et al. 1984) have shown that the wiring of spinous processes combined with cement can fail; so wiring of the laminae (Luque 1982) became the method of choice. The Luque technique is now established in the treatment of scoliosis and has recently been used for thoracolumbar instability due to malignant disease (Flatley, Anderson and Anast 1984). It has the advantages of spreading the load of fixation over all instrumented levels and of minimising stress concentrations on the end laminae of the fused segment (Wenger et al. 1982). The possible complication that laminar wires may cause pressure on the dura (Herring and Wenger 1982) should not, however, be forgotten.

For spinal instrumentation in the treatment of thoracolumbar fractures, Luque, Cassis and Ramirez-Wiella (1982) recommended that three levels above and three levels below an unstable fracture should be immobilised. Since the load on the cervical spine is considerably less than that on the thoracolumbar spine, only two levels above and below the diseased vertebrae were included in this series. This also preserves more mobile segments, and the compromise, supported by bone cement, has proved to be effective.

Allen and Ferguson (1982) emphasised that the stability of Luque instrumentation was improved when the wires held the rods firmly against the laminae, rather than when the wires spanned a gap between rod and bone. Cement acts as a non-compressible spacer between bone and metal and thus enhances stability. The thin layer of granulation tissue which forms between cement and bone after total hip and knee replacement (Charnley...
obtained present dura a the causing the the cement as a spacer.

The best possible interdigitation of cement is obtained by using a low viscosity type such as Simplex (Noble and Swarts 1983) or Allofix G immediately after mixing so that it will flow around the metal and into all the nooks and crannies of the exposed bone. Because of the almost perfect fit between bone and cement, no movement is possible while the cement is held in place by the laminar wires. Such rigid fixation is, however, very stiff (Whitehill et al. 1983) and, especially if it includes the skull, must subject the next mobile segment to excessive strain (White and Panjabi 1978b). This has not yet caused a problem, but patients are advised to protect their necks with a brace when there is the possibility of a sudden jolt, such as could happen when they are riding in a car.

One possible objection to the use of cement near the dura or the nerve roots is the fear of thermal damage. However, the temperature at the cement–bone interface is less than 48°C, some 8°C lower than the temperature causing denaturation of protein (Reckling and Dillon 1977), and the canine experiment of Scoville et al. (1967) has shown this fear to be unfounded provided that care is observed. In the reported operations, exposed nerve root or dura was covered by a free-fat graft, with the further protection of a 5 mm layer of Gelfoam; cement was cooled with saline during polymerisation. There were no untoward effects. No cardiovascular complications of cement were seen (Burwell 1974; Andersen 1983), probably because of the lack of pressurisation and the ease with which excess monomer could escape from the open wound. Six patients had fixation which included cement and five had no cement. Both groups had relief of symptoms but those in whom cement was used had the advantage of rapid postoperative mobilisation without external fixation.

Although the combination of steel supports, laminar wires and cement provides excellent fixation, there is the possibility that even the laminar wires could eventually break (Bernard et al. 1983) or cut out and the fixation work loose (Dunn 1977). Because of this, autografts were added when the life expectancy was more than six months. All but one (Case 8) of our cases with autografts have remained solid up to the current maximum follow-up of two and a half years.

One disadvantage of the posterior approach is that normally tumour tissue is not removed; radiotherapy or chemotherapy is relied on to treat the metastasis. However, a metastasis of the cervical spine is usually small and reducing its bulk by resection probably has little effect. None of the patients in this series or in that of Clarke et al. (1984) have developed cord compression after operation. The posterior approach also has the advantage that any bone graft is usually a long way from the metastasis and therefore is not easily invaded by extension of the tumour.

Ancillary radiotherapy should be given whenever possible, but the dose given previously and the danger of radiation myelopathy (Palmer 1972; Kagan et al. 1980) must be borne in mind. In the cases involving the cervical spine reported by Fielding, Pyle and Fetti (1979) and by Harrington (1981) there were no recurrences in those who each had total radiation of 3000 to 5000 rads; the two cases not irradiated developed local recurrence. In the present series three patients had local progression. The effect of radiation on bone grafts is not known but it has a deleterious effect on the healing of fractures in the absence of rigid internal fixation (Bonarigo and Rubin 1967). Although the fixation technique described here rigidly stabilises the vertebrae, grafts are held in place only by soft tissues and at first may move a little. Radiotherapy, when possible, is therefore given pre-operatively or else postponed to at least six weeks after operation, to give the best chance of the graft taking. Cement is not a significant impediment to radiotherapy and cement is not itself affected by radiation (Murray, Bruel and Lindberg 1974; Eftekhar and Thurston 1975).

Little is known of the effect of chemotherapy on the incorporation of autografts, but azathioprine does not affect the healing of autografts in dogs (Burchardt, Glóczweskie and Enneking 1977) whereas methotrexate and Adriamycin increase the chance of failure (Burchardt, Glóczweskie and Enneking 1983). Until the effect of each chemotherapeutic agent on autograft incorporation is known, it is probably best to delay operation until the blood picture has recovered from the most recent treatment and to avoid chemotherapy for six weeks after any grafting operation.

The postoperative survival times of the patients in this series ranged from one month to two and a half years, similar to those reported by Dunn (1977) and by Harrington (1981). These times are short, but at the time of operation all the patients had advanced disease and no more conservative treatment was possible. The quality of remaining life was improved.

CONCLUSIONS

Posterior stabilisation by operation is a useful addition to the treatment of patients suffering from metastases in the cervical spine. It removes or reduces pain and allows the patient to resume a comfortable, mobile and independent existence.

The use of posterior segmental instrumentation with bone cement effectively stabilises the cervical spine at any level. Involved nerve roots can be decompressed, though serious anterior cord compression would require additional anterior decompression. When life expectancy is less than six months, stabilisation with metal and cement alone is advised, whereas an expectancy of over six months merits an additional autograft to help provide long-term stability.
Ancillary radiotherapy, when possible, is best given before operation. Postoperative radiotherapy or chemotherapy should probably be postponed for some weeks if bone has been grafted. The cooperation of surgeon, radiotherapist and oncologist is essential.

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