Treatment of odontoid fractures in cancer patients

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A series of 18 patients with odontoid fractures due to metastatic cancer were treated at Memorial Sloan-Kettering Cancer Center between 1974-1980. The primary source of cancer was breast (12 cases), lung (two cases), nasopharynx (one case), multiple myeloma (one case), colon (one case), and rhabdomyosarcoma (one case). The clinical features consisted of severe neck pain and neck stiffness in 17 patients; signs of cord compression were noted in only four patients. Tomography and computerized tomography were useful in identifying both the osseous and soft-tissue involvement by tumor. Initial treatment in all patients except those with myelopathy consisted of high-dose steroids, and immobilization in a hard collar. Ten patients were treated with radiation therapy alone; six patients underwent surgical fusion (four before and two after radiation therapy); and two patients died before completion of treatment. Conservatively treated patients were allowed to walk with the support of only a collar following radiation therapy. We believe that the initial management of patients with odontoid fractures secondary to cancer should be high-dose steroids and radiation therapy, unless displacement is marked. Assessment for surgical fusion should be made following radiation therapy, since conservative treatment may suffice in most patients. Early recognition is important so that treatment can be instituted before C1-2 subluxation becomes severe.

KEY WORDS • atlantoaxial subluxation • odontoid fracture • cervical spine • metastatic tumor • atlas • axis

Fractures of the odontoid process in patients with cancer are most often secondary to destruction of the axis, and represent an important subgroup of vertebral metastases from systemic cancer. Involvement of the axis is usually caused by hematogenous dissemination of tumor, but direct extension from an adjacent neoplasm may occasionally be responsible. The resultant instability at the atlantoaxial junction poses a small but significant risk of cord transection, and early recognition and treatment is warranted.

Unlike patients with traumatic fractures, cancer patients often have involvement of the spine at several levels, and may have metastases to other organ systems. Prolonged recumbency is not desirable in these patients because they may have hematological abnormalities that render them more susceptible to thromboembolic phenomena. In addition, the presence of associated epidural tumor at the involved vertebral level requires radiation therapy, and is an important aspect in treatment planning. Although the surgical literature stresses that significant palliation may be obtained in selected patients by posterior fusion, it is apparent that many patients may not be suitable candidates for surgery. We have, therefore, analyzed our experience during the past 7 years with this group of patients to determine the optimal therapy, and to decide on the indications for surgery.

Summary of Cases

Clinical Symptoms

The records of 18 patients with pathological odontoid fractures treated at Memorial Sloan-Kettering Cancer Center between 1974 and 1980 were reviewed. Twelve patients were female, and six were male. Their ages ranged from 8 to 70 years (median, 56 years). Of the 12 female patients, breast cancer represented the primary neoplasm in 11 and lung cancer was the primary neoplasm in the remaining patient. In the six male patients, the primary source was different in each, namely, colon, lung, nasopharynx, breast, rhabdomyosarcoma, and multiple myeloma. The follow-up period ranged from 4 months to 5 years in patients who are still alive; all patients who died were followed until the time of death.
The clinical symptom in all except one of these patients was typically one of neck pain with suboccipital headache. Minor trauma was the precipitating event in three patients. Four other patients had associated radicular symptoms and signs referable to the upper extremities. Symptoms of cord compression consisting of weakness in the lower extremities or hemisensory deficits were noted in only four patients. Two patients had involvement of the lower cranial nerves due to metastatic tumor at the base of the skull. These symptoms had been present for several weeks, and in some cases for almost 2 months before the diagnosis of odontoid fracture was made. In one patient with colon cancer, pain and stiffness of the neck was the presenting problem that brought him to the attention of a physician. On examination, all patients had neck stiffness with limitation of flexion and extension of their necks. Rotational movements were, in particular, markedly impaired. Often, tenderness of the suboccipital region could be elicited on deep palpation. Although hyperreflexia was noted in the majority of patients and positive Babinski signs were present in seven patients, actual weakness of the lower extremities on neurological examination was seen in only four patients. The interval between the diagnosis of cancer and diagnosis of odontoid fracture varied considerably (0 to 14 years), with a median of 3 years.

**Radiological Features**

The diagnosis of odontoid fracture with atlantoaxial subluxation was easily established by plain lateral radiographs in 17 patients (Fig. 1). In one patient, plain x-ray films were unrevealing, and the diagnosis was made following tomography (Fig. 2). In three patients, initial cervical spine x-ray films were obtained because of neck pain and were thought to be normal. Neck pain persisted, and reevaluation several weeks later showed lytic lesions of the C-2 vertebra with minimal subluxation. Both the direction and degree of displacement of the odontoid process were analyzed using criteria established for traumatic lesions. Of the 15 patients who had anterior displacement of the odontoid, six patients had minimal displacement (less than 4 mm), seven had moderate displacement (5 to 8 mm), and two had marked displacement (greater than 8 mm). In three patients, there was retrodisplacement of the odontoid process. In contrast to traumatic fractures, where the base of the odontoid is most often involved, the majority of our patients had either lytic destruction of the body (11 patients), or extensive disruption of the entire C-2 vertebra (six patients). In only one patient was a fracture line demonstrated running through the base of the odontoid process. Computed tomography (CT) was performed in seven patients to delineate extension of the tumor into both bone and soft tissue, and provided additional information with respect to the presence of epidural tumor (Fig. 3). Myelography was performed initially in three
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patients, and was used mainly to assess treatment following radiation therapy. In 13 patients (72%), there was associated involvement of the spine, either in the lower cervical region or the thoracic region (Fig. 4).

*Treatment*

Of the 18 patients, two did not complete their course of radiation therapy, and died within 30 days. One of these deaths was attributable to progressive systemic carcinoma, but the second death was caused by hypoxic encephalopathy, presumably secondary to epidural tumor at the Cl-2 junction which resulted in cord compression. This patient had been in cervical traction at the time of death. Five patients were initially considered candidates for surgery. These patients were placed in skeletal traction to realign the cervical spine preparatory to surgery. One patient sustained a myocardial infarction and, therefore, surgery was not performed. The remaining 11 patients were treated initially with a collar support and radiation therapy to the entire cervical spine. Total dose used was between 2000 and 3000 rads administered in 1 to 2 weeks. All these patients were also treated with high-dose steroids (dexamethasone, 4 mg every 6 hours) after the diagnosis had been established, and steroid coverage was maintained during the course of radiation therapy. In one patient, persistent pain and rotatory subluxation were noted following radiation therapy, and surgery was performed after completion of radiation. An additional patient underwent surgery because increased displacement was noted following radiation therapy.

The surgical treatment in six patients consisted of realignment of the spine with skeletal traction. These patients were placed on a Stryker frame, and, under fluoroscopic control to check proper alignment, the laminae of C-1 through C-3 were wired together with No. 20 stainless steel wire. While the patients were in the prone position, the alignment was reevaluated by lateral spine x-ray films taken with an image intensi-
had marked pain relief, but was noted to have further displacement at the C1–2 junction. Evidence of osseous union was seen in three patients on follow-up x-ray films after 6 months, even though there was residual subluxation. Repeat myelography following radiation therapy showed resolution of epidural tumor without instability at the C1–2 junction. The median survival of the conservatively treated group of patients was 6 months, but three patients with breast cancer are still alive more than 1 year after diagnosis. All conservatively treated patients could walk with only a hard collar for support. In those patients who died, death was attributable to progression of systemic cancer rather than acute cord transection.

**Discussion**

The treatment of traumatic odontoid fractures with atlantoaxial subluxation has been the subject of controversy. Immediate fusion of C-1 through C-3 has been advocated to allow early ambulation and prevent the consequences of delayed myelopathy. The rationale for this approach was based on the belief that conservative treatment was associated with a high incidence of delayed or non-union. Recently, conservative treatment with various forms of cervical orthoses in patients with minimally displaced fractures has given equally good results. In patients with cancer, the goal of treatment is to alleviate pain, relieve compression of the spinal cord, and preserve stability of the cervical spine. The therapeutic approach in these patients should take into consideration their limited life expectancy and extent of systemic disease.

Early clinical recognition of cervical osseous metastases is important because radiation therapy can be instituted before misalignment becomes evident. Most of our patients had severe cervical and suboccipital pain for several weeks to months before the clinical diagnosis became apparent. Even if plain radiographs are negative, radionuclide bone scans and tomography should be performed in patients who present with severe suboccipital pain and neck spasm.

Following diagnosis, the initial management of these patients would depend on the degree of displacement and osseous destruction, and extent of neurological findings. In patients with minimal displacement, immobilization in a hard collar (Philadelphia collar) and recumbency are indicated. Although more rigid forms of cervical orthoses, such as the halo device, are more effective in limiting movement of the cervical spine, patients feel more comfortable with the collar and it has proven just as effective. These patients should then be treated with high-dose steroids and given a course of radiation therapy (2000 to 3000 rads). Following therapy, these patients may be permitted to walk in a hard collar. Continued assessment of potential neck instability is mandatory until radiographic evidence of fusion is visible. Even in patients...
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with moderate displacement, we would advocate a trial of recumbency and external immobilization in a hard collar. Since cord compression is likely to be due to epidural tumor rather than mechanical deformity, we believe that these patients require high-dose steroids and emergency radiation therapy\(^6\) (Fig. 5). We have shown that early aggressive radiation therapy along with steroid therapy will produce marked symptomatic and objective relief of cord compression in most patients with epidural and osseous involvement by systemic cancer.\(^8\)\(^,\)\(^9\) The wide sagittal diameter of the C1–2 junction affords an additional significant margin of safety, and allows initial conservative treatment to be given without deterioration of neurological function.\(^8\) No evidence of neurological deterioration was noted in any patient in our series treated in this fashion. Following radiation therapy, these patients may then be ambulated gradually. Persistence of pain and neurological symptoms at the end of radiation therapy may indicate mechanical instability at the atlantoaxial junction, and the need for surgical stabilization should be reassessed. Immediate skeletal traction should be considered only in those patients with marked displacements or significant cord compression. These patients may frequently have osseous metastases to the skull, and placement of the skeletal device must be planned after evaluation of skull films.

Plain tomography and CT are extremely helpful in delineating the osseous destruction, misalignment, and associated soft-tissue mass. Patients with cancer often have involvement of the neural arch or other cervical vertebrae; in our series, 72\% had involvement at multiple levels in the cervical region. Myelography is rarely indicated if suspicion of instability exists, but is useful in assessing response to radiation therapy.

Surgical fusion should be considered, depending on the variables of displacement, instability, pain, and prognosis. Patients with significant displacement requiring skeletal traction or those with persistent pain following radiation therapy would be candidates for surgical fusion. Our experience indicates that patients with breast cancer in particular have a median survival of at least 1 year, despite bone involvement at multiple sites, and we believe surgical stabilization should be strongly considered in this group of patients. In performing cervical fusion, immediate fixation by wiring the laminae of C-1 through C-3 and reinforcement with methyl methacrylate provide immediate stabilization.\(^7\)\(^,\)\(^10\) The longest survivor in our series so treated has lived more than 5 years with excellent alignment and no instability of the cervical spine. Recently, however, the use of autogenous bone graft in patients with neoplastic disease of the spine suggests that this type of graft may be desirable in expected long-term survivors.\(^6\) Since two patients showed further destruction of the lower cervical vertebrae, consideration should be given to extending the fusion below C-3 in patients who exhibit radiographic evidence of osseous metastases in the lower cervical vertebrae.

Timing of radiation therapy in these patients is still an unsettled issue. The patients treated earlier in this series all underwent radiation therapy following surgery. Although radiation therapy may be given after fusion without apparent deleterious effects on the bone graft,\(^8\) we currently believe that a prior course of radiation allows more effective treatment of the epidural tumor. This treatment can be initiated immediately upon diagnosis, and may provide complete resolution of neurological symptoms without the need for surgical intervention. Three (all with breast carcinoma) of the five conservatively treated patients who lived more than 6 months showed radiological evidence of fusion of the odontoid process. They had no instability at the atlantoaxial junction on flexion-extension views. Even though residual subluxation was apparent in these patients, this result is acceptable in patients with limited life expectancy. Two patients (both with lung carcinoma) failed to show radiological evidence of union. The type of tumor may be critical in determining the outcome of the healing process, since breast carcinoma is a relatively radiosensitive tumor.

**Conclusions**

1. Odontoid fractures in cancer patients are most often secondary to lytic destruction of the C-2 vertebra, and early recognition and treatment prior to subluxation is important.
2. Minimally displaced fractures can be treated conservatively by placing the patient in a hard collar and giving radiation therapy alone.
3. Even in moderately displaced fractures, initial management with a collar and radiation therapy will provide symptomatic and objective relief in the majority of patients.
4. Surgical fusion is indicated in selected patients with marked displacement, persistent symptoms following radiation therapy, and in those patients with a reasonable life expectancy.

**References**


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