Case Report

Removal of a Vertebral Metastatic Tumor Compressing the Spinal Nerve Roots via a Single-Port, Transforaminal, Endoscopic Approach Under Monitored Anesthesia Care

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Free full manuscript: www.painphysicianjournal.com Spinal cord or nerve root compression from an epidural metastasis occurs in 5-10% of patients with cancer and in up to 40% of patients with preexisting nonspinal bone metastases. Most metastatic spine diseases arise from the vertebral column, with the posterior half of the vertebral body being the most common initial focus, and/or the paravertebral region, tracking along the spinal nerves to enter the spinal column via the intervertebral foramina.

An 82-year-old man diagnosed with sigmoid colon cancer and liver metastases experienced intractable pain described as being like an electric shock on the right T11 dermatome. Imaging studies revealed a huge metastatic mass destroying the right posterior T11 body and pedicle and compressing the right posterior spinal cord and nerve roots.

Even after using neuropathic medication and a neural blockade, the extreme paroxysmal pain continued. Considering his elderly, debilitated state and life expectancy, removal of the vertebral metastatic tumor compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach and percutaneous vertebroplasty (PVP) under monitored anesthetic care (MAC), rather than 3-port endoscopic surgery and corpectomy with or without fusion under general anesthesia with lung deflation, was decided upon and scheduled prior to radiotherapy.

A needle was placed into the intervertebral foramen under fluoroscopy in the same manner as a transforaminal epidural block at T11. A guidewire was inserted into the needle after the needle stylet had been removed. An obturator dilator was inserted over theguidewire, and a working sleeve was inserted over the dilator. After the dilator was removed, a spinal endoscope with a 2.7 mm working channel was placed over the guidewire. Careful removal of the tumor emboli during verbal interaction with the patient was performed under MAC using dexmedetomidine, fentanyl, and ketorolac. PVP at T11 was performed through the right osteolytic pedicle. The paroxysmal pain disappeared immediately after the operation without any complications.

Removal of a vertebral metastatic tumor compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach under monitored anesthesia care without lung deflation may be an effective and safe modality for minimally invasive pain management of a single-level spinal tumor metastasis causing intractable radicular pain in patients with cancer who have generalized debilitation.

Key words: Combined anesthetics, endoscope, intractable pain, minimally invasive, neoplasm metastasis, palliative care, radiotherapy, spinal nerve roots, surgical procedures, vertebroplasty.

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urgical intervention, including decompressive surgery for the treatment of metastatic epidural spinal cord or nerve root compression before radiotherapy, is recommended for carefully selected patients with a single site of cord or nerve root

compression who are fit for surgery and have not been paraplegic for more than 48 hours (1).

Metastatic disease is revealed postmortem in approximately 70% of patients who die of cancer. The spinal column is the most common osseous site of metastatic deposits. Spinal involvement may occur in up to 40% of patients with cancer. Spinal cord or nerve root compression from an epidural metastasis occurs in 5-10% of patients with cancer and in up to 40% of patients with preexisting nonspinal bone metastases. Among patients with bony spinal disease, 10-20% develop symptomatic spinal cord compression. Most metastatic spine diseases arise from the vertebral column, with the posterior half of the vertebral body being the most common initial focus, and/or the paravertebral region, tracking along the spinal nerves to enter the spinal column via the intervertebral foramina. The thoracic spine is the most common site of disease (70%), followed by the lumbar spine (20%), and the cervical spine (10%) (2).

Treatment options available for metastatic spine tumors include radiation therapy, surgery, and chemotherapy. Radiotherapy is accepted as the first-line choice for most patients with metastatic spinal tumors (3). For the endoscopic removal of thoracic metastatic tumors, at least 3 ports, including an endoscopic port, a working port, and a suction port, have been placed using deflating of the ipsilateral lung under general anesthesia with somatosensory-evoked potentials and motor-evoked potentials monitoring (4). However, both single-port minimally invasive endoscopic spine surgery using the transforaminal approach without the need for lung deflation and patient-cooperative monitored anesthesia care (MAC) using dexmedetomidine and intravenous opioid/nonopioid analgesics in the prone position dramatically improve surgical outcomes for elderly, debilitated patients with cancer.



Fig. 1. Preoperative imaging studies revealed a huge metastatic mass destroying the right posterior T11 body and pedicle and compressing the right posterior spinal cord and nerve root. (A) Sagittal view of positive emission tomography. (B) Axial T1-weighted magnetic resonance imaging. Here we describe a successful case of removing a vertebral metastatic tumor that was compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach under MAC without lung deflation, which demonstrated an effective and safe modality of minimally invasive pain management for a single-level spinal tumor metastasis causing intractable radicular pain before radiotherapy in a generalized debilitated patient with cancer.

CASE REPORT

An 82-year-old man diagnosed with sigmoid colon cancer and liver metastases was referred to our pain clinic because of constant, intractable pain described as being like an electric shock on the right T11 dermatome that prevented him from sleeping. The pain was aggravated by position change from lying to sitting and from sitting to standing or walking. He rated his pain as 8-10 on the verbal numeric 0-10 rating scale. His daily medication for neuropathic and somatic pain was 300 mg pregabalin, 100 mg nortriptyline, 200 mg tramadol, codeine-containing nonsteroidal anti-inflammatory drugs, 22.5 mg dexamethasone, 80 mg oxycodone, and a 50 μ g/h transdermal fentanyl patch. Despite this, the patient rated his pain 7/10.

A physical examination revealed severe tenderness of the T11 spinous process, suggestive of a vertebral compression fracture. A huge metastatic mass destroying the right posterior body and pedicle, and compressing the right posterior spinal cord, dorsal, and ventral nerve roots, dorsal root ganglion, and spinal nerve was revealed on abdominal computed tomography (CT) in a previous work-up for the evaluation of the cancer's progression. He had already undergone colon stent placement for an obstructed lumen because his general condition was poor and he was unable to receive open surgery. Magnetic resonance imaging, positron emission tomography, and bone scans were performed to further evaluate the detailed pathology of the compression of the nerve structures and metastasis to other organs (Fig. 1).

The patient agreed to undergo both removal of the vertebral metastatic tumor compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach and percutaneous vertebroplasty at T11 via the right pedicle under MAC without lung deflation before radiotherapy. Informed consent was obtained for the risks of dural puncture, spinal cord or nerve root damage, hemorrhage, and infection due to endoscopy and cement embolism, as well as needle-induced spinal cord damage, cement leakage into the posterior wall of the vertebral body, infection, and bleeding after vertebroplasty. A 5% lidocaine patch was applied to the anticipated skin site of the endoscopy and vertebroplasty one hour before the procedure.

Basic monitoring included noninvasive blood pressure, pulse oximetry, electrocardiography, capnography, and bispectral index. After a skin test, one g of cefazolin was injected intravenously 30 minutes before the procedure. Dexmedetomidine was started with 0.5 μ g/kg over 10 minutes for a loading dose, followed by titration to induce an appropriate sedative level with dosage of 0.3-0.5 μ g/kg/h. The patient was placed in a prone position. Fifty micrograms of fentanyl and 30 mg of ketorolac were administrated for analgesia followed by skin infiltration with 10 mL of 1% lidocaine.

A 6-inch-long, 18-gauge needle was placed into the intervertebral foramen under fluoroscopy in the same manner as a transforaminal epidural block at T11. Contrast medium was injected to confirm the needle placement in the posterior epidural space. Spread of the contrast medium was observed within the posterior epidural space below the injection level and into the distal part of the spinal nerve; however, no spread was seen into the anterior epidural space or the posterior epidural space above the injection level. The skin was incised around the inserted needle. A guidewire was inserted through the needle after the needle stylet had been removed. An obturator dilator was inserted over the guidewire, and its location was confirmed under fluoroscopy. A working sleeve was inserted over the dilator and tightly fixed with a holder. After the dilator was removed, the working sleeve with the guidewire was observed inside the intervertebral foramen on the lateral fluoroscopic view. The guidewire was then removed, and a 30° spinal endoscope with a 2.7 mm working channel was inserted into the working sleeve (Fig. 2).



Fig. 2. Intraoperative steps for placing a spinal endoscope using the transforaminal approach. (Upper first to third: oblique, anteroposterior, and lateral views) A 6-inch long, 18-gauge needle was placed into the intervertebral foramen under fluoroscopy in the same manner as a transforaminal epidural block at T11. (Upper fourth and fifth: lateral and anteroposterior views). Contrast medium was injected to confirm needle placement in the posterior epidural space. The contrast infiltrated into the posterior epidural space below the injection level and the distal part of the spinal nerve; however, it could not be disseminated into the anterior epidural space or the posterior epidural space above the injection level. (Middle first) The skin was incised around the inserted needle. (Middle second) A guide-wire was inserted through the needle after the needle stylet was removed. (Middle third and fourth) An obturator dilator was inserted over the guidewire and its location was confirmed under fluoroscopy. (Middle fifth) A working sleeve was inserted over the dilator. (Lower first) The working sleeve was tightly fixed with a holder. (Lower second) A fter the dilator was removed, the working sleeve with the guidewire inside the intervertebral foramen was observed on the lateral fluoroscopic view. (Lower third) The guide-wire was removed. (Lower for ablation and coagulation was inserted into the endoscope. (Lower fifth) The endoscope with the radiofrequency system for ablation and coagulation was inserted into the endoscope. (Lower fifth) The endoscope with the radiofrequency system tip inside the working sleeve on the lateral fluoroscopic view.

The endoscope was first placed dorsally at the 12 o'clock position, ventrally at the 6 o'clock position, cephalically at the 3 o'clock position, and caudally at the 9 o'clock position. Forceps for removal of the tumor mass and a bipolar radiofrequency system for ablation and coagulation were inserted into the endoscope. As soon as the endoscope was inserted, the tumor emboli were located from the 3 o'clock to the 9 o'clock position, and blood-tinged, bright-yellow epidural fat was located at 12 o'clock within the working channel. After the tumor and epidural fat were removed, yellow-colored ligamentum flavum was located from the 2 o'clock to 9 o'clock position. A white transforaminal ligament was located on the right of the tip of the bipolar radiofrequency instrument. Tumor emboli obscured the endoscopic field on the bottom from the 3 o'clock to 9 o'clock position. After the tumor mass was removed, a white, waxy, soft, and detached transforaminal ligament was observed to be hanging from the 9 o'clock position to the middle of the visual field. It was difficult to differentiate the normal structures from the tumor emboli. Forceps were used to detach the tumor emboli from the dorsal root ganglion. In the distant view, a transforaminal ligament at the 9 o'clock to 10 o'clock position and the ventral root and dorsal root ganglion in the middle from the 11 o'clock to 5 o'clock position were seen. In a more distant view, tumor emboli surrounded the nerve structures from the bottom. In the close view, after the tumor mass located at the bottom of the field was removed, a tumor mass was observed over the dorsal root ganglion. The congested dorsal root ganglion was seen more closely from the 1 o'clock to 7 o'clock position, while the ventral root passed parallel to the dorsal root ganglion from afar from the 11 o'clock to 8 o'clock position. The nerve structures were seen clearly after the tumor's removal (Fig. 3).

The patient's skin was closed after the endoscope's removal. Percutaneous vertebroplasty at T11 was performed via the right pedicle. Finally, a piroxicam patch was applied for incisional pain. The patient's radicular pain disappeared immediately after the procedure. Postoperative CT confirmed partial removal of the tumor mass around the neural structures at the right foramen and the filling of the right vertebral body with bone cement (Fig. 4). The patient was able to walk without pain or complications after 2 hours of bed rest and then lived pain-free for 45 days.

DISCUSSION

We describe a successful case of removing a vertebral metastatic tumor compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach u under MAC without deflating the lung. This treatment was shown to be an effective and safe modality of minimally invasive pain management for a single-level spinal tumor metastasis causing intractable radicular pain before radiotherapy in a patient with cancer who had generalized debilitation and did not respond to medication.

Patients will not agree that a minimally invasive procedure was actually minimally invasive if extreme pain is felt during the procedure (5). It is important that appropriate analgesic methods be used in minimally invasive single-port endoscopic procedures. The introduction of dexmedetomidine to the field of minimally invasive spinal procedures in the prone position has become well accepted due to good intraoperative patient cooperation with minimal respiratory depression and some analgesic effect of an alpha-adrenergic agonist (6). In addition, the application of preoperative lidocaine may help alleviate intraoperative pain while postoperative piroxicam patches may help alleviate postoperative pain. Preoperative intravenous fentanyl and ketorolac ensure intraoperative analgesia together with local lidocaine infiltration. In fact, our patient felt complete relief from the radicular pain immediately after the tumor mass was removed from the nerve structures during the palliative decompressive procedure. We completed the endoscopic procedure without interruption by using MAC with dexmedetomidine.

Pain physicians are accustomed to fluoroscopyguided intervention using a bull's-eye technique (also known as the tunnel view technique, a coaxial technique in which a needle is placed parallel to an X-ray beam). A transforaminal epidural block is the best way to approach the dorsal root ganglia in the thoracic vertebrae from the posterolateral aspect of the back without risking a pneumothorax or resecting the bony structures.

In this case, the ligamentum flavum was visible immediately after the tumor mass was removed. It is safer not to remove the ligamentum flavum because the dural membrane is located beneath it. There are 5 types of transforaminal ligaments: the superior corporo-pedicular ligament, the inferior corporo-pedicular



Fig. 3. Intraoperative endoscopic views. (Upper left) Tumor emboli are located from the 3 o clock to 9 o clock position and blood-tinged, bright-yellow epidural fat is located at the 12 o'clock position within the working channel. (Upper middle) After the tumor and epidural fat had been removed, yellow-colored ligamentum flavum is located from the 2 o'clock to 9 o'clock position. (Upper lower) {???} A white transforaminal ligament is seen on the right of the tip of bipolar {???}radiofrequency instrument. Tumor emboli obscure on the bottom the endoscopic field from the 3 o'clock to 9 o'clock position. (Middle left) A white, waxy, soft, and detached transforaminal ligament, suggestive of the superior corporo-pedicular ligament, is hanging from the 9 o'clock position into the middle of the visual field. It is difficult to identify the nerve structures due to the tumor emboli. (Middle middle) Forceps are used to remove the tumor emboli from the dorsal root ganglion. (Middle right) In the distant view, a transforaminal ligament at the 9 o'clock to 10 o'clock position and the ventral root and dorsal root ganglion in the middle from 11 to 5 o'clock position are shown. (Lower left) In the more distant view, tumor emboli surround the nerve structures at the bottom. (Lower middle) In the close view, after removal of the tumor mass at the bottom of the field, a tumor mass is seen over the dorsal root ganglion. (Lower right) The congested dorsal root ganglion is seen more closely from the 1 o'clock to 7 o'clock position, while the ventral root passes parallel to the dorsal root ganglion from the 11 o'clock to 8 o'clock position. The tumor mass has been removed from the nerve structures. A small white intraforaminal ligament is observed between the dorsal nerve ganglion and the ventral nerve root at the center of the endoscopic field.

ligament, the superior transforaminal ligament, the mid-transforaminal ligament, and the inferior transforaminal ligament. There are also intraforaminal ligaments that connect the periosteum and transforaminal ligaments to the nerve root sleeves and vessels within fatty areolar tissue. These intraforaminal ligaments extend around the transforaminal ligaments, periosteum, and vessels to the nerve root (7). The resistance encountered when the needle is passed into the intervertebral foramen originates from the penetration of one of these transforaminal ligaments. The disconnected superior corporo-pedicular ligament was visible in this case, and a small, white intraforaminal ligament was observed between the dorsal nerve ganglion and



Fig. 4. Postoperative computed tomography confirmed removal of the tumor mass from around the neural structures at the right foramen and the filling of the right anterior vertebral body of T11 with bone cement. The red arrow indicated the filling of bone cement.

the ventral nerve root in the center of the endoscopic field. Pain physicians are accustomed to the anatomical structures of the intervertebral foramen and can perform endoscopic decompression of tumor masses under fluoroscopy without complications.

In general, most surgeons agree that excisional surgery should be performed only in patients with an esti-

4.

mated life expectancy of at least 3 months (2). According to Tokuhashi's revised evaluation system for judging the prognosis of metastatic spine tumors (8), the present patient's total score was 8/15, and his preoperative life expectancy was estimated to be no more than 6 months. Surgical intervention including, decompressive surgery for the treatment of metastatic epidural spinal cord or nerve root compression before radiotherapy, is recommended for carefully selected patients with a single site of cord or nerve root compression who are fit for surgery and have not been paraplegic for more than 48 hours (1). The traditional thoracoscopic approach to the lower thoracic spine of T10-T12 requires combination use of 3-ports and thoracoscopic and retroperitoneal approaches (9). In our case, we used a single-port transforaminal approach with 2.7 mm spinal endoscope that combined an endoscopic port, a working port, and an irrigation water input within a working channel used for a suction port under MAC.

CONCLUSION

Removal of a vertebral metastatic tumor compressing the spinal nerve roots via a single-port, transforaminal, endoscopic approach under monitored anesthesia care without lung deflation may be an effective and safe modality for minimally invasive pain management of a single-level spinal tumor metastasis causing intractable radicular pain in patients with cancer who have generalized debilitation.

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