Minimal Invasive Approaches in Primary Spinal Tumors

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ABSTRACT
There has been a great evolution in minimally invasive surgical techniques for the spinal surgery due to developments in diagnostic imaging. Less perioperative pain, less blood loss, less hospitalization time, protection of spine biomechanics, fast recovery and less morbidity in medically debil patients are the advantages of minimally invasive surgical techniques.

Radiotherapy, chemotherapy or combining both treatments are the standard treatment options for spinal tumors following surgery. Standard open approaches are not suitable for some patients due to limited life expectancies, high surgical complication rates and decrease in quality of life. Minimal invasive techniques represent a major advance in minimizing approach-related morbidity in the treatment of spinal tumors.

Thanks to the evolution of minimally invasive surgical techniques for spinal surgery, minimally invasive techniques are now an alternative treatment to standard open approaches for the treatment of spinal tumors. There has been a trend toward the minimalization of spine surgery due to the lower complication rates.

KEY WORDS: Minimally invasive, spine, surgery, tumors

INTRODUCTION

Standard open approaches to treat spinal tumors have complication rates reaching 30%. Neurological deterioration, wound infections and cerebrospinal fluid (CSF) leaks (1, 24, 42) are the common complication that may be seen. Complications after anterior open approaches (thoracotomy) including hemotorax, chylothorax, atelectasis may develop (15). Most of the patients with spinal tumors are debilitated and under high risk of major surgical morbidity and mortality. Because of the high surgical complication rates of open approaches, minimally invasive surgical techniques have become an alternative treatment for the treatment of spinal tumors. Minimally invasive spinal procedures have a shorter operative time, reduced blood loss, shorter hospital stays, less complications and postoperative pain and faster recovery times.

Spinal Tumors

Spinal tumors are classified as primary and secondary spinal tumors. The prevalence of primary spinal cord tumors is 0.74 per 100,000 persons. Primary spinal tumors arise from the intradural-extradural and intradural-intramedullary regions. The most common intramedullary lesions include astrocytomas and ependymomas and the incidence of intramedullary spinal tumours is 35-40% of all spinal tumors (7). Vascular tumors, chordomas, epidermoids are the common extradullary tumors. 35-40% of all spinal tumors are extradullary tumors (37). Extradural lesions and metastases are classified as secondary spinal tumors. 50-55% of all spinal tumors are extradural tumors and 90% of all tumors are spinal metastases (39).
MINIMALLY INVASIVE TECHNIQUES FOR THE TREATMENT OF SPINAL TUMORS

Percutaneous Biopsy

The first percutaneous biopsy of the spine was reported was by Robertson (35). In the following years, image guidance with fluoroscopy or computed tomography (CT) has significantly increased the precision of percutaneous biopsies (5). The rates of tissue diagnosis with these techniques are 71-100% (19).

Vertebroplasty and Kyphoplasty

Vertebroplasty involves the percutaneous injection of acrylic-based cement directly into a vertebral body and kyphoplasty involves an inflatable balloon to restore the compressed vertebra before cement injection (27). These techniques are ideal in patients who have intractable pain, and a limited life expectancy (less than 3–6 months) for the patients who cannot tolerate standard open procedures (2, 4, 10, 33). The technique was used first to treat vertebral hemangiomas. Galibert reported a C2 vertebral hemangioma case treated with percutaneous vertebroplasty with a successful outcome (9, 25). The pain control results were excellent for vertebral hemangiomas (Figure 1). The percutaneous vertebroplasty technique was also used to treat pathological compression fractures. The incidence of pain relief via vertebroplasty/kyphoplasty was reported as 84% with vertebral metastatic compression fractures (8, 21). Dudeney reported excellent pain relief following treatment kyphoplasty for osteolytic vertebral compression fractures (6). The main advantages of kyphoplasty are vertebral body height restoration (6, 22).

The major complications of of vertebroplasty or kyphoplasty are cement leakage and adjacent level fracture. The incidence of cement leakage has been reported as 23–41% for vertebroplasty and 9-23% for kyphoplasty in different series (18). Most of the leakages were asymptomatic (18).

Percutaneous Radiofrequency Ablation

Rosenthal et al. reported the first radiofrequency ablation (RFA) for the treatment of spinal osteoid osteoma (36). Percutaneous radiofrequency ablation has also been used for the palliative treatment of spinal tumors. It is an image-guided technique for tissue ablation at temperatures of 60-100°C and causes immediate protein coagulation, tissue death and irreversible cellular damage (11). Possible mechanisms of RFA in decreasing the pain levels are that RFA destroys sensory nerve fibers in the periosteum, decreases the stimulation of sensory nerve fibers through reducing the tumor's volume and decreases the level of nerve-stimulating cytokines (40). Nakatsuka et al. reported 100% pain relief in spinal tumors treated with RFA (34).

Stereotactic Radiosurgery (SRS)

Spinal radiosurgery may be used to treat patients who have progressive neurological deficits, limited life expectancy and contraindications for open surgical approaches. The role of SRS in the treatment of spinal tumors is well established (30). SRS is typically used for nerve sheath tumors and meningiomas but has also been applied to some kinds of paragangliomas, hemangioblastomas and hemangiopericytomas (3). This method is used for most spinal tumors, especially for patients who cannot undergo surgical treatment. Gerszten et al. combined kyphoplasty and SRS for the treatment of metastatic spinal lesions. They reported 92% pain relief after the procedure (12). Decreased pain was reported at a rate of 86%-96% in different series (12, 13, 14).

MINIMALLY INVASIVE SURGERIES FOR THE TREATMENT OF SPINAL TUMORS

Endoscopic Approaches

Video-assisted thoracoscopic surgery:

Mack et al. described a transthoracic microsurgical endoscopic technique without unaware of each other for vertebrectomy, reconstruction, and stabilization (28). Thoracoscopic anterior stabilization may be achieved with bone graft or PMMA, and an anterolateral plate is specifically designed for endoscopic application. Thoracoscopic can be used to access the entire spine from T1 to T12, allowing for tumor resection (26). Less incisional pain, earlier ambulation, shorter hospital stays, decreased intercostal neuralgia, and less pulmonary complications are the main advantages of this procedure (37).

Patients with severe pulmonary dysfunction, extensive pleural adhesions and patients who have undergone previous surgery cannot tolerate the procedure due to single-lung ventilation. Intraoperative bleeding is the most common complication. Huang also reported that 5% of perioperative deaths were related to respiratory complications (16, 17). Laparoscopic procedures have also been described for retroperitoneal approaches for decompression and corpectomy (23).
**Endoscopy-assisted approaches:**

Endoscopy-assisted approaches may be used for patients who need combined posterior and anterior stabilization and those who have upper and lower thoracic lesions for which thoracoscopic access is difficult (38). This technique allows the transpedicular or the costotransversectomy approaches, which are less morbid than the lateral extracavitary (LEC) or thoracotomic surgeries. McLain successfully treated nine tumor cases with endoscopy-assisted posterolateral decompression (32).

**Minimally Invasive Open Approaches:**

Minimal access approaches have been developed and described for the treatment of spinal tumors (17).

*Figure 1: 36-year-old female patient. C6 hemangioma and pathological compression (above). Anterior percutaneous vertebroplasty. Preoperative and postoperative images (below). Postoperative 5th year.*
Corpectomy, bone grafting, and instrumentation can be achieved with these approaches (16). Jho described a minimally invasive microscopic approach for the resection of cervical spine tumors (20). A tubular retractor has been used for resection of intradural tumors. Tredway et al. reported complete tumor resection through a tubular retractor (41).

Mini-thoracotomies and mini–retroperitoneal approaches allow us to decrease the surgical injury of thoracal corpectomy. Le-Huec and colleagues described a “mini-open” retrosternal approach to the upper thoracic spine (C7-Th3) (26). Percutaneous lumbar pedicle screw instrumentation has been widely reported in several studies (29, 31).

We use minimal approaches with the operation microscope. The advantages are coaxial light, three-dimensional viewing, a very wide range of zooming capabilities, no need for additional equipment except the microsurgical tools and a safe approach because of the comfortable hemostasis possibilities. We may use this approach to any level between the craniovertebral junction and sacrum (Figure 1-4).

Figure 2: 34-year-old female patient. L3 hemangioma. Preoperative CT and MRI. (Above) Postoperative images (below).
Figure 3: 17-year-old male patient with neck pain. C3 osteoid osteoma. (Above) Total tumor resection with anterior microsurgical approach (Below).
Figure 4: 25-year-old male patient with back and leg pain. Foraminal and extraforaminal schwannoma (Above). Total tumour resection via transmuscular transfuraminal approach (Below).
**SUMMARY**

Minimalization is a general trend in spine surgery. Minimally invasive techniques and approaches have to be preferred for patients with spinal tumors who are not able to tolerate open surgery or who have limited life expectancy.

**REFERENCES**


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