



# Minimally Invasive Approaches in Metastatic Spinal Tumor Surgery

## *Metastatik Spinal Tümör Cerrahisinde Minimal İnvaziv Yaklaşımlar*

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### ABSTRACT

The surgical treatment of spinal metastases is still controversial. Due to developments in diagnostic imaging there has been a great evolution in minimally invasive surgical techniques for the spinal surgery. Most of the patients with spinal metastases are debilitated and under high risk of major surgical morbidity and mortality. Less perioperative pain, less blood loss, less hospitalization time, protection of the spine biomechanics, fast recovery and less morbidity in medically debilitated 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 major advance in minimizing approach related morbidity in the treatment of spinal tumors.

Because of the evolution of minimally invasive surgical techniques for the spinal surgery, minimally invasive techniques are alternative treatment to standard open approaches for the treatment of metastatic spinal tumors. Due to less complication rates there has been a trend toward the minimalization of spine surgery.

**KEYWORDS:** Minimally invasive techniques, Metastasis, Spine surgery, Spine tumors

### ÖZ

Metastatik spinal tümörlerin cerrahi tedavisi halen tartışmalıdır. Gelişen görüntüleme yöntemleri ile spinal cerrahide kullanılan minimal invaziv tekniklerde büyük gelişmeler ortaya çıkmıştır. Spinal metastazı olan hastaların büyük bölümünde genel durum bozukluğu vardır ve cerrahi açıdan yüksek oranda mortalite ve morbidite riski taşırlar. Minimal invaziv tekniklerin belli başlı avantajları; daha az ağırlı olması, daha az kan kaybına neden olması, hastanede kalım süresinin az olması, omurga biyomekaniğinin korunması, iyileşmenin daha çabuk olması ve daha az morbidite oranına sahip olması olarak sıralanabilir.

Spinal tümörlerin standart tedavisinde cerrahi sonrası radyoterapi, kemoterapi ya da ikisinin kombinasyonu uygulanmaktadır. Standart açık cerrahiler yaşam beklentisi kısa olan hastalarda yüksek komplikasyon oranları ve yaşam kalitesini düşürmesi nedeniyle uygun değildir. Minimal invaziv tekniklerin bir diğer avantajı spinal tümörlerin tedavisinde işleme bağlı morbiditeyi azaltmasıdır.

Komplikasyon oranlarının az olması nedeniyle spinal cerrahide minimal invaziv tekniklere eğilim mevcuttur. Spinal cerrahi için kullanılan minimal invaziv teknik teknolojilerinin artmasıyla beraber spinal metastazlarda minimal invaziv teknikler klasik açık cerrahiye alternatif olarak kullanılmaya başlanmıştır.

**ANAHTAR SÖZCÜKLER:** Minimal invaziv teknikler, Metastaz, Omurga cerrahisi, Omurga tümörleri

### INTRODUCTION

One-third of all cancer patients develop spinal metastases including post-mortem diagnosis and 90% of all spinal tumors are metastases (5). Diagnosis of spinal metastases has increased due to developments in diagnostic imaging. Standard open approaches to treat metastatic spinal tumors have complication rates reaching in 30%. Neurological deterioration, wound infections and cerebrospinal fluid (CSF) leaks (1, 18, 34) are common complications that may be seen. Complications including hemothorax, chylothorax, atelectasis may develop after anterior open approaches (thoracotomy) (13). Most of the patients with spinal metastases are debilitated and under high risk of major surgical morbidity

and mortality. Because of the high surgical complication rates of open approaches and limited life expectancies of the patients, minimally invasive surgical techniques have become an alternative treatment for the treatment of metastatic 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 are classified as primary and secondary spinal tumors (7, 29). Metastasis are classified as secondary spinal tumors, 50-55% of all spinal tumors are extradural tumors and 90% of all tumors are spinal metastases (31). 70% of the spinal metastases are located in the thoracic spine followed

by lumbar spine (20%) and cervical spine (10%) (27). Spinal metastases originate from the lung, breast, gastrointestinal tract, prostate, lymphoma and kidney (31).

### MINIMALLY INVASIVE TECHNIQUES for the TREATMENT of METASTATIC SPINAL TUMORS

#### **Percutaneous Biopsy**

The first percutaneous biopsy of the spine was reported by Robertson and Ball (28). In the following years, image guidance with fluoroscopy or computed tomography (CT) has significantly increased the precision of percutaneous biopsies (4, 32). The rates of tissue diagnosis with these techniques are 71-100% (16, 19).

#### **Vertebroplasty and Kyphoplasty**

Vertebroplasty involves the percutaneous injection of acrylic-based cement directly into a vertebral body and kyphoplasty involves using an inflatable balloon to restore the compressed vertebra before cement injection (21). These techniques are ideal in patients who have intractable pain, and a limited life expectancy (less than 3–6 months), and patients who cannot tolerate standard open procedures (2, 3). Percutaneous vertebroplasty technique was also used to treat pathological compression fractures. The incidence of pain relief was reported as 84% with vertebral metastatic compression fractures via vertebroplasty/kyphoplasty (8). Weill et al. also reported 73% pain relief for spinal metastases treated with

vertebroplasty (35). Dudeney et al. reported excellent pain relief with kyphoplasty for osteolytic vertebral compression fractures (6). The main advantage of kyphoplasty is vertebral body height restoration (6) (Figure 1A-C).

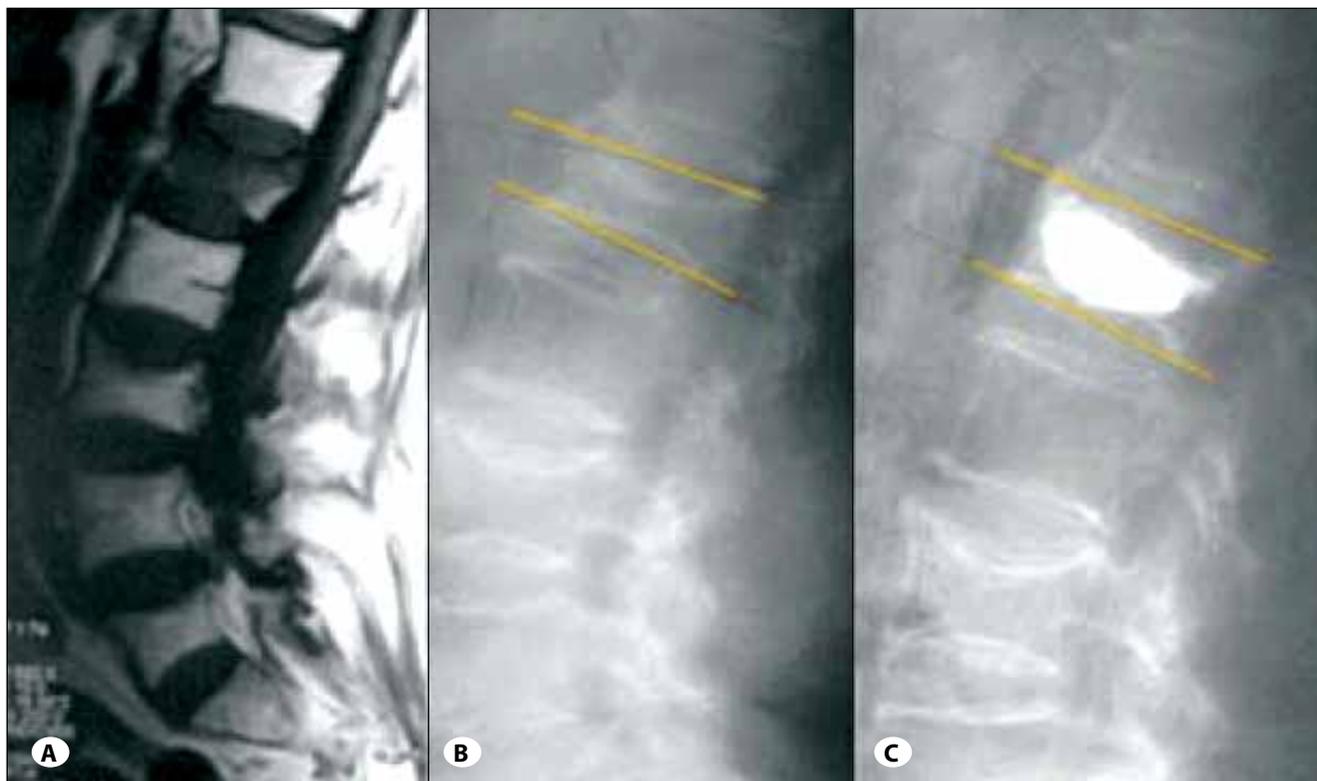
The major complications of vertebroplasty or kyphoplasty are cement leakage and adjacent level fracture. The incidence of cement leakage has been reported as 23-41% for vertebroplasty and 9-23% for kyphoplasty in different series (12). Most of the leakages were asymptomatic.

#### **Percutaneous Radiofrequency Ablation**

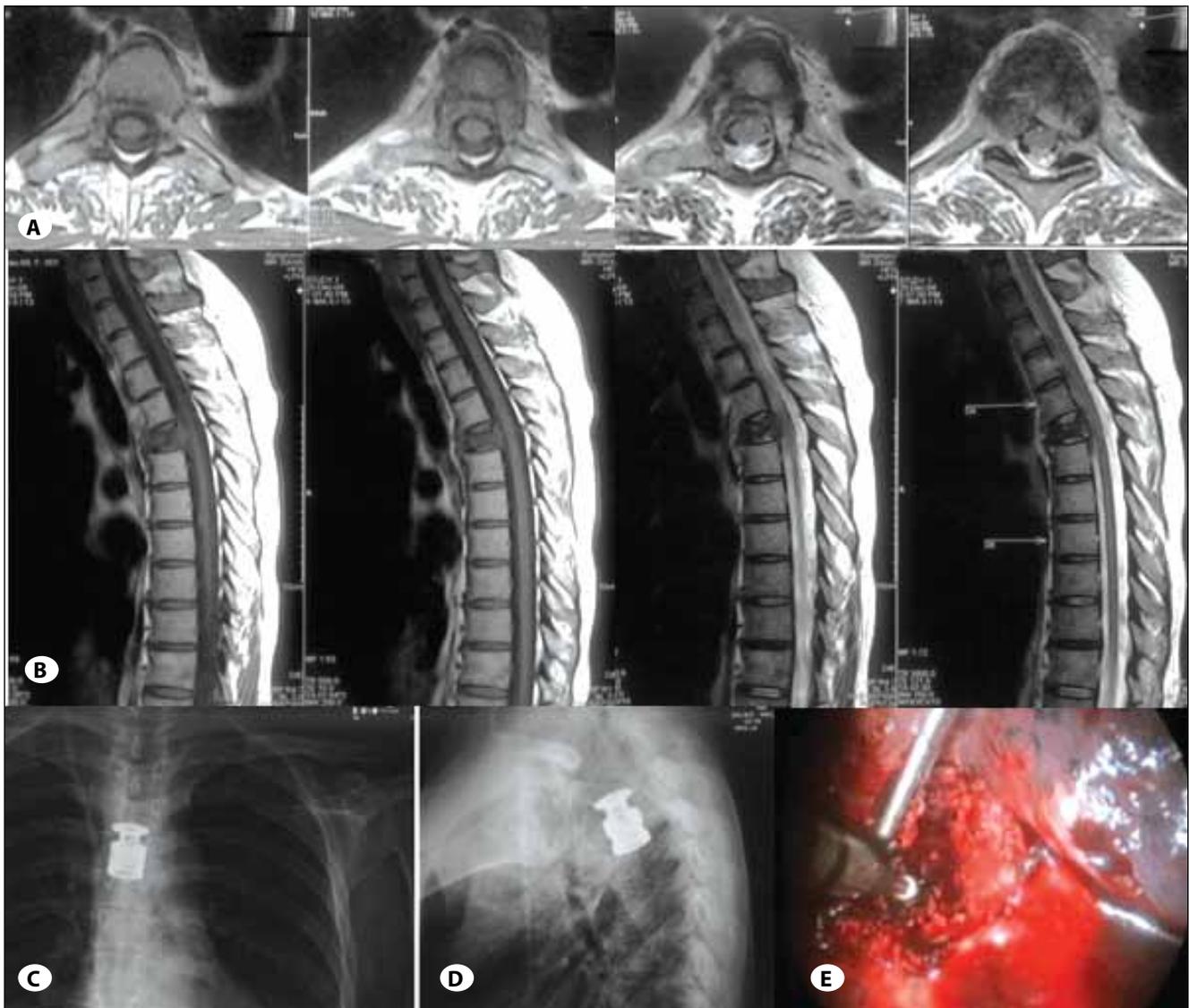
Percutaneous radiofrequency ablation has also been used for palliative treatment of spinal metastases. It is an image-guided technique for tissue ablation at temperatures of 60-100°C, resulting in immediate protein coagulation, tissue death and irreversible cellular damage (9). Possible mechanisms that RFA decreases pain levels with are as follows: 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 (33).

#### **Stereotactic Radiosurgery (SRS)**

Spinal radiosurgery may be used to treat patients who have progressive neurological deficits and limited life expectancy and have contraindications for open surgical approaches. This method is used for most spinal tumors and especially for the patients who cannot undergo surgical treatment. Gerszten



**Figure 1:** 70-year-old female patient who was diagnosed as multiple myeloma. **A)** T1W sagittal MR and **B)** direct radiography revealed a L1 pathological fracture. Preoperative VAS was 2, and postoperative 3rd month VAS was 0. **C)** Corpus height restoration was 52.4% after kyphoplasty. Direct radiography revealed the restoration.



**Figure 2:** A 36-year-old woman with a diagnosis of breast carcinoma admitted to hospital for a T5 pathological vertebral fracture that are seen in T1- and T2-weighted **A)** axial and **B)** sagittal MRI scans. Postoperative direct radiographies show **(C):** Postero-anterior, **D):** lateral) T5 corpectomy + expandable interbody cage application. Intraoperative thoracoscopic view **(E)**.

et al. combined kyphoplasty and SRS for the treatment of metastatic spinal lesions. They reported 92% pain relief after the procedure (11). The rate of decreased pain was reported as 86%-96% in different series (10).

#### **MINIMALLY INVASIVE SURGERIES for the TREATMENT of SPINAL TUMORS**

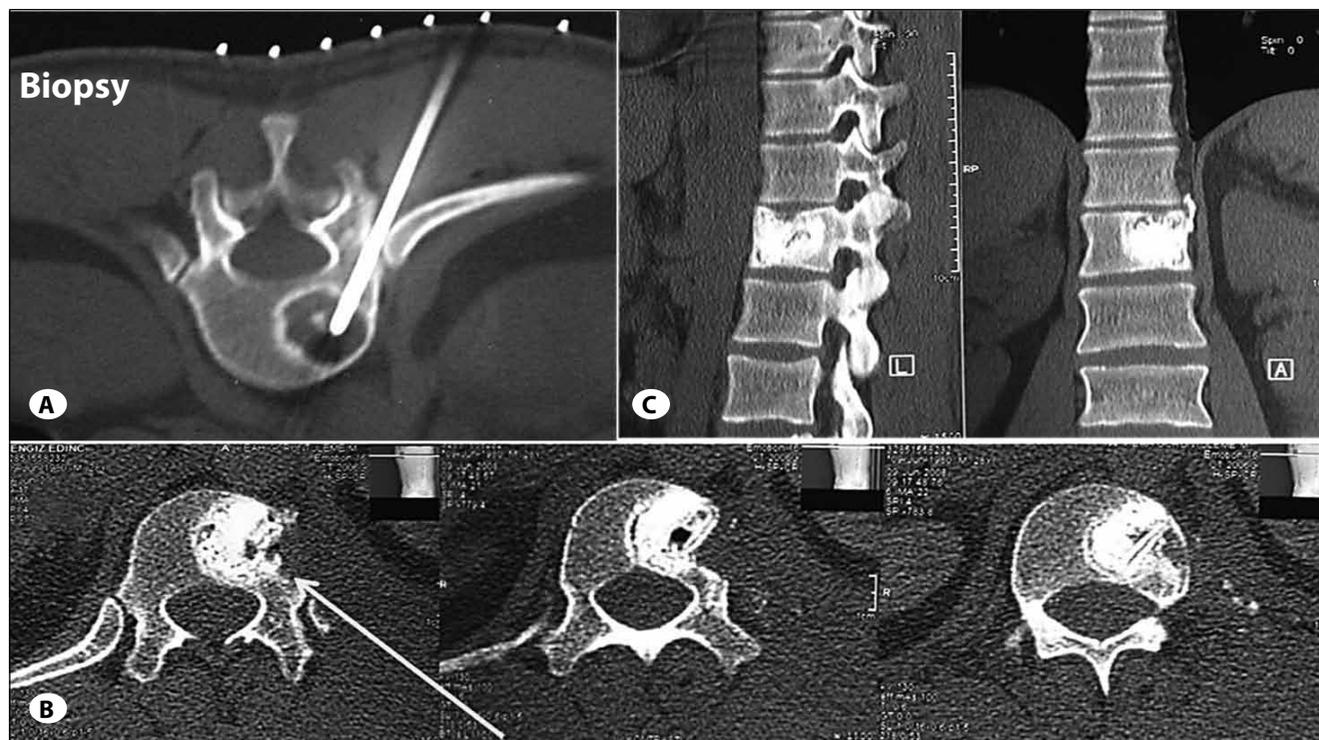
##### **Endoscopic Approaches**

##### **Video-Assisted Thoracoscopic Surgery**

Mack et al. described a transthoracic microsurgical endoscopic technique without unaware of each other for vertebrectomy, reconstruction, and stabilization (22). Thoracoscopic anterior stabilization may be achieved with bone graft or PMMA, and an anterolateral plate is specifically designed for endoscopic

application. Thoracoscopy can be used to access the entire spine from T1 to T12, allowing for tumor resection (20, 25). Less incisional pain, earlier ambulation, shorter hospital stays, decreased intercostal neuralgia, and less pulmonary complications are the main advantages of this procedure (29, 30)

Patients with severe pulmonary dysfunction, extensive pleural adhesions and patients that had previous surgery cannot tolerate the procedure due to single-lung ventilation. Intraoperative bleeding is the most common complication. Huang et al. also reported that 5% of perioperative deaths were related to respiratory complications (14,15) (Figure 2A-E). Laparoscopic approaches have also been described for retroperitoneal approaches for decompression and corpectomy (17).



**Figure 3:** A 45-year-old female diagnosed as breast carcinoma with a thoracic lesion. **A)** CT guided biopsy of the lesion. **B)** Total curettage by lateral extracavitary microsurgical approach. Reconstruction with rib and bone graft. **C)** CT images revealed no recurrence (**left:** sagittal, **right:** coronal).

### Endoscopy-Assisted Approaches

Endoscopy-assisted approaches may be used for patients who need combined posterior and anterior stabilization and patients who have upper and lower thoracic lesions in which thoracoscopic access is difficult (25). 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 (25).

### Minimally Invasive Open Approaches

Minimal access approaches have been developed and described for the treatment of metastatic spinal tumors (14, 15, 26). Corpectomy, bone grafting, and instrumentation can be achieved with these approaches (14, 26).

Mini-thoracotomies and mini-retroperitoneal approaches allow us to decrease the surgical injury of thoracic corpectomy. Le-Huec and colleagues described a "mini-open" retrosternal approach to the upper thoracic spine (C7-Th3) (20). Percutaneous lumbar pedicle screw instrumentation has been widely reported in several studies (23, 24).

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 good hemostasis-providing potential. We may use this approach at any level between the craniovertebral junction and sacrum (Figure 3A-C).

### CONCLUSION

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.

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