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Asymmetric Posterior Thoracolumbar Fixation following a Posterolateral Transpedicular Approach for Unilateral Vertebral Disease

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Abstract

The present study aimed to evaluate the clinical outcomes of patients who underwent asymmetrical posterior screw fixation for the treatment of unilateral posterior vertebral pathological entities. The study included 21 patients with a spinal tumor who underwent asymmetrical posterior spinal fusion surgery between April 2009 and March 2012. The American Spinal Injury Association (ASIA) motor score visual analog scale (VAS) score were used as the outcome measure at admission and follow-up. Among the 21 patients, 12 were male and 9 were female, and mean age was 50.71 (range, 24–78) years. Mean follow-up was 16.04 (range, 4–47) months. Postoperatively, neurological findings did not deteriorate in any of the patients. Among the ASIA grade C and D patients, eight (38%) of them exhibited clinical stability or recovery to ASIA E, whereas none of the ASIA B patients scores changed postoperatively. Perioperative complications were noted in six patients (28%). Spinal stability and fusion were achieved in 18 (85%) patients. The surgical asymmetrical fixation technique described reduced the duration of surgery, and the patients required less dissection of paraspinal muscles than bilateral symmetrical fixation. Asymmetrical fixation provides good stabilization for unilateral thoracolumbar vertebral pathological entities, and facilitates rapid rehabilitation of such patients, who are often elderly with comorbidities.

Key words: asymmetric fixation, thoracolumbar, unilateral vertebral disease, transpedicle

Introduction

Pedicle screw instrumentation is widely used for the stabilization of single and multiple level spinal fusions. Although the ideal fixation construct stiffness is unknown, fusion rates have improved as the rigidity of systems have increased.[1–3] Surgeons advocate enhancing stabilization across vertebral lesions by extending instrumentation to include additional levels and sides. Extending instrumentation, however, has some disadvantages, including increased cost, larger surgical exposure, more bone destruction, and a higher rate of screw-related complications at each level. Posterior fixation has also been shown to be responsible for a reduction in bone mineral content due to stress shielding.[3] Single-stage posterolateral transpedicular approach (PTA) is favored in cases requiring multilevel or circumferential (both anterior and posterior) decompression and fusion. This approach facilitates direct decompression, reconstruction of the anterior column, height restoration, and kyphosis correction.[1,4,5]

In 1992, Kabins et al. reported that clinical results with unilateral variable screw placement instrumentation were nearly identical with those of bilateral instrumentation.[6] However, they confined unilateral instrumentation to single-level (L4–L5) fusion, recommending that unilateral instrumentation not be used for multilevel fusion and that the results with unilateral variable screw placement instrumentation not be extrapolated to other less rigid designs of pedicle screw fixation.

The present study aimed to evaluate the clinical outcomes in patients who underwent asymmetrical posterior screw fixation for unilateral posterior vertebral pathological entities.

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Materials and Methods

I. Study design

This retrospective study included 21 patients who underwent surgery for spinal tumors with asymmetrical posterior spine fusion at our university between April 2008 and March 2012. All patients underwent complete preoperative diagnostic work-up, including X-ray, computed tomography (CT), and magnetic resonance imaging (MRI). Indications for surgical interventions were spinal tumors with asymmetrical posterior spine fusion and unilateral posterior vertebral pathological entities.

II. Outcome parameters

The Tokuhashi scoring system was used to assess the patient's prognosis and to determine the best therapeutic option for the patient.[7–9] The American Spinal Injury Association (ASIA) motor score visual analog scale (VAS) score were used as the outcome measure at admission and follow-up (Table 1).[4,10]

III. Surgical technique

All surgeries were performed under general anesthesia. A single posterior midline approach was used with pedicle screw placement under fluoroscopic guidance two levels above and two levels below the spinal tumor side, and one level above and one level below on the other side. Following pedicle screw placement, decompressive laminectomy was performed, including bilateral facetectomy. Tumor resection and partial corpectomy was performed after removal of the intervertebral discs above and below, via PTA, using an osteotome, curette, and rongeur. In the patient with hemangioma, open vertebroplasty with polymethylmethacrylate was achieved, accompanied by posterior asymmetrical vertebral fixation under fluoroscopic guidance (Fig. 1). In four patients, the pedicles with tumor involvement were removed to allow access to the vertebral body; the nerve roots were preserved in all cases. Next, the nerve roots were gently retracted, a titanium mesh cage was placed over the vertebrectomy defect under fluoroscopic guidance, and then posterior rods were locked (Fig. 2). In other patients, we performed tumor resection and asymmetric posterior lumbar fixation (Figs. 3, 4). The patients were followed-up by the neurosurgery and oncology departments.

Table 1 The American Spinal Injury Association impairment scale

Grade	description
A	Complete no motor or sensory function is preserved at S4–S5.
B	Incomplete sensory but not motor function is preserved below the neurological level and extends through S4–S5.
C	Incomplete motor function is preserved below the neurological level and the majority of key muscles below the neurological level have a muscle grade less than 3.
D	Incomplete motor function is preserved below the neurological level and the majority of key muscles below the neurological level have a muscle grade greater than or equal to 3.
E	Normal motor and sensory functions are normal.

Results

Relevant clinical data for the 21 patients are shown

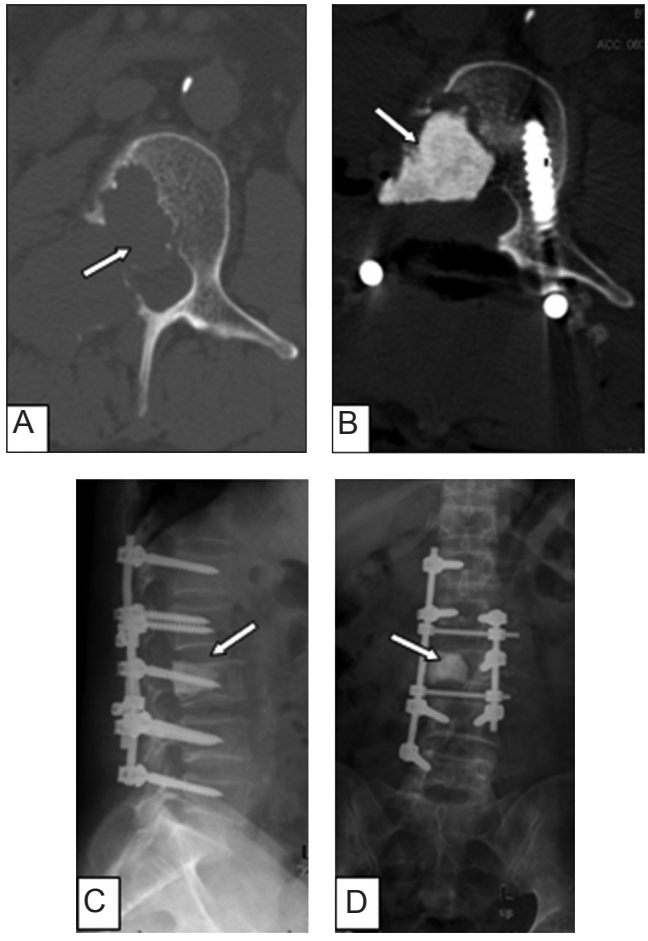


Fig. 1 A: Hypodense destructive lesion (*white arrow*) is seen in the vertebral bone on axial CT scan. B: Vertebroplasty material (polymethylmethacrylate) (*white arrow*) is seen on axial CT scan. C, D: Vertebroplasty material (*white arrows*) (polymethylmethacrylate) and asymmetric posterior lumbar fixation are seen on X-rays. CT: computed tomography.

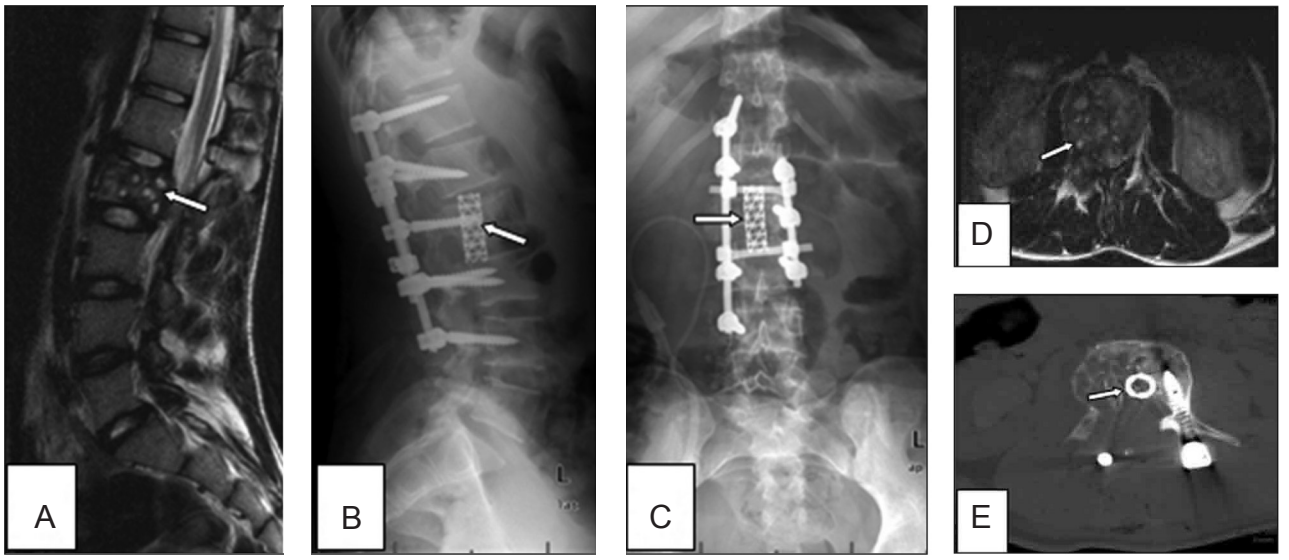
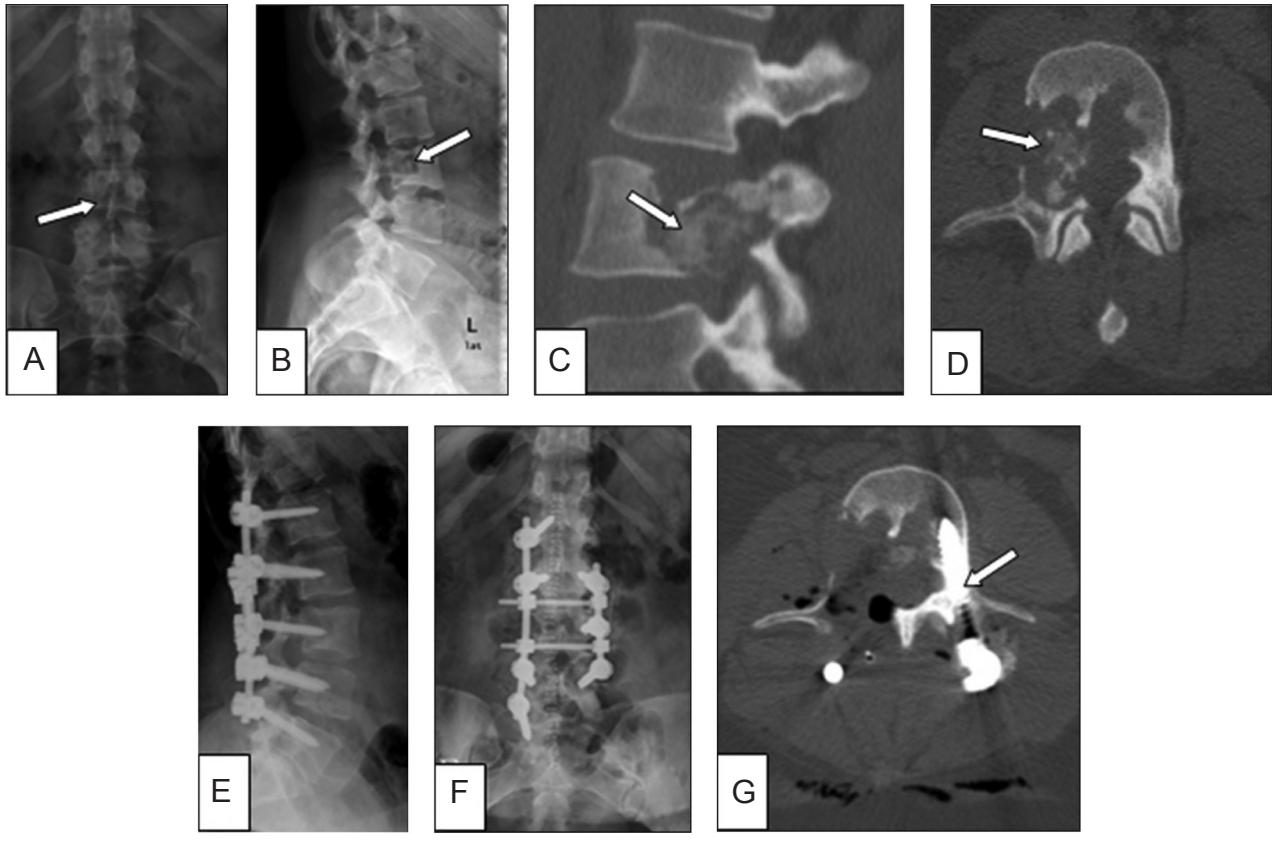


Fig. 2 A: Hypointense lesion is seen in L2 vertebra (*white arrow*) on T_2-weighted sagittal MRI. B, C: Titanium cage and asymmetric posterior lumbar fixation (*white arrows*) are seen on X-rays. D: Hypointense lesion is seen in L2 vertebra (*white arrow*) on T_2-weighted MRI. E: Titanium cage (*white arrow*) is seen on axial CT scan. CT: computed tomography, MRI: magnetic resonance imaging.



Fig, 3 A, B: Radiolucent lesion (osteoblastoma) is seen on the left side of L3 vertebra (*white arrows*) on X-rays. C, D: Hypodense destructive lesions (*white arrows*) are seen in the L3 vertebral bone on sagittal and axial CT scans. E, F: Asymmetric posterior lumbar fixation is seen on X-rays. G: Unilateral screw placement to the intact pedicle of L3 vertebra (*white arrow*) is seen on axial CT scan. CT: computed tomography.

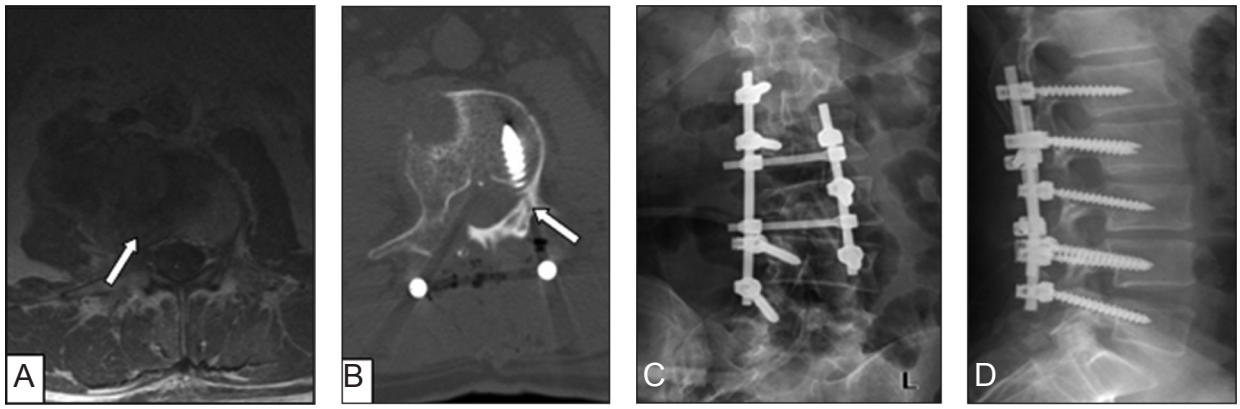


Fig. 4 A: Hypointense lesion is seen in vertebral bone (*white arrow*) on T_1-weighted axial MRI. B: Unilateral screw placement to the intact pedicle of vertebral bone (*white arrow*) is seen on axial CT scan. Intact pedicle (*white arrow*) is seen on axial CT scan. C, D: Asymmetric posterior lumbar fixation is seen on X-rays. CT: computed tomography, MRI: magnetic resonance imaging.

Table 2 Patients' parameters

Patients	Age (yrs)	Sex	Preoperative values		Level	Postoperative values		Pathology
			ASIA scale	VAS score		ASIA scale	VAS score	
1	43	M	D	8	L3	D	3	Metastatic rectum cancer
2	55	M	D	6	L3	E	3	Plasmacytoma
3	24	M	E	7	L2	E	5	Hemangioma
4	53	M	D	8	L3	E	3	Schwannoma
5	30	F	C	9	L3	D	3	Aggressive osteoblastoma
6	78	F	C	8	L2	C	3	Metastatic breast cancer
7	32	F	D	8	L4	E	3	Osteoblastoma
8	58	F	E	6	L2	E	2	Plasmacytoma
9	28	M	B	7	L3	B	3	Metastatic colon cancer
10	50	M	C	9	L3	E	3	Metastatic prostate carcinoma
11	39	M	D	9	L2	E	5	Giant cell tumor
12	67	F	B	7	L3	B	3	Metastatic renal cancer
13	34	F	D	6	L3	D	2	Schwannoma
14	27	M	D	7	L3	E	2	Osteoblastoma
15	63	F	E	8	L2	E	4	Metastatic breast cancer
16	69	M	D	9	L3	E	5	Metastatic prostate carcinoma
17	62	M	C	6	L3	D	2	Plasmacytoma
18	52	F	C	8	L2	C	6	Metastatic colon cancer
19	77	M	D	7	L4	E	5	Metastatic prostate carcinoma
20	59	F	E	8	L2	E	4	Metastatic renal cancer
21	65	M	B	7	L3	B	3	Metastatic colon cancer

ASIA: American Spinal Injury Association, F: female, M: male, VAS: visual analog scale.

in the Table 2. Mean age of the 12 male and 9 female patients was 50.71 (range, 24–78) years. Mean follow-up was 16.04 (range, 4–47) months. Eleven patients had metastatic tumors, four had primary bone tumors, three had plasmacytomas, two had schwannomas, and one patient had hemangioma. All patients presented with back pain, 18 patients had radiculopathy and 12 had myelopathy.

Postoperative neurological findings did not deteriorate in any of the patients. Among ASIA C and D patients, eight (38%) of them exhibited clinical stability or recovery to ASIA E, whereas ASIA B patients' scores did not change. ASIA D and E patients were mobilized using thoraco-lumbo-sacral orthosis

on the next day after surgery. X-ray and CT scans were obtained after surgery. There were no instances of implant malposition or migration observed.

At 14th month postoperative, a 30-year-old patient with an aggressive L3 osteoblastoma showed signs of extensive local recurrence and spinal canal compression. This patient underwent a second operation. Perioperative complications occurred in six patients (28%): two (9%) had exacerbation of cardio-respiratory symptoms, two (9%) had superficial wound infection, successfully treated with antibiotics, and two (9%) had liquor fistula. Spinal stability and fusion were achieved in all the patients. Back pain assessment was performed using the VAS scoring system; mean preoperative VAS score was 7.52 (range, 0–10) and mean postoperative VAS score was 3.42 (range, 0–10).

Discussion

Unilateral vertebral lesions, such as isolated infections of posterior elements, primary and metastatic tumors, degenerative diseases affecting one side of the vertebra, traumatic fractures, and iatrogenic defects following spinal surgery, can all be encountered in clinical practice. The decision to use a particular surgical approach for a spinal tumor is dependent on the location of the bone, epidural or paraspinal tumor, comorbidity, extent of the disease, and surgeon familiarity with particular techniques.[10–12]

In the present study, asymmetrical instrumentation was used for the fixation of vertebrae following resection of vertebral tumors. Postoperative VAS scores were significantly lower ($p = 0.001$). Excellent fusion rates have been achieved with rigid pedicle screw fixation; however, increased stiffness of the instrumented motion segments has been associated with degeneration of adjacent levels, although the findings were inconsistent.[13,14]

Yucesoy et al. reported that biomechanical asymmetric posterior spinal fixation range of motion and lax zone were not quantified in unstable condition due to the fear of damaging the remaining ligaments and in order to reduce exposure time; substantially increased mobility of specimens relative to normal was observed in all directions after making the simulated lesion.[3] The model was considered to adequately represent clinical instability present after resection of typical unilateral pathological entities. Asymmetrical long/short stabilization provided similar stability to symmetrical long stabilization.[3] Compared to bilateral symmetric models, this system also lowered peak stress in the upper and lower levels adjacent to the fusion. Thus, some researchers have reported satisfactory clinical results using unilateral pedicle screw fixation for lumbar fusion, which may be as effective as traditional bilateral fixation. Suk et al. showed that unilateral pedicle screw fixation was as effective as bilateral pedicle screw fixation in lumbar spinal fusion.[14] They concluded that unilateral fixation could be used even in two-segment lumbar spinal fusion and appeared to be a valid substitute for bilateral fixation, which has shown higher risks of adjacent segment degeneration in the long term.

The present findings also indicate that treatment costs were lowered, as a result of shorter duration of surgery and hospitalization in patients who underwent asymmetrical stabilization. Asymmetrical stabilization has some advantages over bilateral symmetrical fixation, including preservation of at least two pedicles contralateral to the lesion. Using two screws less, will lower the cost accordingly and generally provide lower malposition rate. Earlier studies have reported screw malposition rates of 5–20%.[15–18] Asymmetrical stabilization can therefore provide stability sufficient for a good fusion environment in unilateral lumbar vertebral pathological entities. Further biomechanical or clinical studies should examine the stabilizing potential of asymmetrical fixation in the treatment of bilateral lesions and degenerative disc disease, or they should examine asymmetrical constructs in the lumbar and thoracic regions.

Clinical outcome and fusion rates obtained with unilateral pedicle screw fixation were nearly identical with those obtained with bilateral fixation; therefore, the researchers concluded that unilateral pedicle screw fixation was as effective as bilateral pedicle screw fixation in thoracolumbar spinal fusion, independent of the number of fusion segments (1 or 2 segments) and pedicle screw system.[19] Suk et al. showed that metal failures were more common in the unilateral group (12.8%) than in the bilateral group (5.0%).[19] Unilateral fixation is inadequate for stabilizing a 2-level unilateral lesion. Bilateral fixation, whether symmetrical or asymmetrical, provides good stabilization for unilateral lumbar vertebral pathological entities.[3,20]

Conclusion

The benefits of the novel asymmetrical fixation technique were low morbidity rate and reduction in the risk of infection due to shorter duration of surgery, less dissection of paraspinal muscle than bilateral symmetrical fixation. Asymmetrical fixation provides good stabilization for unilateral lumbar vertebral pathological entities; its economic benefits are associated with shorter hospitalization

and rapid rehabilitation, which are especially important because patients requiring this treatment are often elderly and comorbid; besides, there is a reduction in cost with fewer screws and less dissection time.

Conflicts of Interest Disclosure

The authors state that there are no competing interests or financial disclosure exists for this manuscript.

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