ORIGINAL RESEARCH PAPER VOLUME-6 | ISSUE-8 | AUGUST - 2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

POSTERIOR VERTEBRAL COLUMN RESECTION FOR THE TREATMENT OF OSTEOPOROTIC FRACTURES WITH NEUROLOGICAL DEFICITS IN ELDERLY PATIENTS

Orthopedics

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ABSTRACT

Introduction: The purpose of this retrospective study was to evaluate the results of spinal canal decompression and anterior column support via posterior vertebral column resection (PVCR), performed for eliminating the disadvantages of the anterior approach, in the management of osteoporotic vertebral fractures with neurological deficits in elderly patients.

Materials and Methods: Twenty-six patients (20 females and 6 males) with more than 2 years of follow-up were included. The fractures were in the thoracic spine in 14 patients, and thoracolumbar spine in 12. Five patients had ASIA C and 21 patients had ASIA D neurologic deficits. Surgical technique included placement of cement augmented pedicle screws, followed by laminectomy or hemilaminectomy, unilateral or bilateral pediculectomy, sacrifice of nerve roots between Th2 and Th11, decompression of the spinal canal by subtotal or total vertebrectomy, and support of the adjacent discs and anterior column by titanium mesh.

In cases where decompression can be achieved with unilateral approach, contralateral posterior elements were preserved for fusion. Prophylactic vertebroplasties were made in one level above and one level below in all patients. Radiographic analysis was made with local kyphosis angle (LKA) measurements. Changes in the neurological conditions, clinical outcomes and complications were also evaluated.

Results: Mean age was 70.4 (62-84) years, and mean follow-up was 36.5 months (18-72). Mean level of instrumentation was 5.1 (4-8), operation time was 310 (140-410) minutes, and blood loss was 460 (320-700) ml. Mean preoperative LKA of 21.5 degrees improved to 4.6 degrees after the operation and was 5 degrees at the final follow-up. VAS was 7 before the operation, 4 after, and 2 at final follow-up. Full neurologic recovery was achieved in all patients. There were no pseudoarthroses. The major complication was adjacent segment fracture that required revision was made 2 patients (7.69%). The minor complications were superficial wound infections in 3 patients (11.5%), and dural tear in 3 patients (11.5%).

Conclusion: Decompression of the spinal canal and reconstruction of the anterior column via a posterior approach provided satisfactory results in osteoporotic elderly patients. This procedure obviated the need for an anterior approach, which might have caused significant morbidity in these elderly patients. In cases where decompression can be achieved with unilateral approach, preservation of contralateral posterior elements (lamina, pedicle, facet joints) might have helped to obtain higher fusion rates because a 270 degrees fusion is provided.

KEYWORDS:

posterior instrumentation; Vertebral Column Resection; Neurological Deficit; Osteoporotic Fracture

INTRODUCTION

Osteoporosis has a significant role in the etiology of thoracolumbar spinal fractures in older patients. Osteoporosis is a skeletal change characterized by reduction in bone strength due to loss of bone mass, which increases the incidence of fractures in time. These fractures occur typically in older women without significant trauma [1, 2]. It may result in persistent severe pain and limited mobility, and significantly affect the quality of life. Conservative therapy with external bracing, bed rest, and analgesics is necessary for pain control in these patients. However, some patients may experience protracted or persistent pain even with these measures. Surgical treatment is indicated when conservative treatment fails, in patients with spinal instability or neurological deficits. Vertebroplasty has been widely accepted for the treatment of vertebral osteoporotic compression fractures without neurological injuries [2-4]. If a complex osteoporotic fracture is present, which means a concomitant neurological compression and/or a severe spinal deformity, open surgical treatment is advocated. However, instrumenting an osteoporotic spine is challenging because of the patients' advanced ages, medical comorbidities, and poor fixation secondary to osteoporosis [5-7].

The classical management in fractures with neurologic deficits is removal of the vertebral body causing the compression by an anterior surgical approach. The thoracotomy approach provides excellent exposure and treatment especially in the thoracic or thoracolumbar levels. On the other hand thoracotomy is controversial because it requires a second surgical intervention and increases morbidity in elderly patients, especially those with pulmonary problems. [6-9].

The purpose of this retrospective study was to evaluate the results of spinal canal decompression and anterior column support via posterior vertebral column resection (PVCR), performed for eliminating the disadvantages of the anterior approach, in elderly patients having osteoporotic vertebral fractures with neurological deficits.

MATERIALS AND METHODS:

Twenty-six patients who underwent surgical treatment due to the development of neurological deficits after osteoporotic vertebral fractures, and had minimum 2 years of follow up were retrospectively evaluated. There were 20 females and 6 males, mean age was 70.4 (62-84). All patients initially had undergone conservative treatment such as bed rest and thoracolumbosacral orthosis for several months, however vertebral collapse had progressed gradually and neurologic symptoms had subsequently developed. The mean interval between the possible occurrence of the fracture and the emergence of signs of neurological deficit was 4.7 months (range:3-10). Neurological deficit level was ASIA C in 5 patients, and Asia D in 21 patients. The fracture was located in the thoracic vertebrae in 14 patients, and thoracolumbar area in 12 patients. Eighteen patients underwent PVCR in a classical method and total or subtotal corpectomy was performed in 8 patients after unilateral laminectomy and pediculectomy.

Bone mineral density (BMD) of the lumbar spine (L1-L4) was measured using dual-energy x-ray absorptiometry. BMD values were 1.5 or below in all patients. Average preoperative BMD of the lumbar vertebra was 0.642 mg/cm2.

Surgical technique included placement of cement augmented pedicle screws, followed by total or hemilaminectomy, pediculectomy, sacrifice of nerve roots between Th2 and Th11, decompression of the spinal canal by subtotal or total vertebrectomy, removal of adjacent discs (and supporting the anterior column by titanium mesh.

Prophylactic vertebroplasties were performed one level above and one level below in all patients.

The patients were evaluated clinically and radiologically. Radiologic assessment was performed by measuring the local kyphosis angle in the preoperative, postoperative, and follows up X rays. Pain was assessed with the visual analog scale (VAS). An experienced neurologist performed neurologic examinations of the patients. Clinical outcome and complications were also evaluated. Average follow-up time was 36.5 months 18-72).

RESULTS:

Mean operation time was 310 (140-410) minutes and mean blood loss was 460 (320-700) ml. Average level of instrumentation was 5.1 (4-8). Mean preoperative local kyphosis angle improved from 21.5 degrees before the operation to 4.6 degrees after the operation, and was 5 degrees at final follow-up. VAS score was 7 before the operation, decreased to 4 after the operation, and was 2 at final follow-up. Full neurological recovery was achieved in all patients.

There were no non-unions. The major complication was adjacent segment fracture, requiring a revision in 2 patient (7.69%). The minor complications were superficial wound infections in 3 patients (11.5%) and dural tear in 3 patient (11.5%). There was no evidence of either hardware failure or vertebral body collapse at final follow-up.

DISCUSSION:

Osteoporosis is the most frequent skeletal disease, affecting up to 50% of women older than 65 years. Osteoporotic vertebral compression fractures typically involve the middle and lower thoracic spine and thoracolumbar transition. The clinical picture seen in the acute situation is in the form of sudden back pain after minimal injury, and often without any injury [1-3, 10].

The approach to treating osteoporotic fractures of the spine should be individualized, and based on medical history, symptoms, location, and correlation of clinical examination and radiological findings [1, 2]. Osteoporotic fractures of the spine are still treated mostly by conservative measures including rest, analgesics and orthoses. Percutaneous vertebroplasty and kyphoplasty are two augmentation techniques that have become the standard of care for the treatment of vertebral compression fractures refractory to medical treatment [11].

Bone destruction in same cases with osteoporotic vertebral fractures may result in spinal instability. Consequently, patients suffer from pain, immobilisation, kyphotic deformity and neurologic compromise. Re-stabilisation of the spinal column and subsequent decompression of neural structures can provide remobilisation, pain relief, and neurological improvement in patients [12]. The most serious complication of this fracture is delayed neurological deficit, usually due to the retropulsion of vertebral body fragments with significant canal compromise, pseudoarthrosis, or local kyphosis [3, 5-7]. Shikata et al. found that 12.1% of these fractures required surgery because of neurological sequelae [13]. Twenty patients in our study group, the neurological deficit resulted from displacement of the fracture fragments into the canal, and in the remaining six patients the neural structures were impinged due to the resultant kyphotic deformity.

Spinal cord decompression in vertebral fractures that have resulted in neurological deficits can be accomplished by the anterior or posterior approaches. Especially in cases where there are no retropulsed fragments inside the canal, it is possible to obtain good results with kyphosis correction in association with posterior instrumentation subsequent to laminectomy. These major surgical procedures are challenging due to the advanced age, medical comorbidities, and poor fixation secondary to osteoporosis in these patients. When the methods of providing anterior column support are considered it remains unclear whether the anterior or the posterior procedure is optimal [5].

Shikata et al. reported on seven patients with osteoporotic fractures that have resulted in spinal cord compression and incomplete paraparesis, who were treated operatively with posterior decompression and stabilization. Neurological recovery was good in all patients with a mean Frankel grade improvement of two grades. Good correction of preoperative kyphosis was achieved and maintained at follow-up [13].

Sudo et al. reported the results of single stage posterior decompression and instrumented fusion in 21 patients with neurologic deficits caused by osteoporotic vertebral collapse. They obtained neurological improvement in 20 patients. The average correction angle at the final follow-up was 8.0, which showed that the kyphotic angle had significantly improved from before surgery to the final follow-up [14].

Kim et al. used posterolateral decompression and posterior instrumentation to treat 14 patients with neurological deficits caused by delayed vertebral collapse. All patients showed neurological improvement, and the kyphotic improvement achieved was preserved in the long term [15].

Uchida et al. compared the outcomes of anterior and posterior surgeries, and found that the anterior surgery tended to improve neurological deficits in wedge type but not flat type collapse in patients with single-level osteoporotic vertebral collapse with neurological deficit, when compared with posterior surgery.

In patients who have developed neurological deficits due to fragments inside the canal or in patients with severe kyphotic deformities, a frequently used method for both eliminating the compression and correcting the deformity is resection of the vertebral body. This procedure is traditionally performed by the anterior route. Kaneda et al. advocated anterior decompression, bioactive ceramic vertebral prosthesis replacement, and the use of their unique spinal implants. Their series consisted of 22 consecutive patients, and all improved by at least one Frankel grade, except for three patients who failed to improve. None of the patients showed deterioration after the operation. Motor index scores improved from 40.8 to 46.6. The degrees of kyphosis were 27.8° and 13.3° before and after the operation, respectively, and 14.8° at the final follow-up. The authors suggested that the anterior route surgery secured complete decompression, leading to satisfactory results with unexpectedly decreased invasion even in the elderly. They disagreed with violation of the intact posterior spinal elements of the facets, laminae, and interspinous ligaments for the prevention of segmental instability [17].

In addition, Kanayamana et al. demonstrated that anterior spinal reconstruction significantly reduced local kyphosis deformity, and 80.7% of the patients could be successfully treated by anterior spinal reconstruction alone. In this study, anterior spinal reconstruction had several advantages: (a) safe and reliable decompression of neural tissue could be performed under direct vision, (b) structural anterior column support could be provided using titanium cages or ceramic vertebral spacers, and (c) anterior approach to the spine did not disturb "intact" posterior elements and was biomechanically sound. The authors also stated that multilevel corpectomies or severe osteoporosis highly required posterior reinforcement [5]. We also believe that when the osteoporotic properties of the patients are considered, it will be appropriate to add posterior instrumentation to the anterior decompression in order to preserve the correction. The cancellous character of the vertebral bodies and their thin cortical structure is another subject that affects the reliability of the anterior fixation. In contrast, posterior fixation using the pedicle screw system provides a relatively stable fixation even in the osteoporotic spine because the pedicle remains as a strong part of the vertebra [15].

Combined anterior–posterior procedures are usually recommended in cases of kyphotic deformities with neurologic deficit secondary to osteoporosis. This enables anterior support after decompression; also the addition of posterior instrumentation increases the stability of the system, overall preventing the development of kyphotic deformity in the long term [19, 20]. However, combined anterior–posterior surgery is associated with significant morbidity in elderly patients. Especially anterior procedures performed with thoracotomy are controversial because they increase the morbidity in elderly patients with pulmonary problems [6, 12]. The respiratory functions in patients with osteoporotic vertebral fractures were shown to be decreased significantly in the studies by Schlaich et al. [21]. From this respect, anterior decompression and reconstruction with titanium mesh cage using only a posterior approach offers several advantages over traditional anterior or combined anterior–posterior approach for the unstable lumbar burst fractures [20, 22]. In a comparative study Suk et al. demonstrated that the operative time and the amount of bleeding were less in osteotomy operations performed by the posterior route compared to combined approach, and better kyphosis correction was provided [23].

The PVCR method was described for the correction of severe spinal deformities. In the classical technique, the posterior elements, pedicles, and the vertebral body are removed completely together with the adjacent disc structures [24, 25].

In our study, 18 patients underwent PVCR by classical method. In the modified PVCR technique that we used for 8 patient, the pedicle and the lamina are preserved on one side, thereby it is possible to prevent the instability which could result from total removal of the posterior elements often stated by the proponents of anterior surgery **(Figure 1a-1b).** Also, the pedicle screws enable complete correction of the deformity, and provide posterior stabilization in addition to the anterior support.

After decompression, stabilization by a screw-rod construct is easy and is preferred for correction of kyphosis and initiation of early mobilization, however loose transpedicular screws from the vertebral bodies with reduced bone quality may contribute to failure in correction of kyphosis and possible instrumentation failures. In osteoporotic patients, fixation failures have been reported frequently. Many studies demonstrated a correlation between bone mineral density (BMD) and the strength of pedicle screw fixation [26, 27, 28]. Shibata et al recently reported that self-setting hydroxyapatite cement injected transpedicularly into the osteoporotic vertebral body in vivo successfully strengthens anchoring to withstand screw pull-out and axial load [29]. We also used fenestrated pedicle screws along with bone cement in all of our patients and did not encounter any instrument failures during the follow up.

CONCLUSION:

In conclusion the risk of the development of neurological deficits in osteoporotic vertebral fractures should not be underestimated, and the patients should be closely monitored in that aspect. It should be remembered that the risk of the development of neurological injury is greater in injuries where the middle column is fractured from the beginning. The goals in the management of these patients are removal of the neural compression and providing a stable fixation. In patients who have developed neurological deficits, early removal of spinal cord compression is effective in providing recovery. A safe stabilization in osteoporotic patients can be provided with the combined application of anterior and posterior support. Removal of the compression on neural structures, correction of kyphosis, and attaining anterior support in addition to posterior instrumentation is possible with the PVCR method that we applied.

In cases where the spincal cord compression causing the neurological deficit is unilateral, the posterior structures are left intact on one side, which minimizes iatrogenic instability during surgery. The insertion of pedicle screws in association with bone cement is necessary for the stability of osteosynthesis.

ACKNOWLEDGEMENT:

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

74 years old female
T12 vertebra osteoporotic fracture

Figure 1 a: Preoperative anteroposterior and lateral view X-Ray

74 years old female
T12 vertebra osteoporotic fracture
Figure 1 b: Postoperative anteroposterior ve lateral view X-ray

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