

Vertebral Column Resection with Anterior Column Reconstruction through Posterior Only Approach for Thoracolumbar Spine

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Received: 12 August 2024 / Accepted: 2 January 2025 / Published online: 15 June 2025

BACKGROUND: Thoracolumbar vertebral distortion due to either trauma or neoplastic and inflammatory lesions represent a common cause of spinal deformity and neurological deficit. In these cases vertebral column resection (VCR) and anterior column reconstruction is used for maintaining spinal integrity and preventing progressive kyphosis and instrumentation failure

OBJECTIVE: Evaluation of the outcome of posterior only approach for VCR and anterior column reconstruction.

METHODS: Thirteen patients with distorted thoracolumbar vertebrae due to either trauma, infection or neoplastic lesions were included in this study. All patients were operated upon through posterior only approach with local resection via a bilateral transpedicular route with reconstruction of the anterior column using mesh cage or methylmethacrylate (MMA) combined with posterior transpedicular screw fixation. Visual analogue scale (VAS) for pain assessment, American spinal injury association (ASIA) score for neurological status and Cobb angle were used to determine the preoperative condition and the postoperative outcome.

RESULTS: We operated on eight males and five females with a mean age of 48.6 years (28–64 years). Nine patients had a single level VCR, while four patients had double level. All patients had severe back pain, 10 cases had neurological deficit, and 7 cases had local kyphosis. VAS score diminished to a mean of 2.8 from 8.5 preoperatively, eight out of ten cases had improved neurological status and kyphotic angle decreased to $31.8 \pm 10.9^\circ$ in cases presented with kyphosis.

CONCLUSION: This technique of vertebral column resection with anterior column reconstruction through a posterior only approach is safe and effective in achieving the goal of maintaining spinal alignment and preventing neurological deterioration

KEYWORDS: Kyphoscoliosis, Spondylodiscitis, Vertebral Metastasis.

INTRODUCTION

Vertebral column resection (VCR) is removal of the whole vertebra consisting of all three columns of the spine. It is usually used for several purposes; to correct a vertebral distortion due to either trauma, infection mostly tuberculosis, neoplastic lesions or to correct fixed spinal deformities that enables maneuverability required to correct sagittal and coronal deformities.¹ Vertebral column resection was first done by MacLennan in 1922 for scoliosis correction through a posterior only approach that was followed by postoperative bracing.²

From a biomechanical perspective, VCR represents a total failure of spinal stability because the bony vertebra with the three columns together with related ligaments are removed totally. This makes reconstruction a very important step in the treatment paradigm where anterior column reconstruction together with posterior transpedicular fixation is an option.³

Following VCR in the thoracic and lumbar spine, there are numerous known methods for reconstructing the anterior column. Surgeon preference and resources availability

usually impose the technique of reconstruction. In most instances, such reconstructions comprise the application of structural allograft or autograft, with either anterior or posterior instrumentation, or both.⁴

Despite the good results of the two-stages anterior-posterior technique,^{5,6} many studies have reported posterior only VCR.^{2,3,7-9} This approach has the advantage of reducing technical difficulties, operative time, and possibly the complications of the anterior-posterior VCR whether done in a single surgery or in a staged manner.¹

The posterior VCR for fixed kyphoscoliotic malformation in the thoracolumbar spine aims at wide neurological decompression at multiple levels and treating the segmental deformity significantly.¹⁰

Our aim in this article is to report the results and complications of posterior only VCR with anterior column reconstruction for thoracolumbar spinal deformity in thoracolumbar fractures, metastatic spinal tumors in the thoracolumbar region or tuberculous spondylodiscitis in the thoracolumbar spine.

PATIENTS AND METHODS

This prospective study included 13 consecutive patients with different pathologies in the thoracolumbar region admitted for surgery for either correction of kyphotic deformity and/or neurological decompression through

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a single stage posterior only VCR. All cases were operated upon in Alexandria Main University Hospital and affiliated hospitals. Institutional review board (IRB) approval was acquired through Alexandria University ethical committee. Written consents were acquired from all patients.

The primary diagnosis was trauma in 4 patients, tuberculous spondylodiscitis in 5 patients and metastatic tumors in 4 patients.

Preoperative evaluation included patient demographics, present history and thorough neurological examination. Pain assessment was done using the visual analogue scale (VAS) and neurological status was assessed using American spinal injury association (ASIA).

Full laboratory investigations, especially white blood cell count, erythrocyte sedimentation rate and c-reactive proteins were done especially for cases of tuberculous spondylodiscitis.

Radiological assessment included plain x-ray whether static or dynamic whenever possible to assess the stability of the spine, sagittal balance and Cobb angle of kyphotic deformity, if present, between the superior endplate of the upper end vertebra and the inferior endplate of the lower end vertebra, Computerized tomography (CT) scan of the affected segments was performed to determine the involved spinal column. Magnetic resonance imaging (MRI) of the thoracolumbar spine was performed to detect spinal cord or cauda compression and the extent of the disease.

Metastatic workup was done in cases of metastatic spinal tumors to detect the primary, including CT chest and abdomen and positron emission tomography (PET) scan in certain cases.

All patients had posterior VCR and spinal canal decompression with reconstruction of the anterior column using mesh cages and morselized autologous bone grafts or bone cement methylmethacrylate (MMA)

The objectives of these surgeries were total removal of the lesion in cases of infection and neoplasm, spinal decompression, stabilizing the thoracolumbar spine and correction of deformity.

Operative Technique: The affected vertebra were removed through a posterior only approach; in cases of infection or tumors we used costotransversectomy and transpedicular approach to remove the infected vertebral bodies. The procedure was done anterior to the thoracic cord without touching it (Fig. 1).¹¹

In trauma cases where there was burst fracture, partial or complete destruction of the anterior column, we removed vertebral bony fragments, and a graft was inserted to support the anterior column through posterior approach in a single stage.

After completion of the corpectomy and osteotomy,

deformity correction was accomplished by applying pre-shaped final rods with cantilever bending and compression techniques. The operating table was modified gradually and slowly so to raise the foot and head of the table adding more compression and helping in the deformity correction. All cases were operated upon under guidance of intra-operative neuromonitoring (IONM).

When doing VCR at the thoracic region, the spinal root of the same level was sectioned if necessary. In the lumbar region, extreme caution was taken to preserve the spinal roots at both sides.

Postoperatively, patients were encouraged to ambulate as early as possible as long as their neurological status allowed this while wearing a thoracolumbar brace. The average length of hospital stay was about 3 days. Patients were examined clinically and radiologically during the follow up period with a mean of 18.2 months (range 8-34 months).

Paired sample t-test was used to assess preoperative and postoperative changes in VAS score and kyphotic angle correction.

RESULTS

This prospective study enrolled 13 consecutive patients, including 8 males and 5 females, with a mean age of 48.6 years (range 28-64 years) at the time of surgery.

The study included 4 patients with thoracolumbar trauma, 5 patients with tuberculous spondylodiscitis and 4 patients with metastatic tumors (**Table 1**).

The number of removed vertebrae was 1.3 on average (1-2 levels) per patient, where 9 patients had only one level VCR and 4 patients had 2 levels (**Table 2**).

The mean operative time was 218 ± 42 min (range 160-300 min) with a mean blood loss of 1615 ± 544 ml (range 800-2500 ml).

All of our patients suffered from back pain with a mean VAS score 8.5 ± 0.9 (range 7-10), Ten patients had neurological deficit at initial presentation; most of them were ASIA score B and C in the form of paraparesis and sphincteric incontinence, lastly seven of our patients experienced local kyphotic deformity with a mean Cobb angle $84.2 \pm 11.5^\circ$ (range 70-98°) (**Table 3**).

We do not have expandable cages, so we used either mesh cages and autologous bone grafts or bone cement which was used in a single case of metastatic tumor in the fifth lumbar (L 5) vertebral level.

VAS score diminished to a mean of 2.8 from 8.5 preoperatively and this change was statistically significant between preoperative and postoperative values ($p < 0.05$).

We had no cases with postoperative worsening of neurological status, eight out of 10 cases have improved throughout the whole follow up period, 7 of them could walk again after being wheelchair dependent.

Kyphotic angle decreased after surgical correction to $31.8 \pm 10.9^\circ$ (range $20-48^\circ$) and this change was statistically significant between preoperative and postoperative values ($p < 0.05$).

We had 12 patients who postoperatively demonstrated sound fusion at 6–9 months follow-up, evidenced by X-ray or CT scan. There was only one case of displaced graft without neurological deficit nor loss of kyphotic angle correction and no patient got proximal junction kyphosis. There was no screws breakage or recurrence of kyphosis.

Illustrative cases:

Case 1:

A 53 years male patient with a history of road traffic accident 5 months prior to admission, with fracture of dorsal (D)9-10 vertebrae. He presented by lower limb weakness and spasticity (ASIA D), back pain with progressive kyphosis (**Fig. 1**). He was operated upon for D9-10 posterior VCR and mesh cage insertion with pedicular screw fixation of D6-8, D11-L1 (**Fig. 2**). Post-operatively, the patient improved neurologically, and kyphotic deformity was corrected (**Fig. 3**).

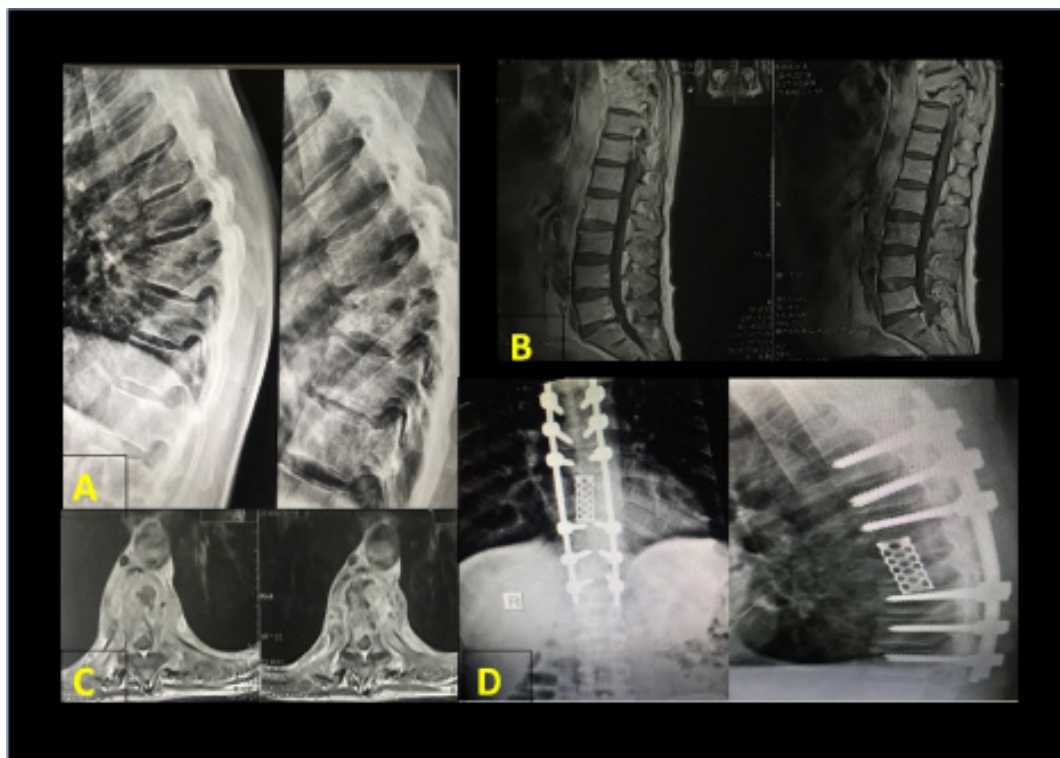


Fig 1: Case 1 Preoperative and postoperative imaging. (A): Preoperative Xray showing the kyphosis at D8-9, (B & C): Sagittal and axial thoracolumbar MRI showing the lesion. (D): Postoperative X-ray showing fixation of D6-8, D11-L1 and insertion of mesh cage.



Fig 2: Intraoperative pictures showing insertion of mesh cage after VCR of D9-10 and ligation of the root. Labelled structures including: Cord (c), divided D10 root (r), resected vertebral body (VB) and pyra mesh harboring the allographic bone (PM).



Fig 3: Inspection of the correction of the kyphotic deformity in the lateral standing position. Postoperatively (A) in comparison with preoperatively (B).

Case 2:

A 57 years female patient with diabetes and hypertension presented by paraparesis ASIA C due to lumbar 4 (L4) metastatic tumor with cauda equina compression. She had a history of breast cancer 1 year ago. She was

operated for tumor resection and decompression of the spinal canal through posterior VCR of L4 with insertion of L3 and L5 pedicular screws and insertion of a mesh cage. (Fig. 4) She had improved neurologically to ASIA D and received radiotherapy and hormonal therapy.

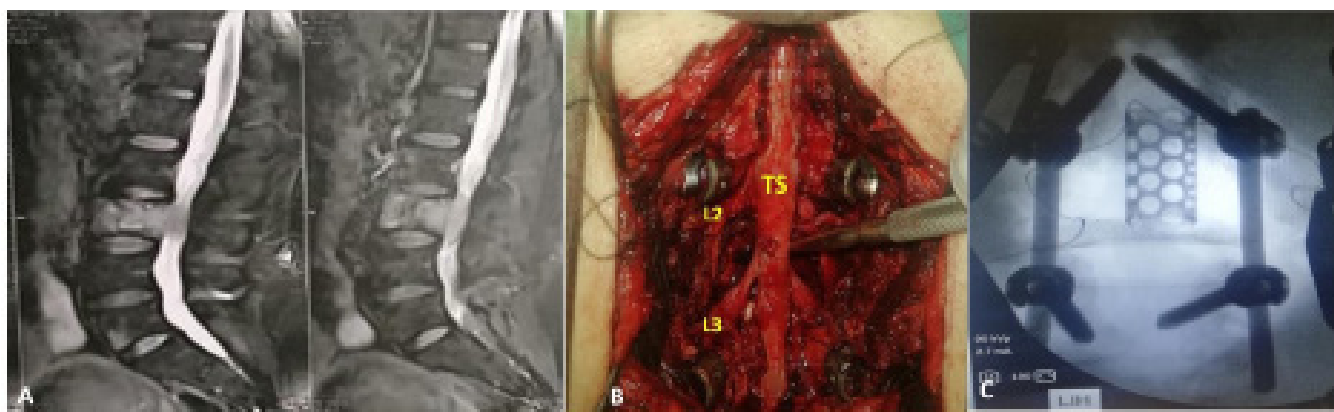


Fig 4: Case 2, (A): Preoperative MRI showing compression of cauda equina by L4 metastatic tumor, (B): Intraoperative picture showing removal of the tumor anterior to the thecal sac (TS), L2 and L3 roots were decompressed at both sides, (C): Intraoperative x-ray showed posterior VCR and insertion of mesh cage.

Table 1: Demographic characteristics

Pathology	Male	Female	Age range
Trauma	3	1	28-40 years
Infection (tuberculosis)	2	3	48-62 years
Tumors (2ry)	3	1	52-64 years

Table 2: Summarized data of our patients

Patient No	Age (yrs) & sex	Instrumented segment	Resected segment	Pathology	VAS Pre	VAS post	ASIA pre	ASIA post
1	35,M	C7-D1,D3-4	D2	Metastasis	8	3	C	D
2	28,M	D12-L1,L3-4	L2	Fracture	9	2	B	D
3	30,F	D10-11,L1-2	D12	Metastasis	9	2	E	E
4	53,M	D6-8,D11-L1	D9,D10	Fracture	7	1	D	D
5	42, M	D4-5,D7-8	D7	TB	10	3	C	D
6	48,F	D4-5,D8-9	D6,D7	TB	9	2	B	B
7	54,M	D6-7,D10-11	D8,D9	TB	10	3	B	C
8	59,F	D5-6,D8-9	D7	TB	8	1	C	D
9	60,M	D8-10,L1-3	D11-12	TB	9	1	E	E
10	57,F	L3,L5	L4	Metastasis	7	2	C	D
11	64,F	L3-4,S1,ilium	L5	Metastasis	9	3	E	E
12	54,M	D10-11,L1-2	D12	Fracture	8	1	A	A
13	50,M	D7-9,D11-L1	D10	Fracture	8	3	B	C

C: Cervical. D: Dorsal. L; Lumbar. S: Sacral.

Table 3: Distribution of different clinical presentations among cases

	Trauma	Infection (Tuberculosis)	Tumors (2ry)
Neurological deficit	4/4	4/5	2/4
Pain	4/4	5/5	4/4
Kyphosis	1/4	4/5	2/4

DISCUSSION

Vertebral column resection is a challenging procedure usually used for several purposes; to correct a vertebral distortion due to either traumatic, inflammatory mostly tuberculosis, or neoplastic lesions or to correct fixed spinal deformities. The choice of the approach whether anterior, posterior or combined is debatable. In that series, we tried to emphasize the feasibility of the posterior only approach and its superiority over other approaches.

Many authors shared us the same concept; Papadopoulos et al. stated that regardless being done as a single surgery or staged procedure, combined anterior and posterior VCR was considered as a major costly surgical procedure that may not be suitable for areas with limited resources.¹

Many authors also preferred the use of posterior only VCR for treatment of spinal deformities, post tuberculous kyphosis, metastatic destruction of the vertebral bodies and traumatic fractures.^{2,8,11-15}

After VCR there was an utmost need for anterior column reconstruction in order to prevent instrumentation failure by helping in load sharing, to enhance fusion and maintain correction. We used mesh cages filled with morselized autologous bone grafts in most of our cases or bone cement MMA which was used in one case. Other options include expandable cages and strut bone graft.

We did not use expandable cages due to availability issues and in the settings of limited resources. Strut bone allograft whether from the iliac bone or rib graft was not used in order not to add donor site morbidity and to decrease bleeding which is a major issue in this approach.

Bony fusion in our series was high where we could record fusion in all of our cases except one of our early operated cases which had mesh cage displacement (92%). Other authors reported fusion rates ranging from 36% to 100% following resection of spinal tumors. This wide range in different studies might be explained by intra- and interstudy heterogeneity.¹⁶⁻¹⁸

Li et al. concluded that despite pseudoarthrosis when it happened, instrumentation failure will be impossible to evade over time due to metal wear and tear. Not every patient with instrumentation failure suffered back pain, and even neurological deterioration was not found in all cases of instrumentation failure. In other words, non-fusion was not necessarily catastrophic.¹⁹ This was similar to what happened in our case of non-fusion and cage displacement.

The major problem of this technique is blood loss and neurological damage. In our series the average blood loss was 1615 ± 544 ml (range 800–2500 ml). We followed certain strategies to minimize blood loss including subperiosteal exposure of the posterior vertebral

elements, meticulous hemostasis using bipolar cautery, bone wax and gel foam and safe hypotensive anesthesia. Many studies reported that intraoperative blood loss will be profuse when VCR is used to manage spinal deformities.^{9,11,20}

Suk et al. operated on 25 patients with kyphosis post spondylodiscitis using a posterior-only VCR, resected 3.7 vertebrae (range 1–7 vertebrae) on average, and the mean blood loss was 2,980 ml (range 1,800–4,200 ml).¹¹ Wang et al. described the posterior-only multilevel vertebral column resection, and they excised 2.5 vertebrae (range 2–4 vertebrae) on average, and the average blood loss was 2,933 ml (range 2,000–6,000 ml).¹² Zhang et al. removed 1.3 vertebra (range 1–2) on average and the average blood loss was 1,653.3 ml (range, 800–3,000 ml).¹⁰

The main benefit of VCR is circumferential exposure of the neural elements, the cord and the roots. In addition to the use of intra operative methyl prednisolone, stepwise correction of the deformity whenever it was there and lastly avoiding over shortening of the cord and the use of IONM help in minimizing neurological injury. Therefore in our study none of our patients deteriorated neurologically. Zhang et al. also reported no neurological related complications in their series.¹⁰ Similarly, Liu et al. had 13 patients out of 14 with preoperative neurological deficit improved neurologically after surgery and only one patient did not experience clinical neurological improvement and no patient deteriorated neurologically.²¹ Akeyson and McCutcheon. in their series of posterior VCR for spinal metastasis out of the 18 patients with a neurological deficit, 10 showed improvement, one was worse and 7 remained unchanged.¹³

In this study VAS score diminished to a mean of 2.8 from 8.5 pre operatively and the difference was statistically significant. This was in accordance with other studies proving the effectiveness of this technique in pain reduction.^{7,10,11,15,16,20-22}

In this study 7 of our patients had local kyphotic deformity with a mean Cobb angle $84.2 \pm 11.5^\circ$ (range $70-98^\circ$). This angle decreased after surgical correction to $31.8 \pm 10.9^\circ$ (range $20-48^\circ$) and this change was statistically significant. Zhang et al. reported correction of sagittal Cobb angle from a mean preoperative kyphosis 92.3° to a mean postoperative angle of 34.5° .¹⁰ Suk et al. reported 25 patients with severe kyphosis following spinal infections who were managed by the posterior VCR, and the mean sagittal correction was 45.2° .¹¹ Liu et al. in their series stated a result of kyphosis improvement from a preoperative angle average of 70.7° to a postoperative angle average of 30.2° .²¹ In Papadopoulos et al. series the average preoperative local kyphosis corrected from 108° to 60° postoperatively.¹

CONCLUSION

This technique of vertebral column resection with anterior column reconstruction through a posterior only

approach is safe and effective in achieving the goals of maintaining spinal alignment and preventing neurological deterioration providing circumferential decompression of the neural elements and reconstruction of the vertebral column through a posterior only single approach.

Abbreviations

ASIA: American spinal injury association.
C: Cervical.
CT: Computerized tomography.
D: Dorsal.
IONM: Intra-operative neuromonitoring.
IRB: Institutional review board.
L: Lumbar.
MMA: Methylmethacrylate.
MRI: Magnetic resonance imaging.
PET: Positron emission tomography.
S: Sacral.
VAS: Visual analogue scale.
VCR: Vertebral column resection.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

Funding

The authors received no financial support for the research, authorship, and/or publication of this paper.

REFERENCES

1. Papadopoulos EC, Boachie-Adjei O, Hess WF, et al. Early outcomes and complications of posterior vertebral column resection. *Spine J.* 2015;15(5):983-991.
2. Suk SI, Chung ER, Kim JH, Kim SS, Lee JS, Choi WK. Posterior vertebral column resection for severe rigid scoliosis. *Spine (Phila Pa 1976).* 2005;30(14):1682-1687.
3. Akamaru T, Kawahara N, Sakamoto J, et al. The transmission of stress to grafted bone inside a titanium mesh cage used in anterior column reconstruction after total spondylectomy: A finite-element analysis. *Spine (Phila Pa 1976).* 2005;30(24):2783-2787.
4. Dvorak MF, Kwon BK, Fisher CG, Eiserloh HL 3rd, Boyd M, Wing PC. Effectiveness of titanium mesh cylindrical cages in anterior column reconstruction after thoracic and lumbar vertebral body resection. *Spine (Phila Pa 1976).* 2003;28(9):902-908.
5. Boachie-Adjei O, Bradford DS. Vertebral column resection and arthrodesis for complex spinal deformities. *J Spinal Disord.* 1991;4(2):193-202.
6. Bradford DS, Tribus CB. Vertebral column resection for the treatment of rigid coronal decompensation. *Spine (Phila Pa 1976).* 1997;22(14):1590-1599.

7. Hamzaoglu A, Alanay A, Ozturk C, Sarier M, Karadereler S, Ganiyusufoglu K. Posterior vertebral column resection in severe spinal deformities: A total of 102 cases. *Spine (Phila Pa 1976)*. 2011;36(5):E340-E344.
8. Lenke LG, O'Leary PT, Bridwell KH, Sides BA, Koester LA, Blanke KM. Posterior vertebral column resection for severe pediatric deformity: Minimum two-year follow-up of thirty-five consecutive patients. *Spine (Phila Pa 1976)*. 2009;34(20):2213-2221.
9. Wang Y, Zhang Y, Zhang X, et al. A single posterior approach for multilevel modified vertebral column resection in adults with severe rigid congenital kyphoscoliosis: A retrospective study of 13 cases. *Eur Spine J*. 2008;17(3):361-372.
10. Zhang HQ, Li JS, Liu SH, et al. The use of posterior vertebral column resection in the management of severe posttuberculous kyphosis: A retrospective study and literature review. *Arch Orthop Trauma Surg*. 2013;133(9):1211-1218.
11. Suk SI, Kim JH, Kim WJ, Lee SM, Chung ER, Nah KH. Posterior vertebral column resection for severe spinal deformities. *Spine (Phila Pa 1976)*. 2002;27(21):2374-2382.
12. Wang Y, Zhang Y, Zhang X, et al. Posterior-only multilevel modified vertebral column resection for extremely severe Pott's kyphotic deformity. *Eur Spine J*. 2009;18(10):1436-1441.
13. Akeyson EW, McCutcheon IE. Single-stage posterior vertebrectomy and replacement combined with posterior instrumentation for spinal metastasis. *J Neurosurg*. 1996;85(2):211-220.
14. Shaw B, Mansfield FL, Borges L. One-stage posterolateral decompression and stabilization for primary and metastatic vertebral tumors in the thoracic and lumbar spine. *J Neurosurg*. 1989;70(3):405-410.
15. Tang HZ, Xu H, Yao XD, Lin SQ. Single-stage posterior vertebral column resection and internal fixation for old fracture-dislocations of thoracolumbar spine: A case series and systematic review. *Eur Spine J*. 2016;25(8):2497-2513.
16. Chong S, Shin SH, Yoo H, et al. Single-stage posterior decompression and stabilization for metastasis of the thoracic spine: Prognostic factors for functional outcome and patients' survival. *Spine J*. 2012;22(12):1083-1092.
17. Elder BD, Ishida W, Goodwin CR, et al. Bone graft options for spinal fusion following resection of spinal column tumors: Systematic review and meta-analysis. *Neurosurg Focus*. 2017;42(1):E16.
18. Yoshioka K, Murakami H, Demura S, et al. Clinical outcome of spinal reconstruction after total en bloc spondylectomy at 3 or more levels. *Spine (Phila Pa 1976)*. 2013;38(24):E1511-E1516.
19. Li Z, Wei F, Liu Z, et al. Risk factors for instrumentation failure after total en bloc spondylectomy of thoracic and lumbar spine tumors using titanium mesh cage for anterior reconstruction. *World Neurosurg*. 2020;135:e106-e115.
20. Snell BE, Nasr FF, Wolfla CE. Single-stage thoracolumbar vertebrectomy with circumferential reconstruction and arthrodesis: Surgical technique and results in 15 patients. *Neurosurgery*. 2006;58(4 Suppl 2):ONS-263-269.
21. Liu C, Lin L, Wang W, Lv G, Deng Y. Long-term outcomes of vertebral column resection for kyphosis in patients with cured spinal tuberculosis: Average 8-year follow-up. *J Neurosurg Spine*. 2016;24(5):777-785.
22. Elsamadicy AA, Adogwa O, Sergesketter A, Lydon E, Bagley CA, Karikari IO. Posterolateral thoracic decompression with anterior column cage reconstruction versus decompression alone for spinal metastases with cord compression: Analysis of perioperative complications and outcomes. *J Spine Surg*. 2017;3(4):609-619.