Original Article

# Posterior vertebral column resection: Exploring practical uses in clinical settings


## ABSTRACT

**Background:** The purpose of this study was to present our experience in patients who had been treated with posterior vertebral column resection (PVCR) for various spinal deformities.

**Methods:** Thirty-seven patients who performed PVCR between 2015 and 2018 were evaluated retrospectively. The mean follow-up period was 24 months (range: 12–50 months). The demographic data of the patients, mean blood loss, amount of blood replacement, duration of operation, intensive care and hospitalization period, PVCR level, instrumentation level, amount of preoperative curvature, amount of postoperative curvature improvement, preoperative and postoperative neurological status, and complications were examined. Angular measurements were performed on X-ray.

**Results:** The mean age of the patients was 37.5 years (range: 3–80 years). PVCR was applied to patients due to different pathologies (congenital, tumor metastasis, posttraumatic kyphosis, revision scoliosis, and infection). The mean operation time was 445.5 min (260–720) with an average blood loss of 1903 ml (400–7000 ml). It was observed that the average local kyphosis angle decreased from 67.65 to 7.42 in 26 patients who were operated for advanced deformity ($P < 0.001$). When these values were compared in all 34 patients, the preoperative angle value decreased from 55.1 to 3.5 ($P < 0.001$) and decreased from 70 to 0 in 13 congenital kyphosis patients.

**Conclusion:** PVCR is an effective method for correcting severe spinal deformities and can be used to correct curvature in different patient groups.

**Level of Evidence:** Level 3.


**Keywords:** Congenital, infection, posterior vertebral column resection, rigid deformity, tumor

## INTRODUCTION

Severe spinal deformities affect the patient's comfort both cosmetically and functionally. Reestablishing anatomical integrity reduces such symptoms. Various surgical procedures have been outlined for this purpose. Posterior vertebral column resection (PVCR) is a surgical technique used to correct advanced spinal deformities, and its application has been expanding day by day over the last two decades. Although it can be a challenging procedure due to potential complications, such as significant bleeding and neurological deficits, the use of this technique is becoming more widespread due to its ability to correct deformities in multiple planes. When implemented correctly and in appropriate cases, it has been demonstrated to enhance patients' quality of life.[1]

The main indications of PVCR are rigid deformities that cause severe sagittal imbalance and require correction up to 45°.


**Mehmet Akif Çaçan, Murat Birinci, Yilmaz Mertsoy[1], Kadir Uzel, Bilal Bostanci, Bekir Yavuz Uçar**

Department of Orthopedic and Traumatology, School of Medicine, Istanbul Medipol University, Istanbul, [1]Department of Orthopedic and Traumatology, Diyarbakir Gazi Yasargil Training and Research Hospital, Diyarbakir, Turkey

**Address for correspondence:** Dr. Bilal Bostanci, TEM Avrupa Otoyolu Göztepe Çikisi, No. D:1, Bağcilar 34214, Istanbul, Turkey.
E-mail: drbilalbostanci@gmail.com


**Submitted:** 29-Jan-24 **Accepted:** 28-Feb-24
**Published:** 24-May-24



**How to cite this article:** Çaçan MA, Birinci M, Mertsoy Y, Uzel K, Bostanci B, Uçar BY. Posterior vertebral column resection: Exploring practical uses in clinical settings. J Craniovert Jun Spine 2024;15:190-5.

| Access this article online | |
|---|---|
| **Website:** www.jcvjs.com | Quick Response Code |
| **DOI:** 10.4103/jcvjs.jcvjs_15_24 | |

Today, the indications and contraindications are still not clear; however, in Kunming Consensus 2017, it was tried to create a common language on this subject.[2]

The aim of our study is to share the results of our patients treated with PVCR and to show that this technique can be used in wider areas.

## METHODS

Thirty-seven consecutive patients (22 females and 15 males) underwent the PVCR technique between 2015 and 2018 at a single institution. The mean age was 38.5 (range: 3–80). A retrospective evaluation was conducted. The advanced spinal deformities have various etiologies, including infection in seven patients, tumor metastasis in seven, isolated congenital kyphosis in seven, congenital scoliosis or kyphoscoliosis in seven, posttraumatic kyphosis in three, revision scoliosis in two, progressive Scheuermann's disease in two, and postoperative junctional kyphosis (PJK) in two patients [Table 1].

PVCR was planned and performed on patients with severe deformity and whose deformity was not expected to improve with other existing osteotomy types, on those patients who had discitis and osteomyelitis not responded to 6-week antibiotherapy, and on patients who had metastatic tumor causing spinal cord decompression or severe osteolysis.

Written consent was obtained from all patients. If the patient is under 18, informed consent has been obtained from the parents or legal guardians of the children.

### Surgical technique

Following routine posterior midline exposure, pedicle screws were surgically implanted. Subsequently, a wide laminectomy was carried out between the proximal and distal vertebral pedicles. A short rod, fitted with a minimum of two pedicle screws located proximally and distally to the pedicle screws on one side, was then inserted to prevent any potential instability. The proximal and distal discs were removed thereafter, and an osteotomy was carried out from the pedicle toward the body. The nerve root was ligated and cut at the thoracic levels and set aside slightly at the lumbar levels. The vertebral body was then removed using high-speed burrs, Kerrison Rongeurs, and osteotomes. A temporary rod was placed on the side of the osteotomy, the opposite rod was removed, and the same procedure was carried out on the opposite side, completing the corpectomy. To enhance fusion, a scraper was used to clean the end plates of the upper and lower vertebrae, exposing the bone surfaces. A corpectomy cavity was filled with a titanium cage containing a cancellous graft. Subsequently, the deformity was corrected and the posterior instrumentation system was secured with pedicle screws. In cases of kyphoscoliosis with severe deformity, our surgical approach aimed to achieve bone-to-bone fusion of the upper and lower vertebrae without any anterior support materials. Following this, we administered 1 g of vancomycin into the surgical area and closed the wound by placing a drain [Figures 1 and 2]. The patients were all monitored in the intensive care unit for at least a day postsurgery.

Patients' preoperative and postoperative local kyphosis angle, amount of improvement, number of resected vertebrae, number of vertebrae with fusion, perioperative blood loss, number of blood units transferred to patients, operation time, and length of stay were recorded. Preoperative and postoperative local kyphosis angle was compared. Eight patients underwent PVCR for tumor or infection, not for rigid deformity.

Angular measurements were taken on plain radiographs both pre- and postoperation. The suture was removed on the 14$^{th}$ day, and control radiographs were taken at the 3$^{rd}$, 6$^{th}$, and 12$^{th}$ months to assess fusion. Failure was defined as recurrence in patients without advanced spinal deformity who underwent PVCR due to infection or tumor.

As exclusion criteria, we identified patients with a follow-up of < 12 months, patients with disrupted controls, and patients without follow-up radiographs.

Data analysis was performed using SPSS Statistic version 22.0 (IBM, Armonk, New York, USA) Kolmogorov–Smirnov test was used to show whether the numerical data were normally distributed. Normally distributed dependent variables were tested with paired *t*-test. Wilcoxon test was used for preoperative and postoperative local kyphosis angle variables that did not fit into the normal distribution. $P < 0.05$ indicated a statistically significant difference.

## RESULTS

Mortality in the 1$^{st}$ year following the surgery was 8% (3/37). One of 37 patients died in the intensive care unit on the 2$^{nd}$ postoperative day, one died in the intensive care unit on the 3$^{rd}$ postoperative day due to myocardial infarction, and the third patient died secondary to the progression of his cancer in the oncology service 5 months after the operation. After the exclusion of these patients, the mean follow-up of the remaining 34 patients was 22.3 months (12–50 months). The mean operation time was 448.5 min (260–720) with an

**Table 1: Patient data**

| Patient | Age | Gender | Etiology | PVCR level | Fusion level | LOS | ICU | Preoperative neurological deficit | Postoperative neurological deficit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 46 | Female | Posttraumatic kyphosis | T12 | 5 | 7 | 1 | | |
| 2 | 78 | Male | Metastasis (multiple myeloma) | L1 | 6 | 10 | 2 | Incomplete paraplegia | |
| 3 | 46 | Female | Infection (nonspecific discitis) | T7+T8 | 5 | 6 | 1 | | |
| 4 | 52 | Male | Infection (*S. aureus*) | L5 | 6 | 15 | 1 | Incomplete paraplegia | |
| 5 | 66 | Female | Metastasis (RCC) | L4 | 5 | 8 | 1 | | |
| 6 | 5 | Female | Congenital kyphosis | L2 | 3 | 7 | 1 | | |
| 7 | 65 | Female | Posttraumatic kyphosis | T4 | 16 | 12 | 2 | | |
| 8 | 12 | Female | Congenital kyphosis | T8 | 15 | 11 | 2 | | |
| 9 | 33 | Female | Congenital kyphosis | T8 | 16 | 10 | 2 | | |
| 10 | 35 | Female | Revision scoliosis | L1+L2 | 17 | 21 | 15 | | |
| 11† | 70 | Female | Posttraumatic kyphosis | T12 | 12 | 3 | 3 | | |
| 12 | 80 | Female | Metastasis | L5 | 6 | 5 | 2 | | |
| 13 | 65 | Male | Hemangioma | T4 | 8 | 6 | 2 | Incomplete paraplegia | |
| 14 | 48 | Female | Metastasis (breast Ca) | T9 | 6 | 3 | 1 | | |
| 15 | 35 | Male | Revision scoliosis | T12+L1 | 18 | 15 | 2 | | |
| 16 | 67 | Male | Infection (*S. aureus*) | L1+L2 | 16 | 12 | 2 | Incomplete paraplegia | |
| 17 | 5 | Female | Congenital kyphosis | T5+T6 | 17 | 13 | 2 | | |
| 18 | 62 | Male | Pott disease | L3 | 6 | 8 | 1 | | |
| 19 | 27 | Female | Scheuermann's kyphosis | T5 | 10 | 5 | 1 | | |
| 20 | 50 | Male | Metastasis (prostate Ca) | T3 | 14 | 15 | 4 | Incomplete paraplegia | |
| 21 | 17 | Male | Scheuermann's kyphosis | T10+T11 | 11 | 8 | 1 | | |
| 22 | 66 | Female | Proximal junctional kyphosis | T9+T10 | 18 | 15 | 2 | | |
| 23† | 68 | Male | Metastasis (multiple myeloma) | L5 | 5 | 13 | 2 | Incomplete paraplegia | |
| 24 | 64 | Male | Infection (nonspecific discitis) | T3+T4+T5 | 8 | 18 | 1 | | |
| 25 | 3 | Female | Congenital kyphosis | L2 | 15 | 11 | 3 | Complete paraplegia | Complete paraplegia |
| 26 | 65 | Female | Pott disease | T4+T5+T6 | 9 | 10 | 2 | Incomplete paraplegia | |
| 27 | 7 | Female | Congenital kyphosis | L1+L2 | 18 | 10 | 2 | Complete paraplegia | Complete paraplegia |
| 28 | 46 | Male | Candida osteomyelitis | L4–L5 | 9 | 8 | 1 | | |
| 29 | 54 | Female | Posttraumatic kyphosis | T10 | 7 | 4 | 1 | | |
| 30 | 4 | Female | Congenital kyphosis | T12+L1 | 18 | 7 | 2 | Complete paraplegia | Complete paraplegia |
| 31 | 17 | Male | Congenital kyphosis | T10+T11 | 18 | 8 | 2 | Complete paraplegia | Complete paraplegia |
| 32 | 10 | Male | Congenital kyphosis | T12+L1 | 19 | 9 | 2 | Complete paraplegia | Complete paraplegia |
| 33 | 3 | Male | Congenital kyphosis | T12+L1 | 17 | 8 | 2 | | |
| 34† | 2 | Female | Congenital kyphosis | T4+T5+T6 | 16 | 2 | 2 | Complete paraplegia | Complete paraplegia |
| 35 | 10 | Female | Congenital kyphosis | L2 | 19 | 14 | 2 | Complete paraplegia | Complete paraplegia |
| 36 | 3 | Female | Congenital kyphosis | L1 | 18 | 8 | 2 | Complete paraplegia | Complete paraplegia |
| 37 | 3 | Male | Congenital kyphosis | L4 | 17 | 7 | 2 | Complete paraplegia | Complete paraplegia |
| Mean | 37.5 | | | | | 9.8 | 2 | | |

†Patients, who died. PVCR - Posterior vertebral column resection; LOS - Length of stay; ICU - Intensive care unit; RCC - Renal cell ca; *S. aureus* - *Staphylococcus aureus*

average blood loss of 1918 ml (400–7000 ml). It was observed that the average local kyphosis angle decreased from 67.65° to 7.42° in 26 patients who were operated for advanced deformity ($P < 0.001$). When these values were compared in all 34 patients, the preoperative angle value decreased from 56.6° to 3.5° ($P < 0.001$) and decreased from 70° to 0° in 13 congenital kyphosis patients.

Descriptive parameters are shown in Table 2.

While 4 (11.8%) patients developed superficial wound problems requiring debridement, one patient (3%) developed recurrent debridement and deep infection requiring removal of all implants at the end of 1st year. In the perioperative period, one (3%) segmental artery bleeding, and two dural tears (5.8%) occurred. Six patients had previously undergone spinal surgery.

In preoperative evaluation, seven patients have incomplete and nine patients have complete paraplegia. Recovering the neurological symptoms after surgical intervention occurred in six patients with incomplete paraplegia [Table 1]. During the follow-up period, neither nonunion, pseudoarthrosis nor implant failure developed.

## DISCUSSION

After PVCR was described by Suk *et al*. in the early 2000s, its use has become widespread day by day.[3] Although it is a method frequently performed in the treatment of severe and fixed deformities in daily practice, we believe that it may have indications in a wider area than described. In addition to deformities, we applied the PVCR technique for vertebral metastases and infections.

**Table 2: Descriptive information of patients**

| | Mean (minimum–maximum) |
|---|---|
| Age | 36.4 (3–78) |
| Follow-up | 22.3 (12–50) |
| Duration of operation | 448.5 (260–720) |
| Blood replacement (unit)* | 2.8 (1–12) |
| Blood loss (mL) | 1918.5 (400–7000) |
| Preoperative kyphosis angle (°) | 56.6 (0–137) |
| Postoperative kyphosis angle (°) | 3.8 (−30–50) |
| Amount of correction (°) | 54.7 (10–150) |

*Replacement during the period until the patient is discharged


**Figure 1: A 72 year old female patient. The patient who had previous spinal surgery had postoperative junctional kyphosis and a neurological deficit. The patient underwent posterior vertebral column resection and proximal level extension surgery. (a) Preoperative magnetic resonance imaging, (b) postoperative anterior posterior plain radiography, (c) postoperative lateral plain radiography**

The circumferential vertebral colon resection performed today was described by Bradford and Tribus.[4] This technique requires posterior and anterior combined approach. With the only-posterior approach developed by Suk *et al*. at the beginning of the 2000s, both the operation time was shortened, and the estimated blood loss was reduced.[3] PVCR allows the correction of large deformities. On the other hand, the difficulty of the technique comparing to other osteotomies such as Smith-Peterson osteotomy (SPO) may cause prolongation of the operation time, increased blood loss, and different complications.[5-7] In one of the first studies on this subject, it was reported that the mean operation time of 16 patients who underwent PVCR for advanced deformity was 6.17 h, and the estimated blood loss was 7034 ml.[3] In a larger series, a meta-analysis involving 7 studies and 390 patients, the mean blood loss was reported to be 2639 ml, and the mean operative time was 430 min.[8] In our series, we found the estimated blood loss to be 1918 ml and the mean operation time to be 448.5 min. The values we obtained in our study are compatible with the literature.

Compared to SPO and pedicle subtraction osteotomy (PSO), PVCR allows more correction. Cho *et al*. compared 71 patients who underwent SPO and PSO for fixed sagittal imbalance and evaluated that the correction value for SPO as 10.7° and for PSO 31.7°.[9] Twenty-one patients with myelomeningocele operated by Özcan *et al*., the kyphotic angle has been reduced from 115° to 3.9° postoperatively.[10] We also found similar correction rates reported in the literature. Preoperative kyphosis angle decreased from 67.65° to 7.42° in patients operated for severe and rigid angulation. The mean amount of curvature correction was 60.2°.

Spina bifida-associated spinal deformities, including congenital kyphosis and kyphoscoliosis, can lead to severe

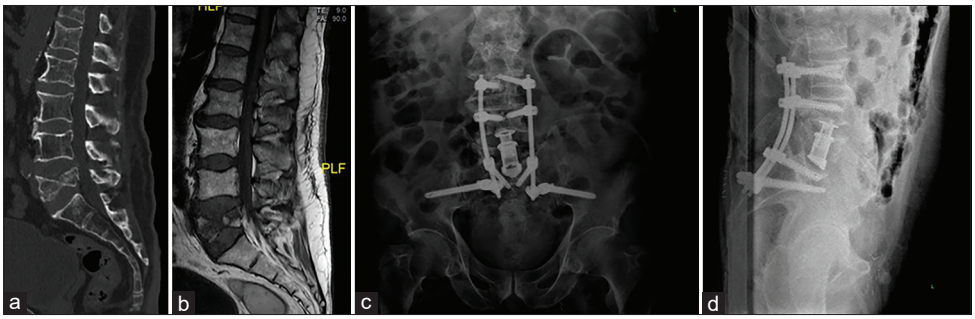


**Figure 2: A 68 year old male patient followed up for multiple myeloma. L5 corpectomy and posterior instrumentation were performed on the patient due to severe low back pain and right L5 neurologic deficit. Patient's preoperative computed tomography (CT) scan image (a). Patient's preoperative magnetic resonance imaging (MRI) scan image (b). Patient's postoperative AP X-ray (c). Patient's postoperative lateral X-ray (d)**

disability. Various surgical interventions have been proposed for this population. Although long-term stabilization has a negative impact on spine growth, it is still necessary for treating advanced deformities in certain patients.[11] According to Wang *et al*., preoperative segmental kyphosis decreased from 87.3 to 17.6 in the follow-up of 24 patients who underwent PVCR for isolated angular kyphoscoliosis.[12] Thirteen patients from our sample group had developed deformities due to spina bifida, and we applied the PVCR technique to treat them. The average local kyphosis angle was 68° before surgery. However, the angle decreased to − 10.5° after the procedure.

PVCR is an ideal method for rigid and advanced deformities that cannot be corrected with simpler osteotomies. Angulation of more than 80° can be fixed with resection of one or more vertebrae and appropriate vertebral fusion.[3] Recently, it has also been used in the surgeries of vertebral tumor metastases without deformity. The thinning of the cortex due to the tumor causes an increased risk of collapse, sometimes causing bone fragments to fall into the spinal cord. Vertebral resection with posterior approach is one of the surgical options in cases where there is spinal cord compression or the risks mentioned above.[13] In four patients who has tumor metastases without deformity < 15° but collapse and spinal cord compression were present, we also performed PVCR [Figure 2]. Their neurologic symptoms regressed after the intervention. Based on current studies in the literature and our own results, we think that this method can also be used in tumor surgery.

Surgery is recommended for discitis and osteomyelitis unresponsive to long-term, suitable antibiotic therapy. In this case, necrotic tissue must be removed, and the vertebral column stabilized, both done through an anterior approach. However, this procedure is associated with major complications since it is in proximity to essential neurovascular structures and organs.[14] Resection of the vertebra through a solely posterior approach was performed on seven patients with an infection restricted to the vertebra [Table 1]. Two patients were diagnosed with *Staphylococcus aureus* osteomyelitis, two with nonspecific discitis, one with *Candida* discitis, and two with Pott disease. The objective for these patients was not only to correct the deformity but also to prevent infection recurrence. During follow-up, none of our patients experienced a recurrence of infection. PVCR may be necessary in situations where removal of the vertebra is needed.

Being a challenging procedure brings the risk of complications. In their PVCR series of 152 patients, Kim *et al*. reported that complications developed in 39.5% of the patients. These complications include dural tear, implant loosening, wound problems, and temporary and permanent neurological deficits.[15] Yang *et al*. reported the complication rate as 32% (121 patients) in their systematic review of 7 studies and 390 patients.[8] In another study, it was stated that 7 out of 66 patients (10.6%) who underwent PVCR died within 30 days of follow-up.[13] (Three of our patients died in the first 12 months). Although our mortality rate in the 1st year was 8% (3/37), one of these patients passed away because of the progression of his cancer. Hence, our mortality rate is close to those reported in the literature.[16] Apart from this, we experienced wound problems in five patients, dural tears in two patients, and segmental bleeding in one patient. Although it is a useful technique, it should be kept in mind that the complication rate is not low. Before the procedure, the patient and relatives should be informed in detail about these risks.

This study has limitations; it is a retrospective study. The absence of a control group for comparing different surgical techniques, the lack of scores indicating satisfaction and pain before and after surgery, the inhomogeneity of the patient group, and the retrospective nature of the study are among these limitations. There is a need for prospective, multicenter studies with a larger number of patients and longer follow-up.

## CONCLUSION

PVCR is currently used for limited indications. We think that it can be used in larger patient groups. More studies can be done on its use in wider indications.

### Ethical approval

This research has been approved by the IRB of the authors' affiliated institutions.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Saifi C, Laratta JL, Petridis P, Shillingford JN, Lehman RA, Lenke LG. Vertebral column resection for rigid spinal deformity. Global Spine J 2017;7:280-90.
2. Xie JM, Chen ZQ, Shen JX, Zhang XS, Yang C, Zheng ZM, *et al.* Expert consensus for PVCR in severe, rigid and angular spinal deformity treatment: The Kunming consensus. J Orthop Surg (Hong Kong) 2017;25:2309499017713939.
3. 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;30:1682-7.
4. Bradford DS, Tribus CB. Vertebral column resection for the treatment of rigid coronal decompensation. Spine (Phila Pa 1976) 1997;22:1590-9.
5. Morales Codina AM, Martín-Benlloch JA, Valverde Belda D, Muñoz Donat S, Sánchez Monzó C, Aguirre García R, *et al.* Comparison of smith-petersen, pedicle subtraction osteotomy and vertebral column resection for the correctıon of sagittal imbalance 2013;12:319-21.
6. Ozturk C, Alanay A, Ganiyusufoglu K, Karadereler S, Ulusoy L, Hamzaoglu A. Short-term X-ray results of posterior vertebral column resection in severe congenital kyphosis, scoliosis, and kyphoscoliosis. Spine (Phila Pa 1976) 2012;37:1054-7.
7. Xie J, Wang Y, Zhao Z, Zhang Y, Si Y, Li T, *et al.* Posterior vertebral column resection for correction of rigid spinal deformity curves greater than 100°. J Neurosurg Spine 2012;17:540-51.
8. Yang C, Zheng Z, Liu H, Wang J, Kim YJ, Cho S. Posterior vertebral column resection in spinal deformity: A systematic review. Eur Spine J 2016;25:2368-75.
9. Cho KJ, Bridwell KH, Lenke LG, Berra A, Baldus C. Comparison of Smith-Petersen versus pedicle subtraction osteotomy for the correction of fixed sagittal imbalance. Spine (Phila Pa 1976) 2005;30:2030-7.
10. Özcan Ç, Polat Ö, Alataş İ, Çamur S, Sağlam N, Uçar BY. Clinical and radiological results of kyphectomy and sliding growing rod surgery technique performed in children with myelomeningocele. J Orthop Surg Res 2020;15:576.
11. Balioglu M, Tacal M, Albayrak A, Atici Y, Kargın D, Kaygusuz M. Posterior vertebral resection osteotomy in a patient with myelomeningocele – Case report and literature review. J Turk Spinal Surg 2013;64:297-308.
12. Wang S, Aikenmu K, Zhang J, Qiu G, Guo J, Zhang Y, *et al.* The aim of this retrospective study is to evaluate the efficacy and safety of posterior-only vertebral column resection (PVCR) for the treatment of angular and isolated congenital kyphosis. Eur Spine J 2017;26: 1817-25.
13. Viezens L, Dreimann M, Eicker SO, Heuer A, Koepke LG, Mohme M, *et al.* Posterior vertebral column resection as a safe procedure leading to solid bone fusion in metastatic epidural spinal cord compression. Neurosurg Focus 2021;50:E8.
14. Kozak JA, Heilman AE, O'Brien JP. Anterior lumbar fusion options. Technique and graft materials. Clin Orthop Relat Res 1994;300:45-51.
15. Kim SS, Cho BC, Kim JH, Lim DJ, Park JY, Lee BJ, *et al.* Complications of posterior vertebral resection for spinal deformity. Asian Spine J 2012;6:257-65.
16. Lee BH, Hyun SJ, Kim KJ, Jahng TA, Kim YJ, Kim HJ. Clinical and radiological outcomes of posterior vertebral column resection for severe spinal deformities. J Korean Neurosurg Soc 2018;61:251-7.