ELSEVIER

CrossMark

The Spine Journal 15 (2015) 2351–2359

THE SPINE JOURNAL

Clinical Study

Apex of deformity for three-column osteotomy. Does it matter in the occurrence of complications?

Cristina Sacramento-Domínguez, MD, PhD[a,*], Mitsuru Yagi, MD, PhD[b], Jennifer Ayamga, BA, MPhil[c], Venu M. Nemani, MD, PhD[d], Harry Akoto, MD[c], Rufai Mahmud, MD[c], Irene A. Wulff, MD[c], Munish Gupta, MD[e], Elias C. Papadopoulos, MD[f], Ferran Pellisé, MD[g], Francisco Sánchez-Pérez-Grueso, MD[h], William F. Hess, MD[i], Han Jo Kim, MD[d], Richard Hodes, MD[j], Oheneba Boachie-Adjei, MDDSc[c], and FOCOS Spine Research Group[c]

[a]*Unidad de Patología Vertebral, Hospital Ruber Internacional, C/La Masó, 38 Mirasierra, 28034, Madrid, Spain*
[b]*Department of Orthopaedic Surgery, National Hospital Organization Murayama Medical Center, Tokyo, Japan*
[c]*FOCOS Orthopedic Hospital, Pantang, Accra, Ghana*
[d]*Scoliosis Service, Hospital for Special Surgery, New York, NY, USA*
[e]*Department of Orthopaedic Surgery, UC Davis Medical Center, Sacramento, California, USA*
[f]*Orthopaedic Clinic, University of Athens, Athens, Greece*
[g]*Spine Unit, Servicio de COT, Hospital Vall d'Hebron, Barcelona, Spain*
[h]*Spine Unit, Department of Orthopedic Surgery, Hospital La Paz, Madrid, Spain*
[i]*Department of Orthopaedics, Geisinger Medical Center, Danville, Pennsylvania, USA*
[j]*American Jewish Joint Distribution Committee, Inc., Bole, Addis Ababa, Ethiopia*

Received 31 October 2014; revised 22 April 2015; accepted 1 July 2015

Abstract

BACKGROUND: Posterior vertebral column resection (PVCR) is a challenging but effective technique for the correction of complex spinal deformity. However, it has a high complication rate and carries a substantial risk for neurologic injury.

PURPOSE: The aim was to test whether the apex of the deformity influences the clinical outcomes and complications in patients undergoing PVCR.

STUDY DESIGN: A historical cohort was recruited from a single center and evaluated preoperatively, postoperatively, and at final follow-up.

PATIENT SAMPLE: Ninety-eight hyperkyphotic patients undergoing PVCR were included. Inclusion criteria consisted of kyphoscoliosis and hyperkyphosis surgically treated with PVCR as a primary or revision procedure.

OUTCOME MEASURES: The outcome measures included a number of neurologic complications.

METHODS: Receiver operator characteristic (ROC) curve analysis and Youden index (J) were used to estimate the optimum cut-off to predict neurologic complications for each potential risk factor. In three ROC analyses, we included separately body mass index (BMI), kyphosis degree, and age as

The authors give permission to reproduce copyrighted materials or signed patient consent forms.

No outside funds were received to complete this study.

This study was approved by the institutional review board of the hospital for Special Surgery New York.

FDA device/drug status: Not applicable.

Author disclosures: ***CS-D:*** Nothing to disclose. ***MY:*** Nothing to disclose. ***JA:*** Nothing to disclose. ***VMN:*** Nothing to disclose. ***HA:*** Nothing to disclose. ***RM:*** Nothing to disclose. ***IAW:*** Nothing to disclose. ***MG:*** Other: FOSA/SRS (Treasurer/Board Member); Personal Fees/Other: Depuy Synthes (F, Consultant/Royalties); Personal Fees: Medicrea (D), Medtronic (B, Consultant); Other: Proctor and Gamble (C), Johnson and Johnson (D), Pfizer (B), Pioneer (B, Stock). ***ECP:*** Nothing to disclose. ***FP:*** Grant: DePuySynthes (F), K2M (D); Personal Fees: DePuySynthes (C). ***FS-P-G:*** Grant: Depuy Synthes (A). ***WFH:*** Other: K2M (C, Research Support). ***HJK:*** Medtronic (B), Biomet (B), Depuy (B), Stryker (B), K2M (B, Speaker Bureau, Honorarium, or Consulting Fees). ***RH:*** Nothing to disclose. ***OB-A:*** Other: Depuy Spine (D, Consulting Agreement); Personal Fees/Non-Financial Support/Other: K2M (D, Consulting Agreement); Non-Financial Support: Medtronic (D); Personal Fees/Other: FOCOS Orthopedic Hospital (D, Board Member and CEO); Pending/Royalties: K2M Mesa deformity system (D). ***FSRG:*** Nothing to disclose.

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

* Corresponding author. Unidad de Patología Vertebral, Hospital Ruber Internacional, C/La Masó, 38 Mirasierra, 28034, Madrid, Spain. Tel.: (91) 387 50 60.

E-mail address: cristisacra@yahoo.es (C. Sacramento-Domínguez)

http://dx.doi.org/10.1016/j.spinee.2015.07.010

independent variables and neurologic complications as the dependent variable. Logistic regression was used to estimate the odds ratios (ORs) and construct 95% confidence intervals (CIs).

RESULTS: Among the 98 patients, the etiologies were: post infectious (50), congenital (31), and others (17). The averages were: age 14±6.5 years, BMI 20±10 kg/m^2, American Society of Anesthesiologists 3±0.7, forced vital capacity 76±23%, fusion levels 10±3, estimated blood loss 1,319±720 mL, surgical time 375±101 minutes, and preoperative localized kyphosis 104±30°. Thirty-three patients had abnormal preoperative neurologic status. Major complications occurred in 46 patients (neurologic in 25). The apex of kyphosis was proximal thoracic T1–T5 (five patients), thoracic (TH) T6–T9 (17 patients), thoracolumbar T10–L2 (55 patients), and lumbar L3–S1 (nine patients). The level of apex and BMI were independent risk factors for neurologic complications: TH apex (OR: 101.30, 95% CI: 1.420–infinite; p=.037); BMI (OR: 1.92, 95% CI: 1.110–infinite; p=.026).

CONCLUSIONS: Posterior vertebral column resection for severe spine deformity is technically demanding and carries a substantial risk. The apex is a variable that influences the occurrence of neurologic complications, and the presence of a TH apex in particular could be a preoperative risk factor for neurologic complications.

Keywords: Kyphosis; Kyphoscoliosis; Vertebral column resection osteotomy; Pediatric deformity; Neurologic complications

Introduction

Vertebral column resection (VCR) was popularized by Bradford in 1987 who described a circumferential vertebral column resection as a combined anterior/posterior procedure for severe rigid spinal deformities and severe imbalance of the trunk [1–3].

Later, Suk et al. in 2002 described the VCR through a posterior-only approach for correction of fixed lumbosacral deformities as a procedure to reduce the morbidity related to the anterior approach, the amount of surgical blood loss, the surgical procedure time. It also allows the translation of spinal column to restore normal spinal alignment [4,5]. In the last decade, the three-column osteotomy has become popular among spine surgeons as a technically demanding but effective procedure for the management of severe rigid spinal deformities [6].

More recently, Lenke et al. [7–9] have described in detail the surgical technique for posterior vertebral column resection (PVCR) and have evaluated the surgical outcomes and the associated complications in a large series.

Posterior-only three-column osteotomy procedures are associated with high complication rates and carry a significant risk for neurologic injury. Minimizing complications and optimizing outcomes should be essential goals of spine deformity surgery.

Several potential risk factors for neurologic complications have been reported; however, the relationship of the level of the apex of the deformity and the risk for neurologic complications has not been reported to our knowledge. During VCR, the site of resection is always at the apex of the deformity. The extent of resection depends on the number of vertebrae involved in the localized deformity, the extent of compression of the spinal cord, and the amount of deformity correction that is needed.

The purpose of this study was to review the clinical outcomes and complications in hyperkyphotic deformity patients undergoing corrective spine surgery with PVCR and to determine whether there is an association between the risk for overall or neurologic complications and the apex of the deformity.

Materials and methods

Institutional review board approval was obtained for this retrospective review of data collected prospectively in consecutive patients with severe kyphoscoliosis and hyperkyphosis surgically treated with PVCR as a primary or revision procedure from 2002 to 2013.

Patients, clinical, and radiographic parameters

Clinical and radiographic data of a total cohort of 98 patients were evaluated. Data collected included morphometric variables such as age, weight, height, and body mass index (BMI). Other variables evaluated were etiology, American Society of Anesthesiologists classification, forced vital capacity, preoperative neurologic status, and intraoperative variables such as operating room time, estimated blood loss (EBL), number of levels fused, and complications.

Radiographic measures were made from 36-inch, standing anteroposterior, and lateral radiographs and were reviewed preoperatively, immediately postoperatively, and at final follow-up to assess the deformity correction and complications related to the procedure. The radiologic parameters evaluated were Cobb angle of major and minor coronal curves, angle of maximum kyphosis, levels involved in localized kyphosis (LK), and location of the apex of the deformity. We categorized the level of the apex as: proximal thoracic (PT) T1–T5; thoracic (TH) T6–T9; thoracolumbar (TL) T10–L2, and lumbar (L) L3–S1.