Spine Deformity
www.spine-deformity.org

Spine Deformity 2 (2014) 340–349

Case Studies

Surgical Risk Stratification Based on Preoperative Risk Factors in Severe Pediatric Spinal Deformity Surgery

Oheneba Boachie-Adjei, MD[a,*], Mitsuru Yagi, MD, PhD[b], Cristina Sacramento-Dominguez, MD, PhD[c], Harry Akoto, MD[d], Matthew E. Cunningham, MD, PhD[a], Munish Gupta, MD[e], William F. Hess, MD[f], Baron S. Lonner, MD[g], Jennifer Ayamga, BS, MPA[l], Elias Papadopoulus, MD[h], Federico Sanchez-Perez-Grueso, MD[i], Feran Pelise, MD[j], Kenneth J. Paonessa, MD[k], Han Jo Kim, MD[a], FOCOS Spine Research Group[l]

[a]*Adult and Pediatric Spine and Scoliosis Surgery, Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021, USA*
[b]*Department of Orthopedic Surgery, Keio University School of Medicine, 35 Shinanomachi, Shinjuku, Tokyo 160-8582, Japan*
[c]*Department of Orthopedic Surgery, Hospital Ruber Internacional, Calle de la Masó, 38, 28034, Madrid, Spain*
[d]*Department of Neurosurgery, Korle Bu Teaching Hospital, P.O. Box KB77, Korle Bu, Accra, Ghana*
[e]*Department of Orthopaedic Surgery, University of California, Davis Medical Center, 2315 Stockton Boulevard, Sacramento, CA 95817-2282, USA*
[f]*Department of Orthopaedics, Geisinger Medical Center, 100 North Academy Avenue, Danville, PA 17822, USA*
[g]*Department of Orthopedic Surgery, New York University-Hospital for Joint Diseases, 301 East 17th Street, 1402, New York, NY 10003, USA*
[h]*2 Orthopaedic Clinic, University of Athens, Greece*
[i]*Spine Unit, Department of Orthopedic Surgery, Hospital La Paz, P° de la Castellana, 261 28046, Madrid, Spain*
[j]*Spine Unit, Servicio de COT, Hospital Vall d'Hebron, Passeig de la Vall d'Hebron, 119-129, 08035 Barcelona, Spain*
[k]*Norwich Orthopedic Group, 82 New Park Ave, North Franklin, Norwich, CT 06254, USA*
[l]*Research Department, FOCOS Hospital, P.O. Box KD 779, Kanda, No. 8 Teshie Street, Accra, Ghana*

Received 21 January 2014; revised 23 May 2014; accepted 25 May 2014

Abstract

Study design: Retrospective review.
Objective: The purpose of this study is to review the postoperative complications in pediatric patients undergoing spine surgery and to establish a preoperative classification that stratifies surgical risk and case difficulty.
Summary of Background Data: Pediatric spinal deformity (PSD) surgery can be challenging technically as well as economically. Often, a multidisciplinary approach to managing these patients is necessary. In an environment where resources are limited, such as in global outreach efforts, a method for stratifying PSD surgical cases can be useful for allocating appropriate resources and assigning appropriate skill sets in order to optimize patient outcomes and to streamline efforts.
Materials and Methods: A total of 145 consecutive PSD patients who underwent instrumented spinal fusion were reviewed. Radiographic measurements and demographic data were reviewed. A classification was established based on the curve magnitude, etiology, ASA grade, number of levels fused, the preoperative neurologic status, body mass index and type of osteotomies. Multiple regression analysis (MRA) and logistic regression analysis (LRA) were applied to indicate risk factors for complications.

Author disclosures: OBA (grants, personal fees, nonfinancial support, and other from K2M; nonfinancial support and other from DePuy Spine; grants from Medtronic; grants, personal fees and other from Baxano (Trans 1), outside the submitted work; a patent K2M with royalties paid and serves on the board of scientific advisors for K2M); MY (nonfinancial support from K2M Inc, grants from Surgical Spine Inc, other from Depuy Synthes Inc, outside the submitted work); CSD (none); HJK (none); HA (none); MEC (none); MG (none); WFH (K2M, outside the submitted work); BSL (grants from Setting Scoliosis Straight Foundation, grants from AO Spine, grants from John and Marcella Fox Fund, grants from OREF, personal fees and other from DePuy Spine, personal fees from K2M, other from Spine Search, other from Paradigm Spine, outside the submitted work); JA(none); EP (none); FSPG (none); FP (none); KJP (Complex Spine Study Group, outside the submitted work).

This study was approved by the Institutional Review Board of the hospital.

*Corresponding author. 535 East 70th Street, New York, NY 10021. Tel.: (212) 606-1948; fax: (212) 794-2562.
E-mail address: oboachie@gmail.com (O. Boachie-Adjei).

2212-134X/$ - see front matter
http://dx.doi.org/10.1016/j.jspd.2014.05.004

Results: The average age was 14.3 years (10–20 years). The etiology was idiopathic scoliosis (n = 71), congenital scoliosis (n = 38), infectious (n = 11), and others. 23 patients had neurologic deficits preoperatively. Twenty-three patients had a posterior vertebral column resection. Patients were classified as Level 1 (n = 5), Level 2 (n = 19), Level 3 (n = 24), Level 4 (n = 58), and Level 5 (n = 39). Intraoperative neuro-monitoring changes were observed in 46 cases. Major complications were seen in 45 cases. A major complication consisted of implant related (n = 13), deep wound infection (n = 8), neurologic deficit (n = 7), death (n = 2), and others (n = 9). MRA demonstrated a significant correlation between classified level and %EBL/TBV, operative time, and complication rate. The risk level predicted the occurrence of general (odds ratio [OR] = 1.54; 95% confidence interval [CI] = 1.08–2.21; p = .019) and neurologic (OR = 3.34; 95% CI = 1.06–17.70; p = .036) complications. Osteotomy and resection procedures were independent predictors for postoperative neurologic complications (OR = 1.7, 95% CI = 1.11–2.85; p = .015).

Conclusion: Corrective spine surgery for complex pediatric deformity is challenging and carries a substantial risk. No single parameter appears to independently predict postoperative complications. However, when all risk factors are considered, there is a trend toward increased intraoperative electromonitoring change and postoperative neurologic risk with the higher level score in our classification. The newly established surgical risk stratification based on patient-specific clinical and radiographic factors can guide surgeons in their preoperative planning and surgical management of severe spine deformity in order to achieve optimal outcomes.

Keywords: Scoliosis; Deformity; Congenital scoliosis; Idiopathic scoliosis; Complication

Introduction

Pediatric spinal deformity (PSD) surgery is technically demanding [1-8]. It often requires a multidisciplinary approach to manage these patients perioperatively [1,9-11]. Therefore, in an environment where resources are limited, a method for stratifying PSD surgical cases can be useful for conserving resources and allocating appropriate skill sets in order to optimize outcomes and to streamline efforts. Recent literature has demonstrated the high perioperative and postoperative complication rates in pediatric complex spine deformity surgery [1-11]. Minimizing the complications and optimizing outcomes is one of the essential goals of spine deformity surgery. Smith et al. reported the high major complication rate seen in pediatric spine surgery involving circumferential osteotomy [12]. Phillips et al. reported the mortality and morbidity rate in early-onset scoliosis surgery [11]. They included congenital scoliosis, syndromic and chromosomal abnormalities, cerebral palsy, and spinal muscular atrophy. The complication rate was 84% overall, with a mortality rate of almost 18%. There is a paucity of information about the complication rate based on the independent or combined perioperative risk factors in relation to complication rates in the surgically treated pediatric patients with complex spine deformity. To our knowledge, there is no study that provides a quantitative risk scoring system for complication development based on independent variables. The purpose of this study is to review the postoperative complications in pediatric patients undergoing spine surgery and to establish a preoperative classification that stratifies surgical risk and case difficulty.

Materials and Methods

A total of 145 consecutive pediatric spine deformity patients who underwent instrumented spinal fusion were reviewed. Radiographic measurements and demographic data were reviewed pre- and postoperatively. All surgeries were performed at a single center in West Africa by Scoliosis Research Society (SRS) senior members traveling to participate in the global outreach program. A classification system (FOCOS level; Foundation of Orthopedics and Complex Spine) was established by the senior author based on the curve magnitude, etiology, American Society of Anaesthesiologists physical status classification (ASA) grade, number of levels fused, the preoperative neurologic status, body mass index (BMI) and type of osteotomies, and the type of rib osteotomies (Table 1) [13].

FOCOS LEVEL: (major scoliosis + localized kyphosis + etiology + ASI/BMI score + preoperative neurologic status + extent of procedure + osteotomy + additional osteotomy score)/40

(Score/40)*100 = %	FOCOS level	5	4	3	2	1
	Range %	65	51–65	41–50	31–40	0–30

Example

Thirteen–year-old female patient with AIS
Demographics: BMI 15.3, ASA 3, normal neurologic status
Radiographs: Major curve Cobb angle 70°
Procedure: Posterior spinal fusion (PSF) T5-L2, no additional osteotomy
Risk score: Curve 70°. (2) + etiology + ASA/BMI (3) + neurologic status (1) + extent of procedure (3) + osteotomy (3) + additional osteotomy (0) = 12/40
FOCOS level = 1 (12/40*100 = 30%)

Multiple regression analysis (MRA), univariate logistic regression analysis (LRA), and multivariate LRA were applied to assess risk factors for postoperative complications, neurologic complications, length of procedure, and estimated