Spine Deformity

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Spine Deformity 5 (2017) 265−271

A Critical Analysis of Sagittal Plane Deformity Correction With Minimally Invasive Adult Spinal Deformity Surgery: A 2-Year Follow-Up Study

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Received 14 July 2016; revised 16 January 2017; accepted 21 January 2017

Abstract

Introduction: Sagittal plane realignment is important to achieve desirable clinical outcomes after adult spinal deformity (ASD) surgery. This study evaluates the impact of minimally invasive (MIS) techniques on sagittal plane alignment and clinical outcomes in ASD patients.
Methods: A retrospective, multi-center review of ASD patients (age ⩾18 years, and with one of the following: coronal Cobb ⩾20°, sagittal vertical axis [SVA] >5 cm, and/or pelvic tilt >25°), MIS surgery, and four or more levels instrumented. Patients were stratified by baseline SRS-Schwab global alignment modifier (GAM) into three groups: 0 (SVA <4 cm), + (SVA 4−9.5 cm), or ++ (SVA >9.5 cm). Radiographic and clinical outcomes measures were analyzed with a minimum of 2-year follow-up.

Author disclosures: GMM (personal fees from NuVasive, personal fees from K2M, personal fees from DePuy Synthes, outside the submitted work; in addition, GMM has patents K2M and NuVasive with royalties paid); JDT (none); VD (personal fees from NuVasive; grants from Globus, NuVasive, and AO Spine, outside the submitted work); JSU (other from NuVasive, outside the submitted work); PN (personal fees and other from Vertiflex, LDR, Spine, and K2M; personal fees from Osprey Biomedical; other from Amedica, Safewire, Paradigm, and Spineology, outside the submitted work); PM (consultancy fees from DePuy Spine; royalty from DePuy Spine, Taylor and Francis, Thieme, and Springer; honoraria from DePuy Spine, Globus, and AO Spine; Director at Large at Scoliosis Research Society; and stocks in Spinicity/ISD); NA (other from Medtronics, personal fees from Medtronics, other from Globus Medical, other from Elsevier, outside the submitted work; in addition, NA has a patent Medtronics with royalties paid); PP (personal fees from Globus, Biomet, and Medtronic; other from Globus; grants from StemCells and Pfizer, outside the submitted work); DOO (other from Biomet, outside the submitted work); MYW (personal fees from DePuy Spine, Aesculap Spine, JoiMax, and K2M; grants from Department of Defense, outside the submitted work; in addition, MYW has a patent DePuy Spine with royalties paid); SB (grants and consulting for K2 Medical, NuVasive, and Innovasis and consulting for Allosource; in addition, SB receives royalties from Pioneer, K2 Medical, and Innovasis); ASK (none); Richard Fessler (others from Medtronic, DePuy, Stryker, DePuy, and Benvenue, outside the submitted work; in addition, RF has patents Medtronic, DePuy, and Stryker with royalties paid, and a patent In Queue Innovations pending); SN (none); BAA (grants and personal fees from NuVasive and K2M, personal fees from DePuy Spine and NociMed, outside the submitted work).

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http://dx.doi.org/10.1016/j.jspd.2017.01.010

Results: A total of 96 ASD patients were identified, and 63 met the study's inclusion criteria of circumferential MIS or posterior MIS only, with four or more levels instrumented (n: Group 0 = 37, Group + = 15, and Group ++ = 11). Group 0 was younger than ++ (56.8 vs. 69.6 years), with a higher proportion of females than Group + or ++ (83.8% vs. 66.7% and 54.5%, respectively).

Baseline HRQoL was similar. Postoperatively, Groups 0 and + had improved Oswestry Disability Index (ODI) and numeric rating scale (NRS) back and leg scores. Group ++ only had improvement in NRS scores. At the latest follow-up, Groups 0 and ++ had similar sagittal measurements except for PT (21.6 vs. 23.6, p = .009). The + group had improvement in PI−LL (24.2 to 17; p = .015) and LL (30.9 to 38.3; p = .013). Eight of 27 (21.6%) Group 0 patients deteriorated (4 to Group +, 4 to Group ++). Three of 15 (20.0%) Group + patients deteriorated to Group ++, and 3 improved to Group 0. Six of 11 (54.5%) Group ++ patients improved (3 to Group + and 3 to Group 0).

Conclusions: MIS techniques successfully stabilized ASD patients with Group 0 and + deformities and improved HRQoL. This study suggests that severe sagittal imbalance is not adequately treated with MIS approaches.

Keywords: Sagittal imbalance; Adult spinal deformity; Minimally invasive; Spine surgery

Introduction

Over the past decade, there has been an expansion in the application of minimally invasive spine (MIS) surgery. The techniques have gained popularity because of their potential to minimize blood loss, decrease morbidity, expedite recovery, and reduce cost [1-6]. MIS surgery is attractive for the treatment of adult spinal deformity (ASD), in particular, given the high complication rates associated with traditional open approaches [7-9]. Although the field of MIS deformity correction is young, several studies have demonstrated favorable outcomes with reduction in morbidity and complication rates [10-14].

A variety of MIS techniques for the treatment of ASD have been described, and this variability remains a concern when discussing less-invasive approaches. We have defined the circumferential MIS (cMIS) technique as a minimally invasive means to achieve interbody fusion and posterior stabilization. Most commonly, interbody access is obtained either through a posterior paramedian, muscle-splitting transforaminal (MIS TLIF) approach, minimally invasive lateral transpsoas approach, or presacral approach for L5−S1 fusion (AxiaLIF). Posterior fixation is achieved with minimally invasive pedicle screw placement.

Sagittal malalignment is the principal cause of disability in ASD patients [15-17], and the restoration of sagittal balance is critical for durable clinical success [16,18,19]. Although the tissue-sparing approach of MIS surgery is believed to have benefit in ASD surgery, the ability to achieve alignment goals is less clear. Here we present a multicenter retrospective analysis of sagittal plane deformity correction using cMIS techniques.

Methods

This study is a retrospective multicenter review of ASD patients undergoing MIS surgery from 2009 to 2012. Institutional review board approval was obtained at all participating sites. Patients were drawn from a multicenter retrospective database. Institutional review board approval was obtained at all participating sites. Inclusion criteria are age ⩾18 years, major coronal Cobb angle ⩾20°, sagittal vertical axis (SVA) ⩾5 cm, pelvic tilt ⩾25°, and/or thoracic kyphosis ⩾60°. Patients with spinal deformity resulting from neuromuscular conditions, tumor, or infection were excluded. Circumferential MIS (cMIS) and posterior-only MIS (pMIS) cases, with four or more levels instrumented, and a minimum of 2-year follow-up were included in the analysis. Patients were stratified using baseline SRS-Schwab global alignment modifier (GAM) into the following groups: 0 (SVA <4.0 cm), + (SVA 4.0−9.5 cm), or ++ (SVA >9.5 cm) (Fig. 1). Case examples of each group are shown in Figure 2.

Radiographic and health-related quality of life (HRQoL) measures were analyzed for all patients at baseline and 2-year follow-up. HRQoL measures included Oswestry Disability Index (ODI), and a numeric rating scale (NRS) of back and leg pain. Radiographic fusion was evaluated at each treated level with plain radiographs using the four-point Bridwell-Lenke grading system [20,21]. Patients with grades 1 and 2 for all treated levels were categorized as "confirmed fusion." Patients with grades 3 or 4 at one or more treated levels were categorized as "pseudoarthrosis." Statistical analysis was performed using SPSS software. Threshold for significance was set at p value less than .05. The Shapiro-Wilks test was used to assess normality of the data. Categorical variables were analyzed with chi-squared and continuous variables with analysis of variance (ANOVA) with the Bonferroni correction for multiple comparisons, and paired *t* test for pre to post assessment.

Global Alignment Modifier	SVA (cm)
0	< 4.0
+	4.0 – 9.5
++	> 9.5

Fig. 1. Patient stratification based on SRS-Schwab global alignment modifier.