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Development of a Preoperative Predictive Model for Reaching the Oswestry Disability Index Minimal Clinically Important Difference for Adult Spinal Deformity Patients

Justin K. Scheer, MD[a,*], Joseph A. Osorio, MD, PhD[b], Justin S. Smith, MD, PhD[c], Frank Schwab, MD[d], Robert A. Hart, MD[e], Richard Hostin, MD[f], Virginie Lafage, PhD[d], Amit Jain, MD[g], Douglas C. Burton, MD[h], Shay Bess, MD[i], Tamir Ailon, MD[j], Themistocles S. Protopsaltis, MD[d], Eric O. Klineberg, MD[k], Christopher I. Shaffrey, MD[c], Christopher P. Ames, MD[b], and the International Spine Study Group

[a]*Department of Neurosurgery, University of Illinois at Chicago, 912 South Wood St., Chicago, IL 60612, USA*
[b]*Department of Neurological Surgery, University of California, San Francisco, San Francisco, CA 94131, USA*
[c]*Department of Neurosurgery, University of Virginia Health System, 1215 Lee St., Charlottesville, VA 22903, USA*
[d]*Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, 301 East 17th Street, New York, NY 10003, USA*
[e]*Department of Orthopaedic Surgery, Oregon Health & Science University, 3181 S.W. Sam Jackson Park Rd., Portland, OR 97239-3098, USA*
[f]*Department of Orthopaedic Surgery, Baylor Scoliosis Center, 4708 Alliance Blvd #800, Plano, TX 75093, USA*
[g]*Department of Orthopaedic Surgery, Johns Hopkins University, Baltimore, MD 21218, USA*
[h]*Department of Orthopaedic Surgery, University of Kansas Medical Center, 3901 Rainbow Blvd., Kansas City, KS 66160, USA*
[i]*Denver International Spine Clinic, Presbyterian St. Luke's Medical Center, 1719 E 19th Ave., Denver, CO 80218, USA*
[j]*University of British Columbia, 2329 West Mall, Vancouver, BC, Canada V6T 1Z4*
[k]*Department of Orthopaedic Surgery, University of California, 1 Shields Ave., Davis, CA 95616, USA*

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Abstract

Study Design: Retrospective review of prospective multicenter adult spinal deformity (ASD) database.
Objective: To create a model based on baseline demographic, radiographic, health-related quality of life (HRQOL), and surgical factors that can predict patients meeting the Oswestry Disability Index (ODI) minimal clinically important difference (MCID) at the two-year postoperative follow-up.
Summary of Background Data: Surgical correction of ASD can result in significant improvement in disability as measured by ODI, with the goal of reaching at least one MCID. However, a predictive model for reaching MCID following ASD correction does not exist.
Methods: ASD patients ⩾18 years and baseline ODI ⩾ 30 were included. Initial training of the model comprised forty-three variables including demographic data, comorbidities, modifiable surgical variables, baseline HRQOL, and coronal/sagittal radiographic parameters. Patients were grouped by whether or not they reached at least one ODI MCID at two-year follow-up. Decision trees were constructed using the C5.0 algorithm with five different bootstrapped models. Internal validation was accomplished via a 70:30 data split for training and testing each model, respectively. Final predictions from the models were chosen by voting with random selection for tied votes. Overall accuracy, and the area under a receiver operating characteristic curve (AUC) were calculated.
Results: 198 patients were included (MCID: 109, No-MCID: 89). Overall model accuracy was 86.0%, with an AUC of 0.94. The top 11 predictors of reaching MCID were gender, Scoliosis Research Society (SRS) activity subscore, back pain, sagittal vertical axis (SVA), pelvic incidence−lumbar lordosis mismatch (PI-LL), primary version revision, T1 spinopelvic inclination angle (T1SPI), American Society of Anesthesiologists (ASA) grade, T1 pelvic angle (T1PA), SRS pain, SRS total.
Conclusions: A successful model was built predicting ODI MCID. Most important predictors were not modifiable surgical parameters, indicating that baseline clinical and radiographic status is a critical factor for reaching ODI MCID.
Level of Evidence: Level II.

Keywords: Adult spinal deformity; Oswestry Disability Index; Minimum clinically important difference; Scoliosis; Predictive modeling

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IRB statement: All patients were enrolled into a protocol for which each site had obtained institutional review board approval.

*Corresponding author. Department of Neurosurgery, University of Illinois at Chicago, 912 South Wood Street, Chicago, IL 60612, USA. Tel.: (312) 996-4842; fax: (312) 996-9018.

E-mail address: jscheer@uic.edu (J.K. Scheer).

Introduction

Adult patients with spinal deformity (ASD) generally present with back and leg pain, neurologic symptoms (leg weakness and/or numbness), and functional limitations (difficulty standing upright, and exercise or ambulation intolerance) [1-11]. Several studies demonstrate significant relief of pain and improved function in a select group of patients with ASD that undergo operative treatment compared to non-operative treatments, including a higher likelihood of reaching a minimum clinically important difference (MCID) [9-19]. Given that ASD surgery is associated with a high complication rate [20-26], it is critical to assess patient reported outcomes in the context of a clinically applicable difference.

Clinical improvement following ASD surgery can be evaluated with changes in common patient reported outcomes scores such as the Oswestry Disability Index (ODI) [27], the Scoliosis Research Society questionnaire (SRS) [28-30], and the Medical Outcomes Short Form-36 (SF36) [31]. However, statistically significant differences in the above outcome metrics may be achieved postoperatively, yet the clinical implications of that difference may remain unknown. The MCID of an outcomes score attempts to define the minimum difference that is clinically meaningful to the patient [32,33]. This definition can aid in identifying the patients that had a clinically significant improvement in their outcome score and MCID values have been previously established [30,34,35] .

Recent attempts have been made to characterize the patients that will have the "best" or "worst" outcome following ASD surgery [16]. Smith and colleagues investigated 227 patients with ASD who underwent surgery and identified factors associated with the best (final Oswestry Disability Index [ODI] $\leqslant$15) or worst (final ODI $\geqslant$50) outcomes. The authors found that patients with the worst outcome had lower baseline ODI and Scoliosis Research Society (SRS)-22r scores, more back pain, greater body mass index (BMI), higher prevalence of depression, and higher prevalence of positive sagittal malalignment than the patients in the best group. Although this study provides valuable insight into which factors are associated with successful surgery, it does not provide a useable model to predict patients' outcome a priori. Such a model can be very beneficial to both the surgeon and the patient. Surgical decision making could involve a predictive model that is deployed at the point of care setting and in real time generate the probabilities of success (MCID), complication rates, length of hospital stay, and potential costs to name a few possibilities. This information would be patient-specific and could influence what surgery is best suited for an individual patient; it could even provide a better discussion for shared decision making. For the surgeon, prior to surgery, the surgeon may identify risk factors that could be used to optimize a surgical plan that will result in a higher success rate of surgery and a complication rate that is low and acceptable to both the surgeon and patient. Predictive modeling could also be used to determine the extent of an operation that may be best suited for an individual patient taking onto account the patient-specific factors. Therefore, the goal of this study was to create a preoperative predictive model from baseline demographic, radiographic, health-related quality of life (HRQOL), and surgical factors that can predict the likelihood that a patient will have the best outcome as defined by meeting the ODI MCID at the two-year postoperative time point.