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Multiple Regression Analysis of Factors Affecting Health-Related Quality of Life in Adult Spinal Deformity

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Abstract

Background: Previous studies demonstrated the adult spinal deformity (ASD) population is heterogeneous. Multiple parameters may affect health-related quality of life (HRQL).
Aim: To understand the ranking of parameters affecting HRQL in ASD using multiple regression analysis.
Patients and Methods: A total of 483 patients enrolled in a prospective multicenter ASD database from the population. Multiple regression analysis was performed for Scoliosis Research Society–22 (SRS-22) and Oswestry Disability Index (ODI) separately. Initially proposed primary variables of diagnosis (highest correlation), age, lordosis gap (L gap), and coronal curve location were regressed for each response variable (SRS-22 and ODI) univariately. Age and L gap could not be used together because of high colinearity. Coronal curve location was removed owing to an insignificant correlation. Two initial models were considered per response, consisting of diagnosis and age in one and diagnosis and L gap in the other. The rest of the potentially predictive variables were introduced in these models one at a time. Final models were evaluated using stepwise automatic model selection.
Results: For ODI, body mass index (BMI), gender, and sagittal and spinopelvic parameters were in the basic model but only BMI and gender in the model with L gap and only gender in the model with age were highly predictive. For SRS-22, a large number of parameters were in the basic model but BMI, gender, coronal balance, lordosis curve, and sagittal vertical axis in the model with L gap and only gender in the model with age were highly predictive. Coronal curve location was not significantly predictive in any model.
Conclusions: These findings reiterate the importance of patient diagnosis, age, and/or the amount of lordosis as the most important factors affecting HRQL in ASD. Gender, BMI, and sagittal vertical axis appear to be consistently important co-variables whereas coronal balance and magnitude of L curves may also be important in SRS-22. These may aid in better understanding the problem in ASD and may be useful in future classifications.

Keywords: Adult spinal deformity; Statistics; Multiple regression analysis; Health-related quality of life

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Introduction

Adult spinal deformity (ASD) is seen in up to 60% of the elderly population and is increasingly becoming an issue. The decision to treat, whether surgically or non-surgically, is further complicated by the heterogeneity of patients' ages, symptoms, expectations, and etiologies. Previous research indicates that whereas treatment in a younger subgroup of patients is affected by the severity of deformity [1], the main considerations regarding the option to treat most patients with ASD are pain, poor function, and disability: to be more concise, health-related quality of life (HRQL) [2,3].

Because surgical decision making and preoperative planning for ASD are strongly interrelated to HRQL, studies have focused on identifying factors that affect HRQL. These factors have evolved from the sole consideration of coronal Cobb angles to more complicated radiographic parameters taking into account the spine, pelvis, and lower extremities [4-7]. Many new radiological parameters have been defined, and along with existing variables such as age, diagnosis and body mass index (BMI), this has given rise to a new dilemma regarding which factors are better predictors of HRQL and, conversely, which are interrelated and not key factors on their own. In other words, which of these parameters can or should be used in classification systems and which should not? This study arose from the perception of the current authors that some decisive parameters in ASD classification systems, such as the coronal curve type, may not be relevant for HRQL measures, whereas others such as age and diagnosis may be highly relevant.

The purpose of this study was to determine which factors have a greater impact on baseline HRQL, to establish a hierarchy of parameters using multiple regression analysis.

Patients and Methods

This study was based on a prospective database on ASD. The purpose of this database is to evaluate the end results of treatment in this population, but for the purposes of the current study the researchers used only the baseline data at presentation. The study was conducted on a total of 483 adult deformity patients enrolled into the database from 5 separate spine clinics. Institutional review board approval was granted from each clinic separately allowing patients to be included in this database and all individual consenting patients to be included. Inclusion criteria for this database are the presence in patients aged 18 years and older of any of the following: coronal deformity greater than 20°, pelvic tilt greater than 25°, sagittal vertical axis (SVA) greater than 5 cm, and thoracic kyphosis greater than 60°. The only criterion for exclusion was the presence of an acute destructive lesion as the cause of the deformity. All patients fulfilling these criteria were enrolled regardless of the etiology of the deformity (idiopathic, degenerative, congenital, etc.) and any previous treatments. All were asked to complete Oswestry Disability Index (ODI) and Scoliosis Research Society–22 (SRS-22) questionnaires as a part of the routine evaluation.

The researchers obtained anteroposterior and lateral X-rays of the whole spine for all patients. Those that were not digital were scanned and all were entered into X-ray analysis software (SurgimapSpine, Nemaris Inc., http://www.surgimap.com) for processing. Patients were classified according to the revised SRS–Schwab ASD (SRS-S) classification based on these X-rays [8].

Health-related quality of life evaluation was performed using SRS-22 and ODI questionnaires. Patients enrolled in the multicenter ASD database were asked to fill out 2 questionnaires: SRS-22 and ODI. Although it was developed for adolescent idiopathic scoliosis patients [9], the SRS-22 has been found to be relevant in the ASD population as well [10]. The ODI has been found to be less responsive in the ASD population than SRS-22 but it is still a valuable tool in the analysis of HRQL in this population.

Non-radiographic variables included SRS-22 and ODI scores, gender, patient age, height, weight, BMI, and diagnosis (grouped as idiopathic, degenerative, and other; determined based on the treating surgeon's decision at each participating center).

Radiographic variables

High-quality, standing, full-length anteroposterior and lateral radiographs of the spine were available for all patients. Radiographs were measured by the senior spine surgeon or fellowship-trained spine surgeons at each institution and measurements were verified by the principal investigator. Coronal radiographic parameters recorded were Cobb angles of the main thoracic and lumbar curves, coronal curve location (CCL) as per SRS-S classification and coronal balance (distance between the center of S1 and the C7 plumbline in millimeters). Sagittal parameters were T1 sagittal tilt, lumbar lordosis (LL), pelvic tilt, pelvic incidence (PI), sacral slope, thoracic kyphosis (T2–T12), and sagittal balance (sagittal vertical axis [SVA] in millimeters). In addition, the researchers calculated and used a new parameter defined by their group: global tilt, incorporating T1 sagittal tilt as well as pelvic tilt (arithmetic sum), thereby providing the cumulative effect of sagittal spinal balance and compensatory pelvic flexion. In addition to those continuous variables, related parameters of the SRS-S classification such as PI–LL (stratified as 0, +, and ++) and SVA (stratified as 0, +, and ++) were used. Furthermore, because there is no established general normal value for lumbar lordosis, a new parameter, the lordosis gap (L gap), was used as a quantitative measure of deviation from ideal lordosis. Lordosis gap was calculated by subtracting the value of actual lumbar lordosis from the