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Adult Spinal Deformity Surgeons Are Unable to Accurately Predict Postoperative Spinal Alignment Using Clinical Judgment Alone

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Abstract

Object: Adult spinal deformity (ASD) surgery seeks to reduce disability and improve quality of life through restoration of spinal alignment. In particular, correction of sagittal malalignment is correlated with patient outcome. Inadequate correction of sagittal deformity is not infrequent. The present study assessed surgeons' ability to accurately predict postoperative alignment.

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Methods: Seventeen cases were presented with preoperative radiographic measurements, and a summary of the operation as performed by the treating physician. Surgeon training, practice characteristics, and use of surgical planning software was assessed. Participants predicted if the surgical plan would lead to adequate deformity correction and attempted to predict postoperative radiographic parameters including sagittal vertical axis (SVA), pelvic tilt (PT), pelvic incidence to lumbar lordosis mismatch (PI-LL), thoracic kyphosis (TK).
Results: Seventeen surgeons participated: 71% within 0 to 10 years of practice; 88% devote >25% of their practice to deformity surgery. Surgeons accurately judged adequacy of the surgical plan to achieve correction to specific thresholds of SVA 69% ± 8%, PT 68% ± 9%, and PI-LL 68% ± 11% of the time. However, surgeons correctly predicted the actual postoperative radiographic parameters only 42% ± 6% of the time. They were more successful at predicting PT (61% ± 10%) than SVA (45% ± 8%), PI-LL (26% ± 11%), or TK change (35% ± 21%; $p < .05$). Improved performance correlated with greater focus on deformity but not number of years in practice or number of three-column osteotomies performed per year.
Conclusion: Surgeons failed to correctly predict the adequacy of the proposed surgical plan in approximately one third of presented cases. They were better at determining whether a surgical plan would achieve adequate correction than predicting specific postoperative alignment parameters. Pelvic tilt and SVA were predicted with the greatest accuracy.

Keywords: Adult spinal deformity; Surgical planning; Deformity correction; Adult scoliosis; Spinal alignment

Introduction

The goals of adult spinal deformity (ASD) surgery include reducing disability and improving quality of life through restoration of spinopelvic alignment and decompression of neural elements. Over the past decade, several studies have highlighted the importance of sagittal spinopelvic alignment in achieving optimal postoperative outcomes [1-3]. Specifically, Schwab et al. demonstrated significant correlations between specific radiographic parameters and standardized measures of health-related quality of life (HRQOL) [4]. It has become apparent that sagittal spinopelvic malalignment is a key factor influencing patient disability, with significant correlations reported between HRQOL and sagittal vertical axis (SVA), pelvic tilt (PT), and pelvic incidence to lumbar lordosis mismatch (PI-LL) [5,6]. Furthermore, it has been demonstrated that more complete sagittal plane deformity correction favors the greatest HRQOL benefit [7]. Determining the degree of correction required to restore sagittal alignment and, in turn, selection of suitable osteotomies, soft tissue releases, implants, and levels of instrumentation to achieve the desired correction, represents a significant challenge. Indeed, Moal et al. [8] demonstrated a relatively high rate of incomplete sagittal correction in ASD surgery of up to 50%.

The complexity of surgical planning, which must take into account radiographic and patient factors in addition to surgeon experience, has resulted in multi-faceted efforts to develop appropriate treatment strategies. Several authors have proposed mathematical models to facilitate accurate calculation of the angle required for spinal osteotomies to correct sagittal deformity [9-12]. Although these formulas represent an important step in improving prediction of postoperative alignment, they may be too complex and thus impractical for routine clinical use [9,10,13]. Alternatively, surgical planning software has been developed which allows simulation of a proposed plan and prediction of postoperative alignment. Such software allows the surgeon to measure spinopelvic, sagittal, and coronal alignment parameters. An osteotomy (or set of osteotomies) can then be simulated. Based on the surgical plan simulation, the software provides predicted values for postoperative radiographic parameters that allows surgeons to assess the adequacy of their plan [4,13].

The accuracy with which surgeons performing ASD are able to predict postoperative alignment in the absence of surgical planning software is currently unknown and represents the central question of the present study. In particular, we sought to determine the extent to which surgeons could judge whether a series of surgical plans would achieve adequate restoration of sagittal spinopelvic alignment without the use of surgical planning software or formula. We also assessed their ability to predict, within a range, the expected values of key postoperative radiographic alignment parameters based on preoperative images and proposed surgical plans. These data may prove useful in assessing the potential value of adjuncts to surgical planning as a means of optimizing the postoperative alignment and outcomes.

Methods

A survey that included 17 ASD cases was administered to surgeon members of the International Spine Study Group (ISSG). The survey was presented in PowerPoint (Microsoft, Redmond, WA) format and cases were prepared at a central location. Each case included a full-length (36-inch) lateral standing radiograph with standard preoperative radiographic measurements and a summary of the surgery performed by the surgeon who treated that patient. The surgical summary included the upper (UIV) and lower instrumented vertebrae (LIV), level of pedicle subtraction osteotomy (PSO), angle of resected wedge in PSO, and level of any interbody grafts (Figs. 1 and 2). Participants were first asked 6 questions to assess their training background and characteristics of their clinical practice, as well as whether they currently use surgical planning software and their beliefs regarding its value