Do preoperative flexibility radiographs predict postoperative residual lumbar curvatures in Lenke 1 and 2 adolescent idiopathic scoliosis?

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INTRODUCTION: Our institution routinely obtains both side-bending radiographs and a supine anteroposterior (AP) view to assess curve flexibility in AIS. This study compares the efficacy of side-bending and supine flexibility radiographs in terms of predicting residual postoperative lumbar curvature after selective thoracic fusion for Lenke 1/2 curves.

METHODS: This was a retrospective review of AIS Lenke 1/2 scoliosis patients who underwent posterior spinal fusion by a single surgeon. All patients had preoperative flexibility radiographs including side-bending and supine AP films, in addition to pre- and postoperative standing PA and lateral radiographs. Lenke modifiers were dichotomized into two groups, “A” and “B or C”, as Lenke B and C curves were noted to behave similarly from a statistical perspective. We used computer-assisted SurgiMap 2.0 software for all radiographic measurements. Pearson and Spearman correlations and linear regression models were developed in SAS.

RESULTS: A total of 86 patients were included, with mean age 14.9 years (10.9-20.8) and follow-up 72.3 months (4.2-239.3). Mean pre-operative standing lumbar Cobb angle was 33.2˚, supine lumbar Cobb 24.8˚, side-bending lumbar Cobb 8.2˚, and post-operative standing lumbar Cobb 12.1˚. As anticipated, the mean postoperative lumbar Cobb angle was larger ($p < 0.001$) for Lenke B or C curves (mean = 19.0°) than Lenke A curves (mean = 8.9°). Preoperative supine ($r = 0.55$, $p < 0.001$) and side-bending ($r = 0.54$, $p < 0.001$) values had similar correlation with postoperative lumbar Cobb angles. Three regression models were constructed to predict post-operative lumbar Cobb angles, using pre-operative supine lumbar Cobb (model S), side-bending lumbar Cobb (model B), and both (model SB) as the primary variable, dichotomized by Lenke modifier (A or B/C). We found that all three models were similar in their ability to estimate the mean post-operative lumbar Cobb angle: model SB ($R^2 = 0.49$, $p < 0.001$) performed slightly better than Model S ($R^2 = 0.39$, $p <0.001$, Figure 1) and model B ($R^2 = 0.44$, $p < 0.001$, Figure 2). Either supine or side-bending radiographs alone estimated mean residual postoperative lumbar curvature to within 5.6° or less after selective posterior thoracic fusion.

DISCUSSION AND CONCLUSION:

We present the largest series of selective posterior thoracic fusions in assessing the prediction capabilities of the pre-operative flexibility radiographs, finding that either supine or side-bending radiographs alone may be used to estimate mean residual postoperative lumbar curvature to within 5.6°, which can be used to guide deformity correction and avoid overcorrection of the thoracic fusion.

This study has important limitations. This is a retrospective study and is thus limited by the availability, quality, and reporting of the source data and radiographs. We attempted to standardize radiographic measurements with two reviewers using computer-assisted SurgiMap software; however, there is still some error that could have been introduced during the radiograph measurement process that could limit the generalizability of the results. Given the variable availability of retrospective data, we were unable to comprehensively study other preoperative and intraoperative variables, such as additional pre-operative flexibility measures (e.g. push-pull, traction), which may have provided further insight into post-operative lumbar predictability.

With the data from our study, one could conceivably make an argument for either supine or side-bending films as the pre-operative measure of choice—just not both. Given that bending radiographs are necessary for Lenke classification, and that Model B performs slightly better than Model S and nearly as well as Model SB, our institution has discontinued routine use of the supine film for Lenke 1 and 2 curves, and we now limit routine pre-operative flexibility evaluation to only side-bending films. This will provide important cost-savings and limit radiation exposure from unnecessary radiographs.

Figure 1. Scatterplot of postoperative Lumbar Cobb angle vs. preoperative supine lumbar Cobb angle with the regression Model S overlaid. (Red is Lenke A; Blue is Lenke B or C). 39% of the variation from patient-to-patient in postoperative lumbar Cobb angles can be explained by this regression model ($R^2 = 0.39$, $P < 0.001$)).

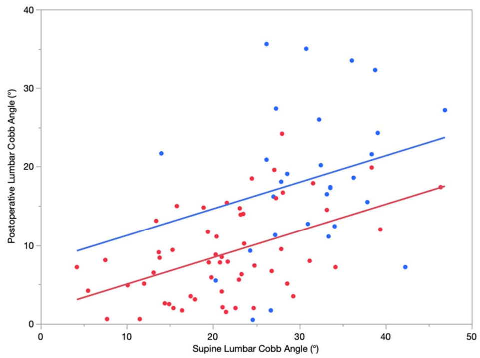

Figure 2. Scatterplot of postoperative Lumbar Cobb angle vs. preoperative bending lumbar Cobb angle with the regression Model B overlaid. (Red is Lenke A; Blue is Lenke B or C). The larger the preoperative Cobb angle, the difference between the Lenke modifier groups tends to increase postoperatively. 44% of the variation from patient-to-patient in postoperative lumbar Cobb angles can be explained by this regression model ($R^2 = 0.44$, $P < 0.001$)).