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Predicting Kyphosis Correction During Posterior-Only Vertebral Column Resection by the Amount of Spinal Column Shortening

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Abstract

Study Design: Retrospective.
Objective: To investigate the relationship between the amount of correction achieved (K°) and extent of vertebral column shortening (mm) with posterior vertebral column resection (PVCR).
Summary of background data: There is no scientific reference to the correlation between K° and column shortening (mm) with PVCR.
Methods: Based on simple geometry, we tested the hypothesis that we could predict the amount of actual kyphosis correction (K°) by calculation on 26 kyphotic PVCR patients. Using multiple linear measurements (mm), two angular approximations (°) were calculated: the geometric approximation (G°) using the geometric calculation (G-cal), and the rough approximation (R°) by more simplistic calculation (R-cal). Both G° and R° were compared against K° as measured on the pre- and postoperative radiographs. If calculated G° and R° is close to measured K°, we can use the calculations (G-cal and R-cal) in the clinical situation.
Results: The mean correction of K° was 38°. K°−G° and K°−R° were not significantly greater than 3° and 6°, respectively. As K° was very close to G° and R°, K° can replace G° and R°. Therefore, we can use G-cal and R-cal in the clinical setting and we can determine how much posterior shortening and what cage size is required to obtain a certain amount of K°.
Conclusions: With two calculations (G-cal & R-cal), we can determine how much vertebral column shortening (mm) we need during PVCR to obtain the amount of kyphosis correction desired (K°). In order to obtain K°, using the formula deduced from G-cal and R-cal, we can determine the shortening between the upper and lower pedicle screws and cage size.

Keywords: Posterior vertebral column resection; Vertebral column shortening; Kyphosis correction; Correlation formula

All research was conducted at Washington University School of Medicine, St. Louis, MO.

Institutional Review Board (IRB) approval was received for this study.

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Introduction

There are various options for correcting severe spinal kyphosis such as pedicle subtraction osteotomy (PSO), Smith-Petersen osteotomy, eggshell osteotomy, or vertebral column resection (VCR). Among them, the VCR is considered the most powerful method in terms of the amount of correction it can provide [1]. Several recent studies by Suk et al. [2-4] and Lenke et al. [5,6] have documented the use of a PVCR to correct severe rigid spinal deformities.

Studies that have reported on the relative correction that can be obtained with various osteotomy techniques have shown that a Smith-Petersen osteotomy can obtain about 10° of kyphosis correction at each osteotomy level [6]. A PSO can obtain about 30° to 40° of correction at each osteotomy level [6-8], as a 1-mm resection will correct approximately 1 degree of kyphosis [9]. However, there is no scientific reference to the correlation between the amount of correction achieved and the shortening of the vertebral column with a PVCR.

During PVCR kyphosis correction, the components of that correction reside in the amount of posterior compression (x in mm) applied to the pedicle screws above and below the resection site along with any anterior height change that occurs via the anterior cage, which acts as an anterior pivot. Because both anterior and posterior vertebral column lengths need to be considered in a PVCR, the authors used a geometric model to calculate the correlation precisely. There have been efforts to geometrically calculate the correlation between angular correction and vertebral column shortening with a PSO [10-12], but those studies were performed only on PSO procedures and focused more on the amount of angular correction needed correlating to the C7 plumbline and sagittal imbalance correction.

The objective was to analyze the correlation between the amount of angular kyphosis correction and vertebral column shortening occurring with a PVCR for the correction of severe kyphosis. We hypothesized that we could predict the amount of actual kyphosis correction by the validated calculation using posterior shortening and anterior cage height. Based on the calculation, in order to obtain a certain amount of kyphosis correction, we reversely sought to determine posterior shortening and anterior cage size required.

Materials and Methods

Because a PVCR involves manipulation of all three spinal columns, both anterior and posterior vertebral column lengths should be considered in the calculations for PVCR, so a geometric model was developed to calculate the correlation precisely. Based on simple geometry, we tested our hypothesis that we could predict the amount of actual Kyphosis correction (K°) occurring by a preoperative geometric calculation (G-cal). However, use of the G-cal may not be practical to calculate intraoperatively. Therefore, we also developed the rough calculation (R-cal). In validating the G-cal and R-cal, the K° was measured and compared with the geometric approximation (G°), which is the calculated degrees of kyphosis correction by G-cal and

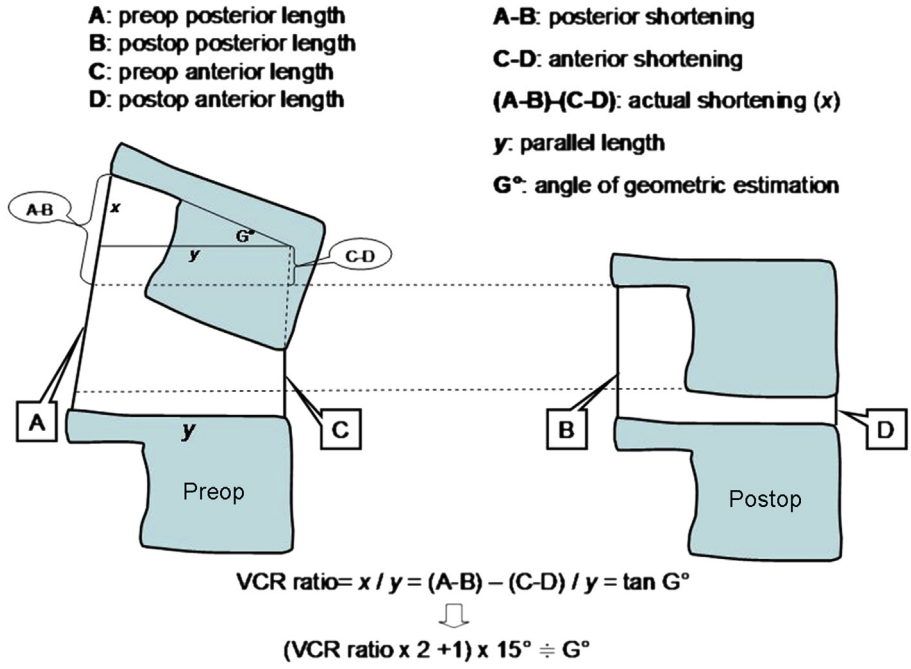

Fig. 1. Several anatomic lines and angle measurements were utilized as depicted. The vertebra above is supra-adjacent and the vertebra below is infra-adjacent, respectively. The body at the level of resection was omitted.