

# Inter- and Intraobserver Reliability of Pelvic Obliquity Measurement Methods in Patients With Cerebral Palsy

M. Wade Shrader, MD<sup>a,\*</sup>, Emily M. Andrisevic, MD<sup>b</sup>, Mohan V. Belthur, MD<sup>b</sup>,  
Gregory R. White, MD<sup>b</sup>, Carla Boan, BA<sup>b</sup>, William Wood, MD<sup>c</sup>

<sup>a</sup>Department of Orthopaedic Surgery and Rehabilitation, University of Mississippi Medical Center, 2500 North State Street, Jackson, MS 39216, USA

<sup>b</sup>Center for Pediatric Orthopaedics, Phoenix Children's Hospital, 1919 East Thomas Road, Phoenix, AZ 85006, USA

<sup>c</sup>Orthopaedic Residency Program, Banner-University Medical Center, 1111 E McDowell Rd, Phoenix, AZ 85006, USA

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## Abstract

**Study Design:** Retrospective, chart review.

**Objectives:** The identification and management of pelvic obliquity in neuromuscular scoliosis can be difficult; therefore, appropriate evaluation of this pathology is important. Variations in presentation have resulted in various methods of measurement, without a consensus or gold standard measurement. This study is the evaluation of reliability of five methods commonly used to determine pelvic obliquity in the frontal plane.

**Summary of Background Data:** Previous studies have used five different methods (ie, the Maloney method, the O'Brien method, the Osebold method, the Allen and Ferguson method, and the Lindseth method) to determine pelvic obliquity in the frontal plane.

**Methods:** Radiographic images of 50 patients with neuromuscular scoliosis involving the pelvic girdle were identified and evaluated by a team of 5 raters. Each rater was instructed to apply five commonly used methods of measuring pelvic obliquity. The same raters were asked to rate the same radiographs again after a minimum of one month. The interobserver reliability was assessed using the intraclass correlation coefficient (ICC) and the intraobserver analysis was assessed using the Pearson correlation. A rating greater than 0.8 was considered excellent reliability.

**Results:** The Maloney method showing the highest interobserver reliability of ICC of 0.965 and 0.964. The Lindseth method had the lowest ICC, but all the methods were considered highly reliable by the rating classification system. The Maloney method also showed the highest intraobserver reliability, ranging from 0.845 to 0.962. The Allen and Ferguson method had the lowest intraobserver reliability.

**Conclusions:** Many of the methods tested had excellent reliability in this study, but our data suggest the Maloney method is the most reliable method of measuring pelvic obliquity on a frontal view radiograph.

**Level of Evidence:** Level III, retrospective, comparative study.

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**Keywords:** Cerebral palsy; Scoliosis; Radiograph; Pelvic obliquity

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\*Corresponding author. Department of Orthopaedic Surgery and Rehabilitation, University of Mississippi Medical Center, 2500 North State Street, Jackson, MS 39216, USA. Tel.: (601) 984-1000; fax: (601) 815-1722.

E-mail address: [mshrader@umc.edu](mailto:mshrader@umc.edu) (M.W. Shrader).

## Introduction

The prevalence of progressive spinal deformity in children with neuromuscular disorders such as cerebral palsy (CP) is between 50% and 80% [1]. Neuromuscular curves typically involve the entire thoracic and lumbar spine and often create pelvic obliquity. Pelvic obliquity can occur in the frontal, sagittal, or transverse planes, although typical

measurements concentrate on the frontal plane. Pelvic obliquity can adversely affect seating and posture, and increase the risk for thoracic-pelvic impingement and ischial decubitus ulcers.

Although nonoperative techniques are often initially used in the care and positioning of these children, posterior spinal fusion (PSF) is recommended for progressive deformity in these children once the curve measures greater than  $50^\circ$  [2]. Fixation typically extends from the proximal thoracic region to the lower lumbar region to prevent future curve progression. The decision to extend fixation to include the pelvis depends on the ambulatory status of the child and the degree of pelvic obliquity [2]. Several studies have shown that extending fixation to include the pelvis improves scoliosis correction and sitting balance if the obliquity exceeds  $10^\circ$  to  $20^\circ$ , especially if the child is nonambulatory [1,3,4]. However, pelvic fixation is technically challenging and is not without its complications, including increased blood loss, longer operating time, wound complications, implant failure, and sacral nerve injury [3,5].

There is very little known about the specific clinical impacts of pelvic obliquity on patients with CP. There are few reports in the literature that investigate what magnitude of pelvic obliquity begins to impact our patients clinically. How much surgical correction of the pelvis needs to occur is also unknown currently. There is a significant need for clinical studies investigating these aspects of spinal and pelvic deformity, but currently very few exist. However, a reliable measurement method must be demonstrated before any critical analysis of pelvic obliquity can be undertaken [3,4].

Currently, there are a variety of methods used to measure pelvic obliquity in the frontal plane [5-9]. Five of the most commonly used methods are those described by Maloney, O'Brien, Osebold, Allen and Ferguson, and Lindseth [5-9]. However, there is a paucity of data comparing these methods. Identification of an accurate and reliable method is important to standardize care and aid in surgical decision making in these patients. The goal of this project is to evaluate the inter- and intrarater reliability of these five commonly used methods for measuring pelvic obliquity in patients with scoliosis in patients with cerebral palsy (CP).

## Materials and Methods

PA scoliosis radiographic images of 50 patients with CP with neuromuscular scoliosis involving the pelvic girdle were identified and evaluated by a team of 5 raters. The images were selected from a database of patients with CP, and the actual radiographs used in clinical care were used for the analysis. The raters included three attending surgeons with experience ranging from 1 to 15 years as pediatric orthopedic surgeons at a tertiary care children's

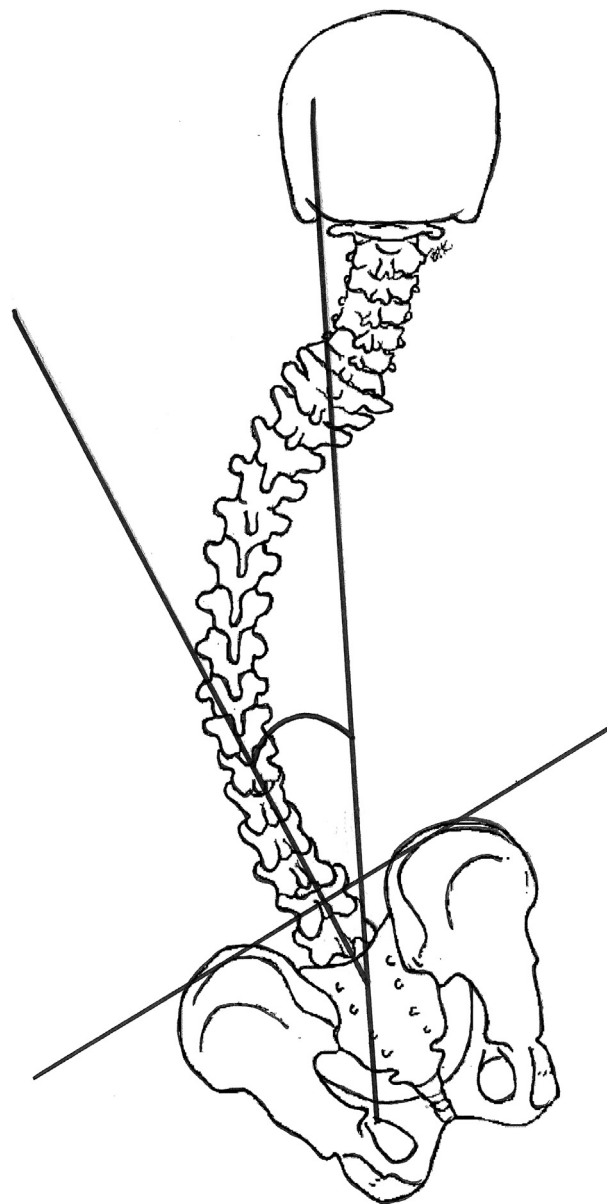


Fig. 1. Maloney method as described in “Simultaneous Correction of Pelvic Obliquity, Frontal Plane and Sagittal Plane Deformities in Neuromuscular Scoliosis Using a Unit Rod with Segmental Sublaminar Wires: A Preliminary Report” [6]. Pelvic obliquity was measured on anteroposterior radiographs of the spine that included the pelvis. They viewed the uncertainty of a standard horizontal line as a major problem in the measurement of pelvic obliquity and thus measured the pelvic obliquity as follows. Two lines were drawn, one across the superior aspect of the iliac crests and a second drawn from the center of T1 to the center of S1. The angle between the second line and one perpendicular to the first line was determined to be the pelvic obliquity.

hospital, one chief orthopaedic resident, and one third-year medical student.

Each rater was instructed to apply five commonly used methods of measuring pelvic obliquity to all images. The methods evaluated were those of Maloney, O'Brien,

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