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# Exploratory Evaluation of the Effect of Axial Rotation, Focal Film Distance and Measurement Methods on the Magnitude of Projected Lumbar Retrolisthesis on Plain Film Radiographs

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**Abstract**

**Objective:** The purpose of this exploratory study was to evaluate the amount of error in retrolisthesis measurement due to measurement methods or projection factors inherent in spinal radiography. In addition, this study compared how accurately these methods determine positions of the lumbar vertebrae being studied and the expected projected size of the retrolisthesis.

**Methods:** Vertebral models were situated in a retrolisthesis position. Radiographs of the models were obtained in positive and negative y-axis rotations at 40- and 84-in focal film distances. The projected retrolisthesis was measured using the Gohl, Iguchi, and Lopes methods.

**Results:** At the 40-in focal film distance, the Iguchi method and Lopes methods were significantly more accurate than the Gohl method. At the 84-in focal film distance, the Lopes method was significantly more accurate than the Gohl method. Almost all measurements overestimated both the actual amount of retrolisthesis as well as the amount of trigonometrically calculated retrolisthesis that should have been present on the radiographs. Findings suggest that measurements were less accurate with vertebrae rotated more than 10°.

**Conclusions:** This study demonstrated that lumbar vertebral rotation, focal film distance, and measurement methods are potential sources of error in retrolisthesis measurement.



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## Introduction

Diagnoses and clinical decision making for a variety of orthopedic conditions depend heavily upon radiographic studies; therefore, measurements derived from radiographs must be accurate.[1] This is especially true in the chiropractic profession with the existing controversy over the historical usage of radiographic measurement of the spine.[2] Gonstead manipulative technique was estimated to be used by approximately 58% of the chiropractic profession in 1998,[3] although it is unknown how many use the Gonstead Method, which includes measurement of misalignment in its analysis system. Although the value of assessing relatively small spinal misalignments has been seriously questioned,[4] some providers who use the Gonstead Method attempt to measure the amount of retrolisthesis seen on radiographs.[5–7] Given that some practitioners use this technique, it would be important to know if the measurements derived from the radiographs accurately reflected the position of the vertebrae being studied.

Because of distortion related to pelvic rotation, the use of radiography in measurement of the pelvis has been questioned.[8,9] As well, other issues have been raised, including a number of general measurement problems related to lumbar vertebrae such that x-axis translation of a vertebra results in projected y-axis rotation and that the irregular shape of the vertebrae can have unexpected effects on the projected image when they are rotated on the y-axis.[10–13] These types of projection errors can lead to inaccurate analysis. Wall and Oppenheim[14] have also noted that the determination of the progression of spondylolisthesis, a condition that commonly occurs in conjunction with retrolisthesis,[15,16] may be hindered by projection errors. Given these findings, radiography is not an accurate tool for the assessment of spinal position; and different measurement methods have not been adequately tested. Clinicians could be using faulty information in their decision-making process. It is therefore important to determine if retrolisthesis measurement on radiographs is subject to significant error.

The purpose of this exploratory study was to evaluate if measurement of retrolisthesis, using the Gohl,[6] Iguchi,[17] and Lopes measurement methods, may have errors in the measurement methods themselves or the projection factors inherent in spinal radiography. Additionally, this study compared how accurately these measurements reflect the actual positions of the vertebrae being studied and the projected retrolisthesis expected to be found on the radiographs.

## Methods

Plastic models of a fourth and fifth lumbar vertebra were used to demonstrate the effects of y-axis rotation and changes in focal film distance on projected retrolisthesis (Fig 1). Holes were drilled in the inferior body of the fourth lumbar vertebral model and the superior body of the fifth lumbar vertebra. A copper wire was inserted into these holes such that the relative positions of the vertebrae could be changed and maintained by the bending of this wire. An angle of 17° was then formed between the inferior end plate of the fourth lumbar vertebra and the superior end plate of the fifth lumbar vertebra by bending the copper wire.

To obtain the desired amount of posterior slippage, we selected a point at the mid line of the posterior inferior vertebral body margin of the fourth lumbar vertebral model and then measured from that point along the inferior of the vertebral body and placed a small line 5 mm from the posterior edge. The fourth lumbar vertebral body was then moved posterior until that mark matched with a point on the mid line of the superior posterior vertebral body margin of the fifth lumbar vertebral model. This produced a 5-mm retrolisthesis of the fourth on the fifth lumbar vertebral body.

The vertebrae were placed on a plastic pedestal. The center of the posterior inferior border of the fifth lumbar vertebral body was positioned on the center point of the pedestal, which was centered on the axis of a turntable upon which a Pickett Model 6180 protractor (Pickett Industries, Tucson, AZ) had been mounted to allow the assessment of the number of degrees the turntable was rotated. The turntable allowed the models to be rotated in both the positive and negative direction on the y-axis. The central axis of the turntable was then positioned on the center line of the bucky at a distance of 17 cm from the

**Fig 1.** Photograph of the models used in the study.