Measuring the Effects of Osteopathic Manipulative Treatment on Range of Motion in Subjects with Postural Asymmetries in the Posterior View: A Potential Implication for People with Lateral Spinal Curvatures

Katherine A. Porpora*[1]; Kerin M. Claeson, MS, PhD[1]; and Lauren Noto Bell, DO[2]

[1]Department of Bio-Medical Sciences and [2]Department of Osteopathic Manipulative Medicine, Philadelphia College of Osteopathic Medicine, *katherinepo@pcom.edu

Introduction

Background: According to the osteopathic principles of medicine, asymmetry is when symmetry is absent in standing position (Chila, 2011). Correct posture is the body's ability to maintain muscle tension in the upright anatomical position (Servid, 2009). A poorly positioned backpack, chronic sitting, and slouching are factors that contribute to negatively modified posture and gait (Cottalorda, 2004). This modification in spinal shape creates poor posture and can manifest as a postural asymmetry. Although postural asymmetries and lateral spinal curvatures, like scoliosis, can be noticeable to the eye, many cases go undetected unless the subject undergoes a radiograph or complains of pain (Goldberg, 2008).

The Cobb angle, established in 1948, is the gold standard for measuring lateral curvatures on diagnostic imagery (Gstoettner, 2007). However, exposure to numerous radiographs can cause undue exposure to radiation. Studies have found that maturing tissues in adolescent girls diagnosed with idiopathic scoliosis are affected by radiation the most during their peak of physiological growth (Cote, 1998). Use of radiographs when assessing for lateral spinal curvatures may be avoided by implementing such techniques as 2D morphometrics. 2D morphometrics has recently been shown to be of benefit when describing posture (Bova et al., in review) and could therefore be implemented as a technique to measure the affects of OMT on patients presenting with somatic dysfunction such as postural asymmetries and restricted range of motion.

Purpose: For my thesis, I expand upon the work initiated by Michael Bova and his thesis committee at the Philadelphia College of Osteopathic Medicine. That initial research was designed to observe the effects of a specific OMT protocol on subjects with documented lateral postural asymmetries, which demonstrated significant changes in patients treated with OMT vs Sham or Control (Bova 2014). I sought to further quantify through morphometrics, the potential changes in range of motion as a result of the same OMT protocol.

***Hypotheses:** I hypothesized that OMT would increase range of motion (ROM) in patients with lateral asymmetries. I further hypothesized Sham treatment would not increase ROM. I expected to see increased ROM reflected in the morphometric shape analyses.*

Materials and Methods

Organization: Subjects who completed 6, 9, and 12 sessions were placed into groups: pre- first treatment and post- last treatment; side bend left and side bend right. For example, Subject 25 (Figure 1) completed Treatments 1-9. I then put the side bend left first pre- treatment 1 and side bend left last post- treatment 9 into the same folder based on the number of times subjects were treated.

Morphometric Shape Analysis: Shape analysis is a way to quantify variation and morphological transformation (Zelditch, 2004), such as potential shifts in posture as a result of OMT. Morphometric analysis through landmarks quantifies shape change for all the subject data points collected throughout pre- and post- treatment (Zelditch, 2004). Shape change was only predicted for OMT subjects, not predicted for Sham subjects. Any evidence of a shape change involved verification by reviewing original images in order to determine alternative reasons for shape change.

Landmarks: Analysis of bony and semi- landmark data points has been conducted by using morphometric shape analysis. The first set of landmarks, referred to as "bony" or "palpated landmarks", consisted of the landmarks palpated and marked on the subjects' posterior back. The second set of landmarks, referred to as "semi landmarks" mapped out the silhouettes of the subjects' back. The combined landmarks are represented as one data point on the graph displaying principle components of shape features. This idea of shape configuration of landmarks is the central theory of geometric morphometrics and will help guide the outcome of the results of OMT. According to Zelditch (2004), "Landmarks are ideally homologous anatomical loci that do not alter their topography relative to other landmarks, provide adequate coverage of the morphology, can be found repeatedly, and lie within the same plane" (Zelditch, 2004). In other words, this means that all the data points collected pre- and post- treatment were not altered when the morphometric test analyzed to see if a shape change occurred with each treatment.

Bony Landmarks: The bony landmarks consisted of 11 landmarks placed on the subjects' backs during treatment (Figure 1A and B). These bony landmarks were created for side bend left and side bend right for 6, 9, and 12 completed sessions.

Semi-landmarks: The semi-landmarks were created by first copying the bony landmark information from all the subjects who completed 6, 9, and 12 sessions. Once the semi-landmark folders were created with the pre and post subject images, I used Paint to draw a line from left axillary fold to right axillary fold. Then I drew a line parallel to the line connecting the axillae and placed such that it passed through the spinous process of C7. The third line was drawn connecting both PSIS landmarks. Once the lines were made in Paint, these boundaries were now made for semi-landmarks to be drawn and to outline the silhouettes of the subjects (Figure 1C and D).

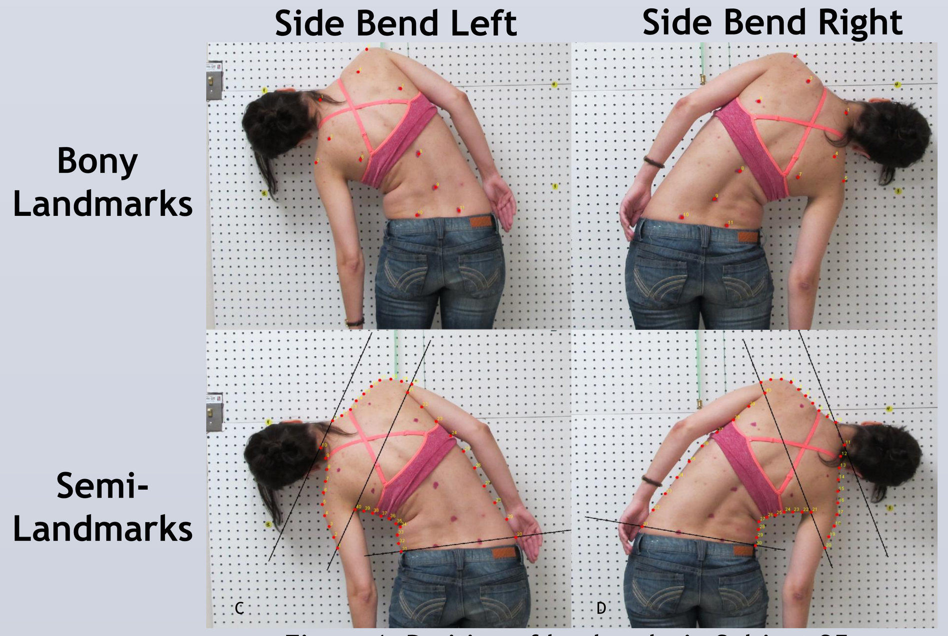

Figure 1: Position of landmarks in Subject 25.
Images A and B show side bend left and side bend right bony landmarks.
Images C and D show side bend left and side bend right semi-landmarks.

ABSTRACT: Poor posture is a part of most people's lives whether they are aware of it or not. While there are many options for correcting a postural asymmetry, many interventions are painful, inconvenient, and/or socially stigmatized. For instance, back braces and surgery are typical ways in which to improve posture when the underlying problem is a spinal lateral curvature. However, osteopathic manipulative treatment (OMT) may be a potential noninvasive treatment for spinal lateral curvatures. My thesis research is centered on testing whether or not OMT improves range of motion and/or changes the overall shape of subjects with spinal lateral curvatures or postural asymmetries.

The research I am conducting studies the efficacy of OMT lateral range of motion using morphometric shape analysis. Morphometrics detects differences in shape and pieces out the principal components of the shape; therefore, it has the potential to determine whether OMT changes the shape of an individual's back and increases range of motion. In my project, I am analyzing pre- and post- OMT treatment digital photographs taken of patients who received treatment in 2014 as part of joint study with the Department of Bio-Medical Sciences and the Department of Osteopathic Manipulative Medicine at PCOM. Photographs were prepared by placing landmarks on specific loci on subjects' backs; the photographs were then interpreted by the morphometrics programs. The morphometric shape analysis program enables observers to visualize treatment progression through graph and statistical analysis. I present the results here on subjects who completed nine treatments and am specifically analyzing range of motion indicated by side bending to the left.

The results for bony landmark palpations showed the greatest change in shape when comparing groups of subjects from a sham protocol and a treatment protocol before the first day of treatments and after the ninth day of treatment. The first five principal component analysis (PCA) eigenvalues accounted for 84.674%, indicating that Landmarks 5, 6, 7, and 10 had the most variation. In addition to PCA analysis, a warp analysis was done, which shows the energy bends in the data and reveals that the same landmarks were indicated to shift the greatest amount. Furthermore, an analysis of shape as a function of the treatments was performed using the canonical variates analysis (CVA). Results of the CVA for subjects as a function of treatment group indicated that the treatment group had the largest change shift in morphospace on the graph, while the sham group did not shift as much.

The same analyses were performed for semi-landmarks, which traced the silhouette of the subjects. The semi data show that a majority of the shape change occurred around semi landmarks 31-41. These semi-landmarks were on the left interior trunk of the subject. Landmark 31 was located on the left hip and Landmark 41 was under the left armpit region. These results may present an increase in range of motion for side bending to the left since these semi-landmarks were indicative of the left side of the subjects. The CVA also showed a larger shift in morphospace for OMT treated subjects as opposed to sham subjects.

Results

Relative Warps and PCA for Side Bend Left Treatment 9 Subjects

- If Bony or Semi- landmarks shifted vertically, then height was being determined on the PC.
- If landmarks 1-8 appeared to move to the side, ROM was determined
- If landmarks shifted horizontally, width was determined on the PC.
- When the relative warp videos were analyzed, I found that PCA 1 described height and PCA 3 described side-bending. They are plotted against one another in Figure 2.

Comparison of individual patients pre- and post- treatment:

- As one moves down the Y-axis, ROM appears to increase.
- Sham Subjects with a shape change were the result of outlier landmarks, not OMT.

Subject Number	Pre and Post Notes
10 (Sham)	Not much of a difference between post and pre dots. Post to the right of Pre
11 (Sham)	Not much change. Post on top of Pre.
14 (Sham)	Post below Pre. Post went down Y-axis.
15 (Sham)	*Large jump occurred between post and pre. Post on the right of pre. *Image Analysis- Right lower scapula landmark is in a different position. May be a mistake on behalf of an OMM Fellow.
16 (Sham)	Post below pre on Y-axis. There is not much of a jump between the two points.
17 (Sham)	*There is a large jump between the two points, however the post point is down the y-axis. *Image Analysis- the subject is bending more in the Pre-Treatment 1 image.
19 (Treatment)	* Large jump for the post treatment down the Y-Axis.
22 (Treatment)	*Large jump for post treatment; below pre on the Y-axis.
25 (Treatment)	*Large jump for post treatment. Post is below pre on the Y-axis.
26 (Treatment)	*Post is above Pre *Image Analysis- Left Pre Bony landmark is not visible.
27 (Treatment)	*Post above Pre *Image Analysis- Left should bony landmark is not visible due to hair.

Table 1: Observed trends of individuals for side bend left treatment 9. ***** *indicates shapes change*

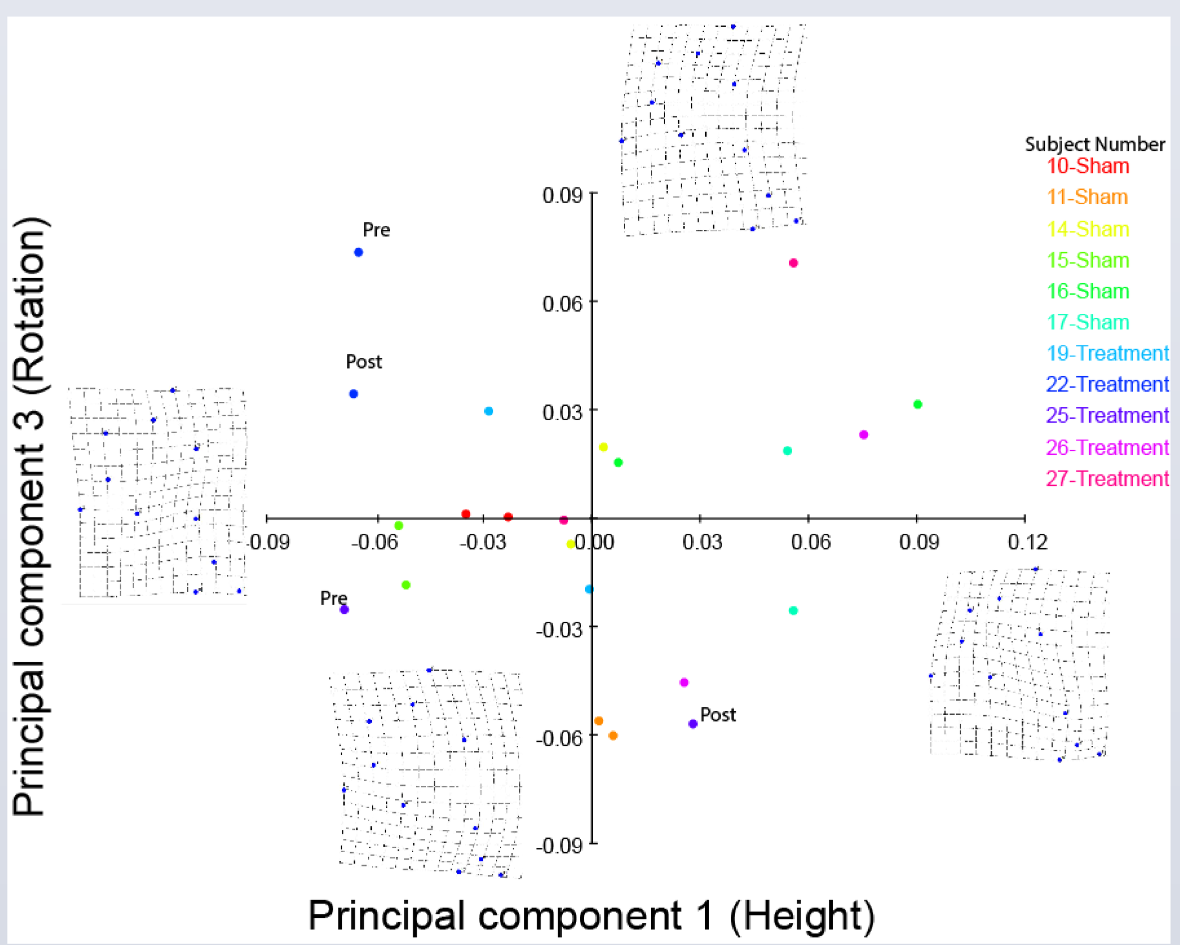

Figure 2: PCA Side Bend Left 9 Sessions Bony Landmarks. Principal Component 1 indicates extremes of subject height variation. Principal Component 3 indicates extremes of left side-bending. Pre- and Post- treatment data points marked for subjects 22 and 25.

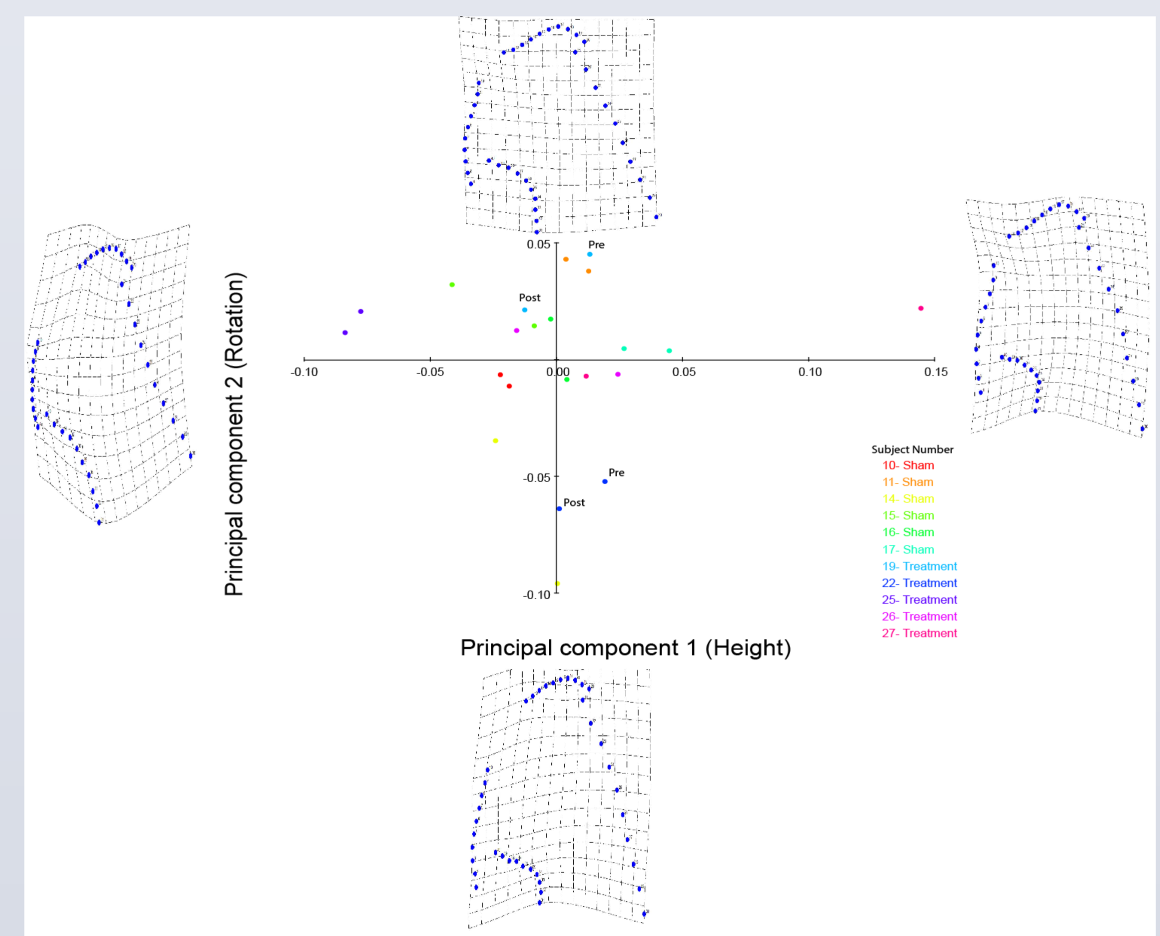

Figure 3: PCA Side Bend Left Treatment 9 Semi-Landmarks. Principal Component 1 indicates extremes of subject height variation. Principal Component 2 indicates extremes of left side-bending. Pre- and Post- treatment data points marked for subjects 19 and 22.

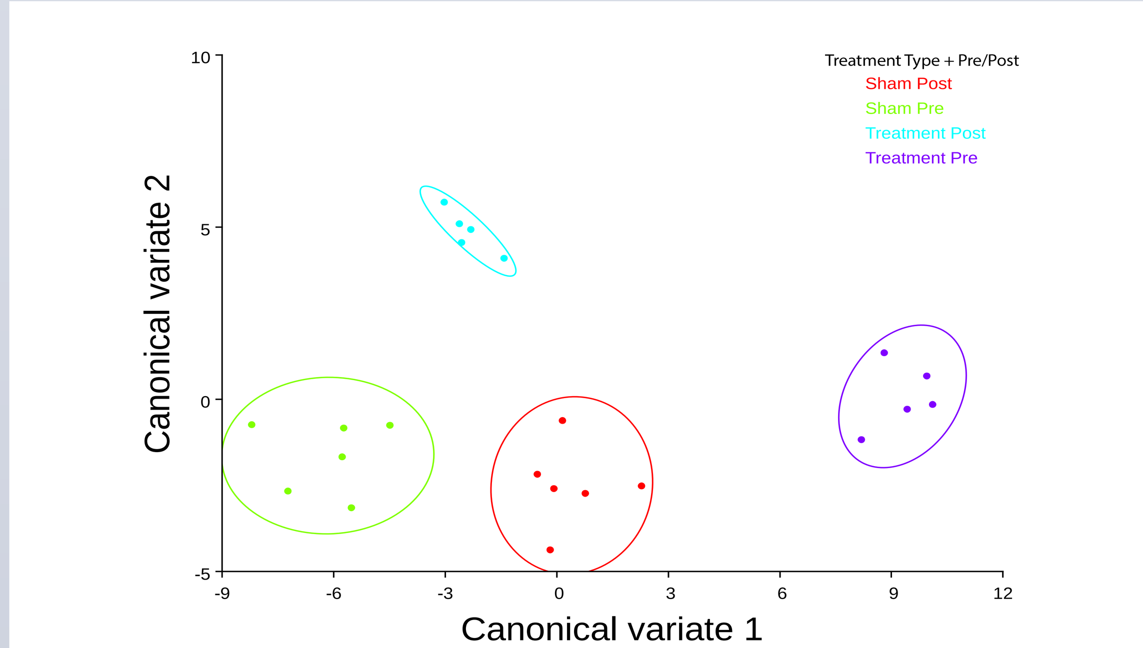

Figure 4: CVA Side Bend Left 9 Sessions Bony Landmark. Treated subjects (purple and blue) exhibited increased ROM. Pre and post treatment groups show the largest shift in Morphospace in the CVA.

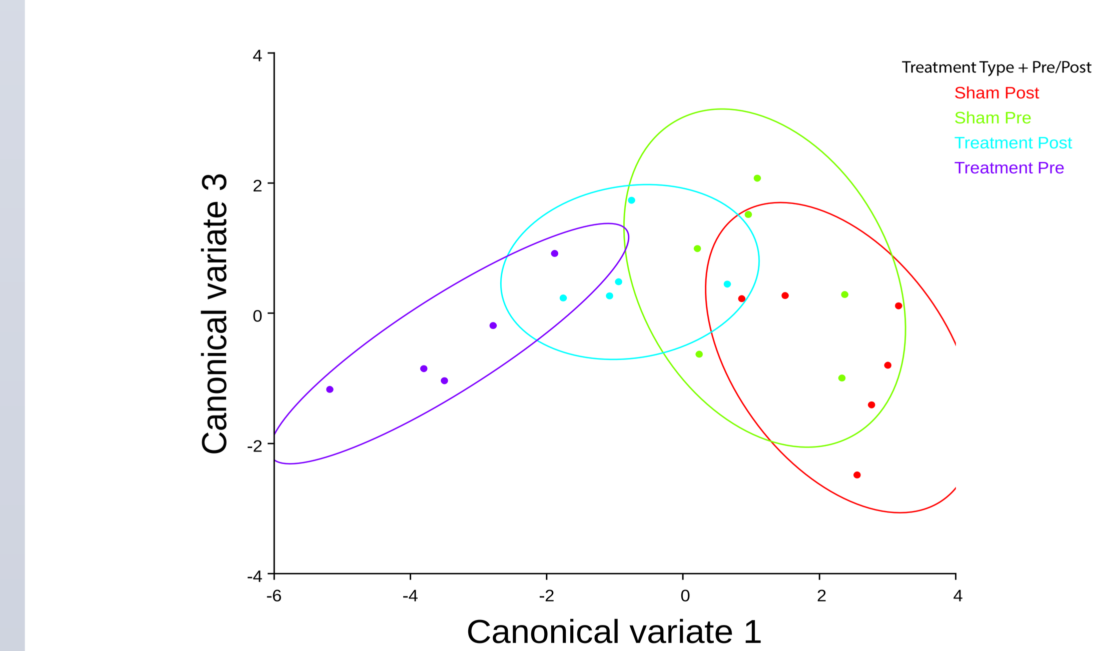

Figure 5: CVA Side Bend Left Treatment 9 Semi-Landmarks. Treated subjects (purple and blue) exhibited increased ROM. Pre and post OMT groups show the largest shift in Morphospace, but overlap.

Conclusions

- Subjects (predominantly OMT subjects) with correctly palpated bony landmarks showed increase in ROM according to the relative warp analysis, PCA principal component analysis, and CVA canonical variates analysis.
- Principal Component Analysis results show shape changes indicating lateral ROM increased for individual subjects treated with OMT, but not in sham or control.
  - Moving down the Y-axis (Figures 2 and 3), warp shapes showed increased side-bending left.
  - Therefore observers would expect a drop along the Y-axis indicates an increase in ROM.
  - ROM appears to increase most in subjects who received OMT.
- Canonical Variates Analysis showed a larger morphospace change, indicating lateral ROM increased, for groups of subjects treated with OMT but not in sham or control subjects.
  - Groups formed predictable clusters in Bony Landmarks CVA.
  - More overlap for groups in Semi-Landmark CVA, may indicate a need for different semi-landmark and and standardization of attire.

Recommendations

- All Bony Landmarks must be present when still images are taken of subjects.
- All hair must be tied in a bun, revealing C7, scapula and Acromion Process Landmarks.
- Tight clothing should not be worn when posterior shots are taken for analysis.
- Pre- and Post- images from previous treatments will be compared to see if subject is side-bending to their full potential.
- Surveys will be taken at the end of treatment to evaluate subject experience.

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- Methods were performed in accordance with the IRB protocol #H13-040.

References

- Bova, M. J., K. M. Claeson, L. Noto Bell. (In review). *Journal of the American Osteopathic Association.*
- Bova, M. J. 2014. Assessing Effectiveness of Osteopathic Manipulative Treatment on Lateral Spinal Curvatures Using 2D Morphometrics. Unpublished M.S. Thesis. Philadelphia College of Osteopathic Medicine, 222p.
- Chila, A. (2011). *Foundations of Osteopathic Medicine*. Philadelphia, PA: Wolters Kluwer Lippincott Williams & Wilkins.
- Cote, P. (1998). A study of the diagnostic accuracy and reliability of the scoliometer and Adam's forward bend test. *SPINE*, *23*, (7), 796-803.
- Cottalorda, J. (2004). Backpack and spinal disease: Myth or reality? *Revue de Chirurgie Orthopedique Reparatrice de l'appareil Moteur. 90*(3): 207-214
- Goldberg, C. (2008). *Pediatric Surgery Int. Scoliosis*: A review. *24*: 129-144.
- Gstoettner, M. (2007). Inter- and intraobserver relaiability assemsent of the Cobb angle; Manual versus digital measurement tools: *Eur Spine J, 1,* 1587-1592.
- Servid, L. (2009). Dimensions of alignment: An Aston-patterning perspective. *Associated BodyWork & Message, 66*.
- Zelditch, M. (2004). Geometric morphometrics for biologists: A primer