Accuracy of Anterior Superior Iliac Spine Symmetry Assessment by Routine Structural Examination

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Context: Assessment of the anterior superior iliac spine (ASIS) is a key component in generating the pelvic diagnosis of somatic dysfunction, but studies have shown poor reliability between examiners.

Objective: To assess the influence of homogeneous training, years of experience, and eye dominance on the percentage of correctness, sensitivity, and specificity of ASIS evaluation.

Methods: Osteopathic physicians, predoctoral teaching fellows, and first- and second-year osteopathic medical students from a single teaching institute assessed 3 plastic pelvic models with ASIS anatomic landmarks set at different levels: even and 5- and 10-mm descrepancies. Dominant and nondominant eyes were used independently to assess ASIS levels.

Results: A total of 147 examiners (participantss) participated in this study (66 first-year and 61 second-year medical students, 15 fellows, and 5 osteopathic physicians). The overall percentages of correct results were 31.0% (even levels), 82.8% (5-mm discrepancy), and 91.7% (10-mm discrepancy). Differences by level of training were statistically significant only for the 5-mm ASIS discrepancy, where participants with more experience performed better. The overall sensitivity was 82.8% (5-mm discrepancy) and 91.7% (10-mm discrepancy), and the specificity was 31.0%. No statistically significant differences were found in the percentage of correct results by eye dominance.

Conclusion: Assessment of ASIS is sensitive but not specific at discrepancies of 5 mm or greater. Length of experience positively influences the percentage of correct results, and eye dominance does not significantly change this outcome. This form of assessment can be used to screen for ASIS asymmetry.

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The osteopathic structural examination is key to evaluating patients from an osteopathic perspective. Its physical findings can lead to the diagnosis of somatic dysfunctions that guide patient treatment. Various bone landmarks are assessed in this examination. The symmetry or asymmetry of the right and left anterior superior iliac spine (ASIS) anatomic landmark levels is used to help identify muscle imbalance in the pelvic region and dysfunction of the iliosacral joints,[1,2(pp14-21),3(pp238-241),4(pp228-237),5(p503)] which can contribute to complaints such as low back pain. The ability to accurately determine symmetry of the ASIS levels is critical because errors in this assessment can lead to inaccurate diagnosis and improper intervention with osteopathic manipulative treatment.

Similarly, physical therapists and chiropractors rely on palpatory diagnostic principles and tests to guide their diagnoses and treatments. Studies performed by these professionals have evaluated both the reliability and the validity of these tests. In a meta-analysis including 37 studies of palpatory evaluation of the lumbopelvic spine, chiropractors Hestbaek and Leboeuf-Yde[6] concluded that none of the techniques studied met sufficient minimal validity or reliability criteria. In the physical therapy literature, studies assessing palpatory reliability on live participants found interrater reliabilities only slightly greater than would occur by chance.[7-10] These findings held true whether palpatory techniques were standardized or not.[11]

Several studies have found a wide range of interexaminer reliability for the assessment of ASIS symmetry.[12-15] Interexaminer reliability studies provide valuable information regarding the ability to agree on physical findings with another examiner, but they do not allow analysis of whether the assessments are accurate, because the true values are unknown. To the best of our knowledge, only 2 studies have used a preset pelvic model to assess the ability of osteopathic physicians (DOs) and osteopathic medical students to assess symmetry of ASIS levels.[16,17] The study by Bengaard et al[16] used only a single-level anatomic model and included DOs and osteopathic medical students trained at different institutions. This study design had 2 significant limitations. First, ASIS assessment is often performed and taught differently at different osteopathic medical schools, despite attempts by the American Osteopathic Association to standardize physical examinations and textbooks. Second, the single fixed and symmetric model did not assess practitioners' ability to appreciate ASIS level differences when asymmetry was present.

The second study, by Stovall et al,[17] found that after additional training, predoctoral teaching fellows have increased interexaminer reliability when assessing the symmetry of ASIS levels. Furthermore, the percentage of agreement between groups increased as the discrepancy between the ASIS levels increased. That study, however, had a small sample size of 10 examiners and focused primarily on the effectiveness of a training session on intraexaminer and interexaminer reliability.[17]

Another factor that might affect the accuracy of osteopathic structural examination is eye dominance (or eye preference), an asymmetric use of one eye more than the other. It is often but not always correlated with handedness. Some evidence points to a genetic predisposition to eye dominance, and functional theories as to the advantage of eye dominance include improved efficiency of binocular vision in animals with large, overlapping monocular fields of view.[18]

Studies have been performed in the past to establish the accuracy of assessing other structural landmarks by comparing findings with known positions of landmarks derived from radiographic images.[17,20] In lieu of imaging studies, we used several pelvic models in the current study to provide the known independent variables (ASIS symmetry or asymmetry). Our study had 3 objectives: to assess the ability of DOs and osteopathic medical students to accurately evaluate ASIS levels using a single uniform technique, to assess whether using the dominant eye over the midline influences accuracy, and to determine whether the level of training affects accuracy.

Methods

Design

We performed a cross-sectional study of DOs, predoctoral teaching fellows in the neuromusculoskeletal medicine/osteopathic manipulative medicine department, and first- and second-year osteopathic medical students at Western University of Health Sciences College of Osteopathic Medicine of the Pacific (WesternU/COMP), in Pomona, California, using convenience sampling to recruit participants. Examiners (participants) were blinded to pelvic symmetry or asymmetry in the models and to the correctness of the results. After providing written informed consent, they were asked to

assess both symmetric and asymmetric pelvic models, using first their dominant and then their nondominant eye. Pelvic models were covered in a nonpatterned felt fabric to prevent visual inspection of the entire pelvis. The study was reviewed and granted exempt status by the institutional review board of WesternU/COMP.

Participants

Study participants included first- and second-year osteopathic medical students, fellows, and DOs at WesternU/COMP, who volunteered their time to assess ASIS symmetry on 3 covered pelvic anatomic models. Participants were recruited by e-mail and word of mouth and were offered no incentive to participate. No personally identifying information was collected other than the year of schooling for students or year in practice for DOs.

Pelvic Models

Three stations were set up on fixed-height osteopathic manipulation tables, each with a plastic pelvic model affixed to a board. The ASIS levels of each model were set in place with bolts and at fixed heights, even on both sides, 5 mm superior (coronal plane) on the left, and 10 mm superior on the left. Anteroposterior leveling of the ASIS landmarks was also performed, using a digital level and fixation with bolts. The models were then covered with a thick nonpatterned felt fabric to mimic tissue and remove any visual cues, forcing examiners to rely solely on their palpatory assessment of the ASIS landmarks to determine levelness and symmetry.

After collection of baseline demographic data, participants were asked to stand on the right side of the table with their right eye over the midline, using the palpatory methods they were taught, as outlined in the following ASIS Assessment Method section. They were instructed to state whether one ASIS was superior to the other in the coronal plane or whether they were both even with each other. The results were collected at each station by one of the principal investigators (A.S.L., C.W.P.). To minimize potential confounding variables, all participants examined the models in the same order. After assessing all 3 pelvic models with the right eye, participants were then asked to reassess the models while standing on the left side of the table with their left eye over the midline. The pelvic models and their setup are shown in *Figure 1* and *Figure 2*.

ASIS Assessment Method

At WesternU/COMP, students are taught to assess the ASIS level by standing to the side of the supine patient. With the dominant eye over the midline, the examiner places his or her thumbs under the patient's ASIS landmarks bilaterally to identify the level of each ASIS in relation to its contralateral counterpart.[14] The examiner identifies the dominant eye by looking at a distant object with both eyes open and making a ring around the object with his or her index finger and thumb. Next, the examiner alternates closing one eye and then the other, identifying the dominant eye as the eye that, when open, keeps the object in the center of the ring.[15]

Statistical Analysis

We used χ^2 tests to evaluate the differences between categorical data. Differences were considered statistically significant at $P<.05$. All statistical analyses were performed using SPSS software (version 21.0; SPSS Inc).

Results

The 147 study participants included 66 first- and 61 second-year osteopathic medical students, 15 fellows, and 5 DOs. Two participants (1 fellow and 1 first-year student) identified no dominant eye; their data were therefore not incorporated in the analyses involving eye dominance. Of the other participants, 87 had right-eye and 68 had left-eye dominance. Participants' visual characteristics are shown in *Table 1*.

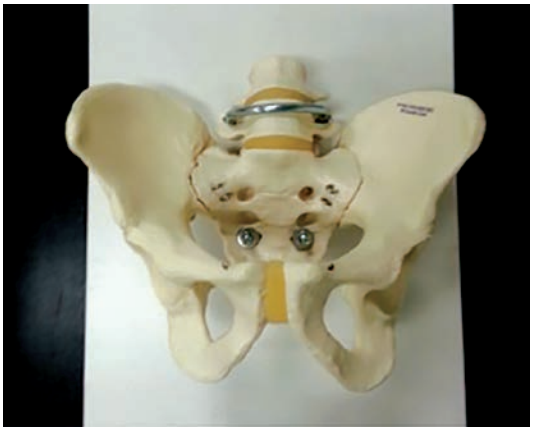

Figure 1.
Pelvic models used to test the ability of osteopathic physicians, fellows, and medical students to assess the anterior superior iliac spine.

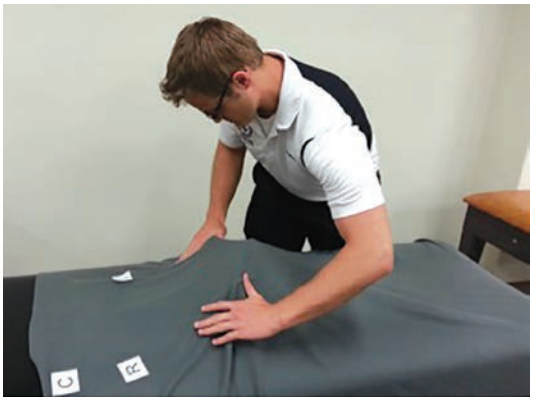

Figure 2.
A postdoctoral teaching fellow evaluating the pelvic model for anterior superior iliac spine symmetry assessment.

The overall percentages of correct results achieved using the method taught at WesternU/COMP were 31.0% (even levels), 82.8% (5-mm discrepancy), and 91.7% (10-mm discrepancy). By training level, the percentages of correct results for the even-leveled ASIS model were 30.8% for first-year medical students, 24.6% for second-year students, 53.8% for fellows, and 40% for DOs. The respective percentages were 87.7%, 73.8%, 100%, and 100% for the model with the 5-mm discrepancy and 87.7%, 96.7%, 92.3%, and 100% for the model with the 10-mm discrepancy. Statistical significant differences in these percentages between groups were observed only with the 5-mm discrepancy (*Table 2*). Subgroup analysis of the percentages for the 5-mm discrepancy revealed significant differences between first- and second-year medical students (P=.026), between second-year students and fellows (P=.009), and between second-year students and DOs (P=.024), as shown in *Table 3*.

The percentages of correct results by dominant vs nondominant eye are listed in *Table 4*. For the dominant eye, the percentages of correct results were 31.0% (even levels), 82.7% (5-mm discrepancy), and 91.7% (10-mm discrepancy), compared with 21.4%, 77.9%, and 84.1%, respectively, for the nondominant eye; none of these differences was statistically significant.

Sensitivity and specificity were calculated for our method of ASIS assessment. The sensitivity was 82.8% for the 5-mm and 91.7% for the 10-mm discrepancy, and the specificity was 31.0% overall. These results are displayed in *Table 5*.

Discussion

The results of the current study indicate that osteopathic medical students, fellows, and practicing DOs can accurately identify discrepancies in ASIS heights when they are at least 5 mm. The threshold discrepancy may be less than 5 mm, but owing to the incremental fixed differences in our pelvic models, we are unable to determine the threshold from our collected data. However, it should also be pointed out that the osteopathic medical profession has not defined what degree of asymmetry is clinically significant. A few millimeters of asymmetry might be a biologic variant that does not manifest as a clinical condition. This concept of functional or at least nonpathologic asymmetry could be expanded to many, if not all, components of the structural examination. Perhaps certain regions of the body can tolerate larger margins of nonpathologic asymmetry than others, further chal-

Table 1.
Vision Characteristics of Participants Assessing Symmetry of ASIS (N=147)

Characteristic	Participants, No. (%)[a]			
	First-Year Students (n=66)[b]	Second-Year Students (n=61)	Fellows (n=15)[b]	DOs (n=5)
Corrective lenses	45 (68.2)	38 (62.2)	12 (80.0)	3 (60.0)
Right-eye dominance	41 (62.1)	32 (52.5)	11 (73.3)	3 (60.0)
Left-eye dominance	24 (36.4)	29 (47.5)	3 (22.0)	2 (40.0)

[a] Students were osteopathic medical students; fellows were predoctoral teaching fellows.
[b] One first-year student and 1 fellow identified no dominant eye; therefore, their data were not incorporated in this analysis.

Abbreviation: ASIS, anterior superior iliac spine; DOs, osteopathic physicians.

Table 2.
Correctness of ASIS Symmetry Assessment by Participant Level of Training[a] (N=147)

Training Level	Correct Results, No. (%)		
	Even	5-mm Discrepancy	10-mm Discrepancy
First-year student	20 (30.8)	57 (87.7)	57 (87.7)
Second-year student	15 (24.6)	45 (73.8)	59 (96.7)
Fellow	8 (57.1)	14 (100)	13 (92.3)
DO	2 (40.0)	5 (100)	5 (100)
P value	.060	.021	.158

[a] Date are given as No. (%) unless otherwise indicated. Students were osteopathic medical students; fellows were predoctoral teaching fellows.

Abbreviations: ASIS, anterior superior iliac spine; DOs, osteopathic physicians.

lenging DOs to elucidate meaningful discrepancies in more subtly discrepant body regions.

As the discrepancy increased, so did the percentage of correct results, which is expected. However, accuracy was greatly diminished when ASIS levels were even in height. One possible explanation for this finding is an expectation of dysfunction, wherein examiners may seek out dysfunction and are thus more apt to say that 2 things are different even when they are the same. Our results are similar to those reported by Stovall et al,[17] who found the lowest percentage of agreement among DOs and fellows at discrepancies near 0 mm. They also found a marked increase in accuracy and the percentage of agreement at an ASIS discrepancy of 4 mm, consistent with our findings at 5 mm. This finding also greatly affected the speci-

Table 3.
Subgroup Comparisons for Percentage of Correct Assessment Results With a 5-mm Discrepancy in ASIS Levels[a]

Comparison	*P* Value
First-year vs second-year students	.026
First-year students vs fellows	.057
First-year students vs DOs	.175
Second-year students vs fellows	.009
Second-year students vs DOs	.024
Fellows vs DOs	.052

[a] Students were osteopathic medical students; fellows were predoctoral teaching fellows.

Abbreviations: ASIS, anterior superior iliac spine; DOs, osteopathic physicians.

ficity, because specificity is inversely related to the proportion of false-positives, indicating that the low specificity of the assessment method used in this study may suggest that it is not a strong diagnostic tool. In contrast, the results of our sensitivity analysis indicate that our method of ASIS assessment is useful as a screening tool during a structural examination, because a negative finding—that is, an assessment of evenness, or symmetry—indicates that asymmetry is indeed most likely absent, because few false-negatives result from this test.

No significant differences were found between assessments of ASIS symmetry using the dominant and the nondominant eye in the midline, even though the observed differences were as high as 10% between dominant and nondominant eyes, with dominant eyes having higher percentages of correct results. Level of training had an interesting impact on ASIS interpretation. No significant differences were found in the percentage of correct results by level of training for the even-leveled model or the 10-mm discrepancy. With the 5-mm discrepancy, however, overall performance of the first-year medical student, fellow, and DO groups was significantly more accurate than that of the second-year student group.

Our study had several limitations. First, the samples based on training level varied in size, including 65 first-year and 61 second-year medical students with 14 fellows and 5 DOs. Moreover, the applicability of our study to currently practicing DOs is limited because we used pelvic models, not live humans. Next, participants were volunteers, which could lead to selection bias; students who practice osteopathic manipulative medicine and are confident in their palpatory skills might be more likely to volunteer. The incremental discrepancy of 5 mm might also have been insensitive for identifying the degree of pelvic asymmetry at which groups become more accurate in their diagnosis; a model capable of 2-mm increments, as used by Stovall et al,[17] might have defined this cutoff better. Finally, we evaluated only left-side-superior ASIS. Because most of our participants were right eye dominant, the percentage of correct results may have been affected.

Conclusion

Osteopathic medical students and practicing DOs can accurately identify ASIS asymmetry at discrepancies of 5 mm or greater. Using the dominant eye over the midline, rather than the nondominant eye, did not improve accuracy significantly. The association of operator training level with the accuracy of ASIS assessment yielded mixed results. More studies are needed to further investigate the accuracy of ASIS evaluation and its role in the osteopathic assessment of patients.

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Table 4.
Correctness of ASIS Symmetry Assessment by Participant Level of Training[a] (N=147)

	Correct Results, No. (%)		
Eye	**Even**	**5-mm Discrepancy**	**10-mm Discrepancy**
Dominant eye	45 (31.0)	120 (82.8)	133 (91.7)
Nondominant eye	31 (21.4)	113 (77.9)	122 (84.1)
P value	.062	.301	.070

[a] One first-year student and 1 fellow identified no dominant eye; therefore, their data were not incorporated in this analysis.

Abbreviation: ASIS, anterior superior iliac spine.

Table 5.
Sensitivity and Specificity for ASIS Assessment Among All Study Participants

Result	Even	5-mm Discrepancy	10-mm Discrepancy
Positive for asymmetry	100	120	133
Negative for asymmetry	45	25	12
Sensitivity, %	82.8	91.7	NA
Specificity, %	NA	NA	31.0

Abbreviation: ASIS, anterior superior iliac spine; NA, not applicable.

Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; Drs Lee and Pyle drafted the article or revised it critically for important intellectual content; Dr Redding gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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