Lumbar Diagnosis and Pressure Difference Variance

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Context: There is no consensus on the correlation between clinical experience and accuracy in diagnosing somatic dysfunctions, which makes it difficult to justify the use of more subjective measures to evaluate this important association. To better understand this relationship, palpatory forces can be observed while diagnosing a somatic dysfunction.

Objective: To quantify the pressure applied in diagnosing lumbar somatic dysfunction, find a correlation between accuracy of diagnosis and palpation pressure, set the standards for palpation, and develop precise palpatory skills for osteopathic medical students.

Methods: The palpatory forces were evaluated between participants with varying experience levels (osteopathic medical students and attending physicians from the New York Institute of Technology College of Osteopathic Medicine). Two osteopathic physicians confirmed an L5 somatic dysfunction diagnosis in a volunteer standardized patient (SP), who served as the control. Participants then palpated the lumbar segment of the SP in a prone position with F-Scan System (TekScan) sensors, which recorded the amount of pressure and time used to reach a full diagnosis.

Results: Participants (11 osteopathic medical students and 10 attending physicians) who diagnosed an L5 somatic dysfunction consistent with the SP's diagnosis had less of a difference in peak force (mean [SD] difference, 62.50 [325.7] g/cm²) between the contact points (right hand vs left hand). In contrast, participants with a dissimilar L5 diagnosis from the SP's had a mean (SD) difference in peak force of 319.38 (703.1) g/cm². Similarly, the difference in the mean (SD) force of palpation between the contact points was lower in participants who made the correct diagnosis (16.81 [117.4] g/cm²) vs those who made an incorrect diagnosis (123.92 [210.3] g/cm²). No statistical significance was found between the diagnostic accuracy of the students and physicians ($P=.387$) or the time taken to reach a diagnosis ($P=.199$).

Conclusion: We observed that using equal pressures in both hands while palpating a lumbar segment correlates to more accurate somatic dysfunction diagnoses.

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Palpatory skills are an essential diagnostic tool used during the physical examination to evaluate somatic dysfunction, and palpation comprises multiple features: motor, perception, tension, edge discrimination, and layer-by-layer palpation.⁴ Osteopathic physicians apply posterior-to-anterior pressure during palpation to assess vertebral segmental rotational asymmetry, a practice that is necessary to make a correct somatic dysfunction diagnosis.² Osteopathic medical students develop the skills to identify asymmetry in bony anatomic landmarks and muscles per the Fryette principles.^{1,2} Students learn to apply these palpatory skills when performing osteopathic manipulative treatment to monitor progress from the initial diagnosis.³ They further refine their skills through experiences in their clinical rotations and with their patients as they continue to practice medicine.³ These palpatory skills are crucial to make a correct diagnosis.

Most methods of palpatory examination in osteopathic manipulative medicine lack a reference standard, making dependence on interexaminer reliability vital in finding a correct diagnosis and deciding whether a technique is reliable.⁵ However, interexaminer reliability (examined by the κ statistic) has been consistently shown to be poor, making it imperative to establish a reference standard.⁶ A follow-up study showed that once consensus has been established between examiners, this level of interexaminer reliability in diagnosis can be maintained for several months.⁷ With an established reference standard, dependence on interexaminer reliability to make a correct somatic dysfunction diagnosis would be reduced.⁵ Providing landmark locations allows for more accurate diagnoses.⁸ Hence, localizing a landmark before making a diagnosis helps students identify somatic dysfunction characteristics (tenderness, asymmetry, restriction, etc).⁶ Overall, enhancing the palpatory skills of osteopathic medical students should be emphasized to improve the ability to correctly diagnose somatic dysfunctions.²

The purpose of this study was to find an objective measure of the amount of pressure and time used by participants in palpation while diagnosing somatic dys-

function in the lumbar spine. We aimed to compare whether these values varied with the level of osteopathic clinical experience (0 vs >0 years of clinical experience). We hypothesized that the time needed to palpate a designated lumbar somatic dysfunction and the magnitude of pressure used would decrease in participants with advanced clinical training compared with those with no clinical training.

Methods

Participants and Standardized Patient

Advertisement to recruit participants and a volunteer standardized patient (SP) for the study was conducted through the New York Institute of Technology College of Osteopathic Medicine's student Facebook groups and by word of mouth. Participants were required to be currently attending or had graduated from an osteopathic medical school and demonstrate an understanding of the osteopathic diagnosis. Participants were excluded if they were repeating an academic year or had recent trauma, such as a sprain or fracture. Inclusion criteria for the SP included being older than 18 years; exclusion criteria included spinal deformities, fractures, trauma, and herniated discs.

Procedure

The palpatory pressure used by examiners was measured objectively with the F-Scan System (TekScan) tool. This technology has been used to evaluate high pressures such as gait analysis and stress distribution of the foot and also detect smaller pressures such as trigger points and pain in various muscles. However, it has not been used to measure the force applied in diagnostic palpation among different skill ranges of osteopathic physicians.^{9,11-14}

The sensors were calibrated for all experimental trials. The SP was prone on the examination table and a physician (S.Y.) identified the L5 transverse processes under 2-dimensional ultrasonography guidance. Two physicians (one of whom was an author [S.Y.]) who were both board-certified in neuromusculoskeletal

medicine and osteopathic manipulative medicine diagnosed the L5 segment dysfunction and determined the control diagnosis. The somatic dysfunction diagnosis included 3 planes: flexion/extension, sidebending, and rotation. The designated control diagnosis was extended rotated left sidebent left.

The sensors were reinforced onto the lower back of the SP with Velcro brand straps to prevent movement of the sensors during palpation. Participants were then asked to approach the SP from their dominant side, locate the appropriate anatomic landmarks on the SP, and make a full diagnosis of the L5 segment dysfunction. Each participant was prompted to start diagnosing when the researcher (N.V.) started the recording. The forces used by the participants' left and right hands and the time to make a somatic dysfunction diagnosis were measured and recorded. Once all of the participants made their diagnoses, the lumbar segment was reevaluated by the 2 physicians who had given the control diagnosis to ensure that the segment was not unintentionally manipulated during the study; the reevaluated diagnosis remained extended rotated left sidebent left.

Data Analysis

Data recorded included the palpatory forces used for each hand, the time it took each participant to make a diagnosis, and diagnostic accuracy. The diagnoses were evaluated as correct or incorrect in 2 ways: (1) by the entire diagnosis, and (2) individual aspects of the diagnosis (flexion/extension, rotation, and sidebending). Fisher exact tests were used to analyze differences in L5 diagnoses based on experience levels. An independent samples *t* test was performed to analyze differences in time taken to reach a diagnosis based on experience levels. In addition, a *t* test was used to compare the forces used with participants who made the correct diagnosis vs participants who made an incorrect diagnosis. A 1-way analysis of covariance was used to evaluate the mean force used in each hand based on experience level.

Results

No statistically significant difference was found between medical students ($n=11$) and attending physicians ($n=10$) in the accuracy of the L5 diagnosis ($P=.387$) or time taken to reach a diagnosis ($P=.199$). No statistically significant difference was found between attending physicians and students regarding the mean force used to palpate (left hand, $P=.252$; right hand, $P=.554$). The [Table](#) depicts the correct vs incorrect diagnoses found by participating medical students and attending physicians.

The mean peak force for participants who found the correct diagnosis (826.63 g/cm^2) was less than the mean peak force of participants who found an incorrect diagnosis (1080.62 g/cm^2 ; $P=.005$). The mean force was also lower for those who found the correct diagnosis at 334.92 g/cm^2 compared with those who found the incorrect diagnosis at 583.05 g/cm^2 ($P=.10$). The smaller force difference between hands yielded correct diagnoses more often. The [Figure](#) depicts the force differences between hands by diagnosis correctness.

Participants who made a correct L5 diagnosis had a mean (SD) difference of 62.50 (325.7) g/cm^2 between the peak pressures of their contact points (right vs left hands). Participants with an incorrect L5 diagnosis had a mean (SD) difference of 319.38 (703.1) g/cm^2 . Participants with the correct L5 diagnosis had a smaller mean (SD) difference of 16.81 (117.4) g/cm^2 between the mean pressure in their left and right contacts vs participants who did not, with a mean (SD) difference of 123.92 (210.3) g/cm^2 . Overall, participants who made a correct diagnosis were found to have a smaller difference in peak pressure and mean pressure between their contact points.

Discussion

In total, there was no significant pressure difference or time to diagnosis between the students and attending physicians. However, these values trended toward significance as participant numbers increased. Our results

Table.
Correct vs Incorrect Diagnoses Found by Participating Osteopathic Medical Students and Attending Osteopathic Physicians^{a,b}

Participant	Experience, y	L5 diagnosis	Correct Diagnosis?	Time to diagnosis, s	Peak force, g/cm ²		Mean force, g/cm ²		Peak force difference between hands, g/cm ²	Average force difference between hands, g/cm ²
					Left	Right	Left	Right		
1	A/27	ERS _L	Yes	30.58	526	842	246.2	485	316	238.8
2	A/4	ERS _L	Yes	27.1	1513	1109	493.1	420.3	404	72.8
3	A/12	No Somatic Dysfunction	No	23.78	1199	791	380.6	341.3	408	39.3
4	A/24	ERS _L	Yes	40.26	727	481	345.7	230.5	246	115.2
5	S/0	FRS _R	No	21.98	832	1380	564.3	683.9	548	119.6
6	S/0	ERS _L	Yes	65.62	836	888	239.6	357.5	52	117.9
7	S/0	FRS _R	No	30.66	820	1742	251.7	775.2	922	523.5
8	S/0	FRS _L	No	42.68	1116	473	341.9	351	643	9.1
9	S/0	ERS _R	No	33.2	666	1073	355	551.3	407	196.3
10	A/13	FRS _R	No	37.16	2001	1577	1201.6	1479.2	424	277.6
11	A/15	ERS _L	Yes	31.82	362	280	111.4	128.6	82	17.2
12	A/10	NR _R S _L	No	24.78	2041	478	665.7	798.6	1563	132.9
13	S/0	ERS _L	Yes	71.72	629	1151	295.8	373.4	522	77.6
14	S/0	R _R	No	39.68	814	164	361.6	238	650	123.6
15	A/14	NR _R S _L	No	55.28	1101	1578	583.6	936.7	477	353.1
16	S/0	FRS _L	No	18.02	838	472	286.5	334	366	47.5
17	S/0	ERS _R	No	35.62	1221	326	473.4	280	895	193.4
18	S/0	ERS _L	Yes	45.6	954	795	326.2	326.2	159	0
19	S/0	FRS _L	No	70.9	1135	824	617.8	522	311	95.8
20	A/18	ERS _L	Yes	32.92	1316	817	554.1	425.1	499	129
21	A/18	ERS _R	No	41.18	2340	1094	690.4	1093.9	1246	403.5

^a The diagnosis, extension rotation sidebend left, was used as the control.

^b The F-Scan System (TekScan) was used.

Abbreviations: A, attending physician; E, extension; F, flexion; R, rotation; R_R, rotation right; S, osteopathic medical student; S_L, sidebend left; S_R, sidebend right.

demonstrated that participants who made a correct diagnosis had a smaller difference in their peak and mean pressures between their left and right hands than those who had an incorrect diagnosis. This finding suggests that using equal pressures with both hands during palpation may increase the likelihood of a correct somatic dysfunction diagnosis.

One study¹⁵ found that students were more likely to accurately perceive digit asymmetry than to localize the

transverse process landmarks. Localizing the lumbar transverse process before palpation confirmed that the participants were palpating the correct transverse process and ensured that the diagnosis would be more accurate.⁸ The potential limitation of inaccurate lumbar segment diagnosis was prevented by using ultrasonography-guided localization of the L5 transverse processes.

This study was limited by the small sample size, which may have led to an incomparable measure of

Figure. Force differences between hands by diagnosis correctness found by participating osteopathic medical students and attending osteopathic physicians. The difference is represented as an absolute value.

palpation time and the use of force between the students and attending physicians. To correct for this limitation, future studies could increase the number of participants, which may lead to a significant difference in the amount of pressure used among the students compared with attending physicians. Another limitation was the variability in the training of the attending physicians. The attending physicians had between 4 and 24 years of experience in osteopathic manipulative medicine, which may have contributed to the disparity of the pressures used to diagnose a segment. Additionally, the use of osteopathic manipulative medicine in the attending physicians’ clinical practices may have had a notable effect on their skill level.

A few participants forgot to inform the researcher when to stop the trial, which potentially added time to the diagnosis period. However, the data were corrected to ensure that the time to diagnosis was more accurate by omitting pressure values of 0 at the end of the palpation session. Furthermore, some participants were not comfortable palpating with the sensors. The sensors were paper-thin, flexible, and somewhat transparent, but felt like plastic, which may have made it difficult for participants to distinguish landmarks. The repetitive palpation on the SP was a limiting factor that was

corrected for and may have led to the unintentional management of the somatic dysfunction.

Despite the limitations of the study, we established that using equal pressures during an examination may yield a correct somatic dysfunction diagnosis. Hence, these sensors could be used as a tool to enhance palpatory skills and perhaps improve interexaminer reliability of osteopathic medical students. In a study using virtual haptic feedback,¹³ researchers trained students with sensors that allowed them to feel abnormalities simulated by electric motors. Similarly, these sensors could be used to train osteopathic medical students to use equal pressures in palpation and provide immediate feedback to improve their palpatory skills.

Conclusion

Our findings demonstrated no statistical significance in the correlation between accuracy and pressure use and time to diagnosis with experience level. However, diagnostic accuracy increased with participants who used a more equal force in both contact points. These results suggest that the accuracy of diagnosis could be improved with the use of pressure sensors in training students and physicians to use more equal pressure while palpating.

Future studies should be conducted to further evaluate time to diagnosis, level of training, diagnostic accuracy, peak pressure used, and variance in pressure between hands with a larger sample size. Osteopathic medical faculty should consider using F-Scan System technology or similar technology as a teaching tool to aid in learning palpatory diagnosis.

Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; Student Doctors Voleti and Gaspari and Dr Yao drafted the article or revised it critically for important intellectual content; all authors 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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