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The Reliability of the Thoracic Percussion Test

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THE RELIABILITY OF THE THORACIC PERCUSSION TEST

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A doctoral project in partial fulfillment of the requirements for the

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ABSTRACT

Objective: To investigate the reliability of the Thoracic Percussion Test (TPT), which is a quick screening tool used by manual therapists to assess hypomobility in the thoracic spine.

Participants: 36 healthy subjects (18-60 years old), with or without back pain, and 10 therapists participated in the study. Six of the therapists with less than 5 years clinical experience were considered "novice" and 4 with at least 20 years experience were considered"expert" therapists.

Methods: All participants were divided into a morning and an afternoon group. Both groups consisted of 18 subjects and a mix of novice and expert therapists. All therapists were given a 30-minute instructional PowerPoint on the TPT upon arrival. The therapists and subjects were randomized and therapists were instructed to tap along each subject's paraspinal musculature and asked to indicate the most significant level of the thoracic spine that they felt would require treatment first. The therapists and subjects were randomized once again and the therapists were asked to repeat the same protocol.

Data Analysis: Descriptive statistics, including estimates of central tendency and variability, were calculated to describe the sample of subjects and therapists. Intra-rater reliability of the TPT was estimated for judgments of the most significant spinal segment. We calculated agreement within each rater through linear weighted Kappa coefficients with 95% confidence intervals. Negative Kappa values would indicate agreement less than chance. We determined *a priori* that if intra-rater reliability was only fair (between 0.21 and 0.40), there would be no need to test for inter-rater reliability

Results: The mean linear-weighted Kappa statistic for judgments of the most significant spinal segment for all therapists was 0.21 ± 0.190 and ranged between -0.21 and 0.40. These results indicate that agreement within therapists was between slight and fair at best. Because of the poor intra-rater reliability, we did not examine inter-rater reliability in this study.

Discussion: Our findings suggest that the TPT has poor intra-rater reliability and concur with those of a previous reliability study performed by Ghoukassian et al 2001, which found the TPT to have poor reliability. Our study expanded the results to include male and female spines of varying ages, in addition to including novice and experienced clinicians, and yet we found the TPT had poor reliability.

Conclusions: The intra-rater reliability for the TPT was not strong enough to justify it's continued use as a screening or assessment tool in evidence based practice until further research is performed.

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INTRODUCTION

Back pain affects a significant proportion of people in the US and is the most common reason for missing work. Approximately 80% of Americans experience back pain at some point in their life, and back pain has been estimated to cost $33.6 billion annually.[1] Musculoskeletal (MSK) pain and dysfunction in the thoracic spine continues to have less research devoted to it. Specifically, the thoracic spine has received less attention in terms of clinical, genetic, and epidemiological research when compared to the lumbar and cervical spine.[2] However, MSK pain in the thoracic spine can be equally disabling, and impose similar burdens on the individual, community, and workforce.[3] One in ten men, and one in five women suffer from thoracic spine MSK pain, which highlights the widespread impact of this disorder.[4] A more recent meta-analysis shows that the median prevalence of thoracic spine pain in working adults is as high as 30% around the world.[5]

Unfortunately, many cases of thoracic spine pain are poorly understood and one possible reason for this may be the difficulty in manually assessing the thoracic spine. There are very few non-invasive tests for clinicians to assess the thoracic spine, and for manual physical therapists in particular, there are very few to choose from. The diagnosis of biomechanical dysfunction is fundamental to disease classification within the MSK system. For manual physical therapists, palpation is the method of choice for diagnosis of biomechanical dysfunction.[6] However, currently there is no gold standard method to assess the thoracic spine utilizing palpation; there is also a lack of a general consensus for any manual technique when assessing the thoracic spine.

Posterior to anterior (PAs) mobilizations are one of the most commonly used manual techniques in assessment and treatment of the thoracic spine.[7] This mobilization technique requires the therapist to apply pressure to the spine using either the heel of the hand (pisiform

grip) or both thumbs, and is an extremely common manual assessment tool for the spine.[8] The patient is in a prone position during the PA technique. When defined by magnitude, frequency, amplitude, and displacement, PA mobilization forces have been show to be extremely variable among clinicians applying the same manual technique, and therefore application of this technique in the clinical setting is considered to be unreliable.[9] Further research has indicated that physical therapists have demonstrated poor inter-rater reliability when palpating MSK stiffness.[10] Specifically, a study published in 1994 by Maher and colleagues assessed the inter-rater reliability of the PA on lumbar vertebrae 1-5. The ICC values for stiffness judgments ranged from .03 to .37, with agreement scores ranging from 21% to 29%. Judgments of stiffness made by experienced manipulative physical therapists examining patients in their own clinics were found to have poor reliability as well.[11] When assessing range of motion, inter-rater reliability of spinal motion assessment rarely exceeds poor to fair chance-corrected agreement.[12] Another study performed by Binkley and colleagues found that therapists demonstrate poor reliability when asked to identify a specific spinal level.[13] Therapists have "fair to moderate" reliability when assessing passive intervertebral motion of the cervical spine according to another study.[14] Yet again, Hicks and colleagues found segmental mobility testing of the lumbar spine to have poor reliability among skilled clinicians.[15] A systematic review performed in 2004 concluded that the quality of the research on inter-rater reliability and intra-rater reliability of spinal palpatory diagnostic procedures needs to be improved.[16] Pain provocation tests are most reliable.[16] Also according to the systematic review, soft tissue paraspinal palpatory diagnostic tests demonstrate poor reliability.

A study performed by Brismee and colleagues examined the inter-rater reliability of a 3-dimensional passive physiological intervertebral motion (PPIVM) palpatory test of the lumbar

spine by three experienced clinicians. The outcome of this study indicated that the technique demonstrated fair to slight inter-rater reliability when performed on asymptomatic subjects, highlighting again the poor reliability found between clinicians when manually assessing the spine.[12]

Christensen and colleagues examined the inter-rater and intra-rater reliability for 3 palpation procedures; prone motion palpation, sitting motion palpation, and palpation for paraspinal tenderness. They assessed for spinal biomechanical dysfunction in the upper 8 segments of the thoracic spine utilizing chiropractors and a blend of symptomatic and non-symptomatic subjects. They found intra-rater reliability to be good for all 3 palpation procedures of the thoracic spine, and inter-rater reliability to be good when examining paraspinal tenderness.[17] However, when assessing prone and sitting thoracic motion palpation they found inter-rater reliability to be "unacceptably low" even with an expanded agreement window of plus or minus one level on palpation.[17] Two other studies assessed the thoracic spine with manual palpation in similar study designs, with similar conclusions of poor to moderate reliability.[18] These studies illustrate the lack of reliability for manual palpation of the thoracic spine. With this lack of research or agreement for an assessment of the thoracic spine, we were presented with an opportunity to provide a novel technique with evidence for therapists wanting to quickly assess the thoracic spine.

If the thoracic spine cannot be assessed correctly, then treatment quality and outcomes may suffer as well. One current method used to assess the thoracic spine clinically is the Thoracic Percussion Test (TPT). The TPT consists of tapping on the thoracic paraspinal musculature and listening/feeling for differences in acoustic quality, which are thought to represent areas of stiffness in the thoracic spine.[19] This test, however, has not been validated, nor

has it been established if manual therapists can reliably agree that the same level is affected on a person's thoracic spine.

The intra-rater reliability is currently not known for this test, and only one study has examined the inter-rater reliability, but it had poor methodology and some flaws in the execution of the study.[19,20] In that study, examination was performed on 19 asymptomatic male thoracic spines with a mean age of 22 years (19-40), which limits generalizability of the findings to the general population.[19] Also, the manual therapists that performed the tap test had only 2 years of experience using the test, making it difficult to examine the role of experience in their results. From their results, they determined that the reliability of the TPT was only "slight," and suggested further research was necessary in order to determine if the TPT is reliable. The original study only evaluated the probability of "exact" agreement on spinal level.

Cooperstein and colleagues performed additional statistical analysis on the original Ghoukassain study.[20] Using the original data, it was reformatted to permit recalculating the degree of interexaminer agreement using the intraclass correlation coefficient (ICC) statistic, which uses continuous data analysis, unlike Kappa "κ," that performs discrete analysis. With the new reformatted and modified data, ICC (2,1) = 0.253(0.100,0.482), showed the findings as "poor," which is better interexaminer agreement for percussion motion palpation than the original reported Kappa value judged as"slight." Coopersteins results simply suggested that depending on the methodology and data analysis, study results may vary.[20] See Table 1 for Kappa value definitions.

Value of k	Strength of Agreement
0.0 - 0.20	Slight
0.21 - 0.40	Fair
0.41 – 0.60	Moderate
0.61 - 0.80	Substantial
0.81 - 0.99	Almost perfect

Table 1. Guidelines for the interpretation of Kappa values (from Landis and Koch). The original study performed by Ghoukassain et. Al used these Kappa Values.[21]

As there were flaws in the methodology and data analysis of the Ghoukassain et. al study, we chose to further investigate the reliability of the TPT. In contrast to the study by Ghoukassain et al. we would collect data on asymptomatic and symptomatic thoracic spines of both men and women of varying ages. This would allow for our results to be better generalized to a more diverse population than the original study. Also, according to Foucquet, women tend to be affected by thoracic spine pain more often than men, so including women in the study population allows the data to be expanded to a larger demographic.[4] Our study would also include two groups of therapists: a novice group with less than 5 years of experience, and an experienced group that would have 20 years or more of experience to allow us to investigate whether years of experience had any influence on reliability of the TPT. Traditionally, the TPT is performed in a sitting or standing position.[22] Ghoukassain et. al performed their study with their subjects seated on a plinth, and we also had our subjects seated on a plinth.[19] Due to the fact that it was not known whether different therapists have good inter-rater reliability, or if individual therapists are consistent within their own performance, the test needed to be examined further to be included as a part of evidence based practice

Our focus was to determine the intra-rater reliability and inter-rater reliability of the TPT when assessing the thoracic spine. We did not propose to examine what pathologies might cause the perceived variations found with the TPT, or what the appropriate follow-up treatment should be.

We hypothesized that if the clinicians all received the same training before performing the TPT, they would be able to consistently and accurately identify where the changes in acoustic quality and/or feel of the paraspinal musculature occurred. In other words, we expected therapists to consistently identify the same level repeatedly on the same person (intra-rater reliability), and also indicate a level that was consistent with other therapists (inter-rater reliability). We also hypothesized that manual therapists with more than 20 years of experience would have better overall reliability than therapists with less than 5 years of experience.

The TPT is performed in either a sitting or standing position.[19] Brismee et. Al also performed the PPIM in sitting position.[12] However, the PA, one of the most common manual assessment tools, is performed in a prone position.[9,11,13] As many of the studies are performed with the subject in a prone position, it may be difficult to compare seated techniques, such as the TPT, to prone techniques.

Many of the studies we chose to examine recruited experienced therapists, or therapists whom had manual certifications.[9,11,13] Maher et. Al recruited "manipulative" therapists with 5 or more years of experience, Binkley et. Al used "6 orthopedic physical therapists", and Brismee et. Al recruited 3 Manual Therapy Certified Therapists.[12,11,13] Our study included both Novice and Experienced therapists in contrast, in hopes of expanding the research to include therapists with a variety of levels of experience.

METHODS

Subjects: We recruited 36 subjects by advertising around the UNLV campus. Figure 1 illustrates the inclusion and exclusion criteria. In order to be included in our study, subjects needed to be between the ages of 18 and 60. We chose this wide range of ages in hopes of including a sample that would best represent the general population of adults. We excluded those who had a history

of back or neck surgery, had scoliosis, had visible tattoos on their back, or had a history of cancer. Subjects with visible tattoos were excluded as these markings would affect therapist blinding. For the same reason, back and neck surgeries were excluded, to avoid scars and markings that would identify an individual. Scoliosis was excluded as it would also affect therapist blinding, but also due to the possibility that these anatomical differences may compromise the TPT performance. Cancer was excluded as it is considered a contraindication for manual therapy on the spine.

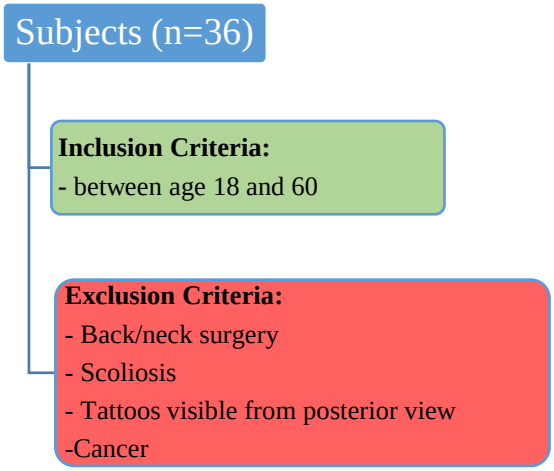

Figure 1. Subject Inclusion and Exclusion Criteria

Novice Therapists: Six "novice" Physical Therapists (PTs) were recruited to participate in the study. The therapists had to be graduates from UNLV Physical Therapy school with less than 5 years of clinical experience. Additionally, they had to currently be using manual therapy in an orthopedic setting, but not utilizing the TPT clinically. Figure 2 illustrates these criteria.

Experienced Therapists: Four "experienced" Physical Therapists were recruited to participate in the study as well. The therapists had to have at least 20 years of clinical practice in an

orthopedic/manual therapy setting in addition to using the TPT clinically. Figure 2 illustrates these criteria.

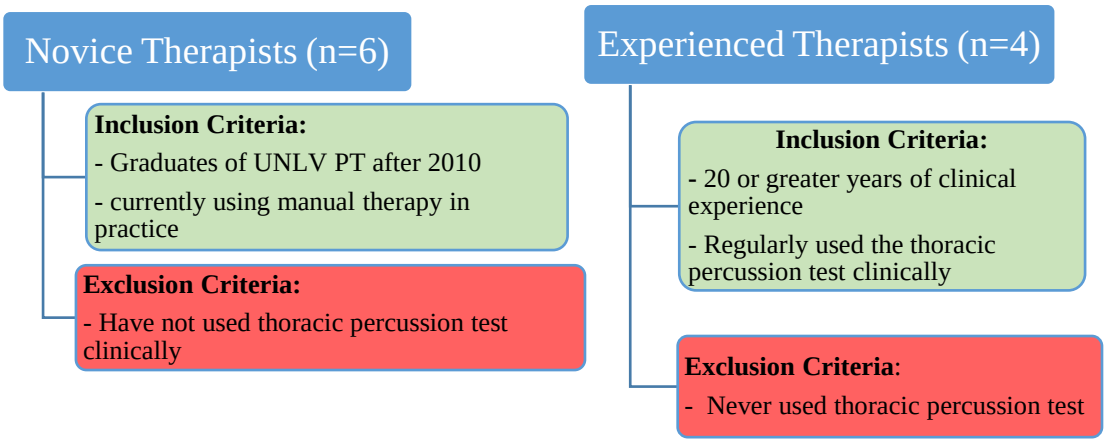

Figure 2. Inclusion and exclusion criteria for physical therapists

We chose to use both novice and experienced therapists in order to determine whether or not the amount of years of experience would have any effect on the reliability of the test. We chose a total of 10 therapists and 36 subjects based on a previous study by Ghoukassian et al 2001.[19] In their study, they recruited 10 examiners with 2 years of clinical experience and 19 asymptomatic subjects. Our study, however, used a mixture of novice and experienced clinicians. We also increased the number of subjects from 19 to 36, and included females and subjects who were experiencing back pain to make our study more inclusive and representative of the general population.

Protocol: Our study required one day to complete, but subjects were only expected to attend either the morning or afternoon session. Subjects and therapists were randomly assigned to the morning or afternoon group. The goal of this was to avoid a high attrition by requiring a small amount of time that our subjects had to commit to. During the morning session, there were 18 subjects and 6 therapists. Upon arrival, all therapists (PTs) were given a 30-minute instructional session on the TPT including a PowerPoint educating them on the history and theory of the TPT. This was followed by instructions on how to perform the test. They were shown how to use their index and middle finger and tap along either side of the spinous processes of the thoracic spine while listening for changes in acoustic quality and also feeling for discrepancies in the feel of the paraspinal musculature. They were allowed 10 minutes to practice on one another, not seeing the subjects the actual test would be performed on. The experienced therapists discussed their use of the tap test and how they conduct it to ensure that the test was being performed identically by both groups of testers. This same procedure of preparing the therapists was repeated in an afternoon session, except this time there were only 4 therapists.

The subjects all wore the same shorts, and females were asked to remove their bras. All subjects were draped in medical gowns for modesty. Nine subjects at a time sat in a line behind a curtain with cutouts that revealed only their backs. The back of their head was not exposed, and hair was pushed out of the way or put in a ponytail. This is demonstrated in Figure 3.
This ensured that the PTs were blinded to which subjects they were performing the test on. Each spinous process of the Thoracic Spine was pre-labeled with a number (1-12) indicating which spinal level it was. Figure 4 Illustrates this labeling. This helped control for disagreement among the clinicians on which level they were assessing. The 5 clinicians were randomized, and they were asked to perform the tap test on each of the subjects and indicate the level where they

Figure 5. Nine subjects seated on the plinth ready for the therapists to tap on their paraspinals. All subjects are wearing the universal gown and shorts provided. Shoes were removed from all subjects.

Figure 4. Labeling of the thoracic vertebrae (1-12) using a marker. The same person palpated each subject and labelled the thoracic spinous processes, 1-12.

Figure 3. A therapist taps along the spine of a subject, and indicates a level. He holds a clipboard in his left hand (not pictured) where he indicates 1 level for each subject. Each of the 9 subjects has a white piece of paper behind them on the plinth that indicated which seat (1-9) they are sitting in

perceived there was a difference in acoustic quality or feel. If multiple areas were found, the PTs were instructed to identify the most significant thoracic spinal segment that they felt would require treatment first. One therapist entered the room at a time, and they were given as much time as they needed to tap on each subject and indicate a level. A therapist performing the test is shown in Figure 5. Once the therapist finished all 9 subjects, they exited the room, and the next therapist entered and repeated the process. After all therapists had completed their tests, the subjects were reassigned a different order to sit in. The tests were repeated in the same fashion.

Then, the second group of 9 subjects were seated and the same procedure occurred for the second round of subjects. The therapists were told that there would be 18 people in a random order, but they were not told when the groups would switch. The same protocol was repeated in the afternoon session with 18 new subjects and 4 different physical therapists.

Statistical Analysis: Data management and analyses were performed using SPSS software version 22 (SPSS, Chicago, IL) as well as NCSS[11] software. Descriptive statistics, including estimates of central tendency and variability, were calculated to describe the sample of subjects and therapists. Intra-rater reliability of the TPT was estimated for judgments of the most significant spinal segment.

We calculated agreement within each rater through linear weighted Kappa coefficients with 95% confidence intervals. Kappa statistics represent the proportion of agreement greater than that expected by chance and have been traditionally interpreted as representing excellent agreement above 0.80, substantial agreement between 0.61 and 0.80, moderate agreement between 0.41 and 0.60, fair agreement between 0.21 and 0.40, and slight agreement between 0.00 and 0.20. Negative Kappa values would indicate agreement less than chance. We

determined *a priori* that if intra-rater reliability was found to be only 'fair' (between 0.21 and 0.40), there would be no need to test for inter-rater reliability (See Table 3).

RESULTS

Descriptive Statistics: Of the 36 subjects, the average age was 26.3 ± 4.70 years (range 21 - 41) and 15 (41.7%) were female. Only 2 of the subjects reported having back pain at the time of testing. The majority had some post-graduate education (75%) and the majority were white or Caucasian (63.9%). Full descriptive data are provided in Table 2.

Of the 10 therapists, 6 were classified as novice and their average age was 32.2 ± 2.64 years (range 28 - 36) and 2 (33.3%) were female. Mean years of clinical practice for the novice therapists was 3.7 ± 1.21 years (range 2 - 5). The remaining 4 therapists were classified as experienced and their average age was 61.0 ± 8.76 years (range 50 - 69) and all were male. Mean years of clinical practice for the experienced therapists was 33.0 ± 8.04 years (range 24 - 43).

Intra-examiner agreement for the novice and experienced therapists with their weighted-Kappa statistics are provided in Table 3. The mean linear-weighted Kappa statistic for judgments of the most significant spinal segment for all therapists was 0.21 ± 0.190 and ranged between -0.21 and 0.40. These results indicate that agreement within therapists was between slight and fair at best. Because of the poor intra-rater reliability, we did not examine inter-rater reliability.

Table 2

Number of subjects	36
Age in years (± SD)	26.3 ± 4.70
Female Gender	15 (41.7%)
Race - White or Caucasian	23 (63.9%)
Race - Asian	7 (19.4%)
Race - Pacific Islander	2 (5.6%)
Race - Hispanic	4 (11.1%)
Current pain - Yes	2 (5.6%)
Education - Graduated High School	2 (5.6%)
Education - Some College	5 (13.9%)
Education - Graduated College	1 (2.8%)
Education - Some Post-Graduate	27 (75.0%)
Education - Completed Post-Graduate	1 (2.8%)
Work - Mostly sedentary	19 (52.8%)
Work - Sedentary, substantial walking	3 (8.3%)
Work - Moderate active	11 (30.6%)
Work - Demanding	3 (8.3%)

Table 2. Demographic information of subjects. The 36 subjects that participated in the study were asked to fill out liability wavers and demographic information prior to participating in the study. Descriptive statistics were run for the information provided by the subjects, and displayed in the table above.

Table 3

Therapist	Weighted K	95% CI	P value
E1	0.29	0.01 - 0.57	0.02
E2	0.04	-0.22 - 0.30	0.76
E3	-0.21	-0.45 - 0.03	1.00
E4	0.34	0.02 - 0.67	0.01
Mean for E	**0.12 (0.252)**		
N1	0.24	-0.01 - 0.49	0.03
N2	0.24	-0.10 - 0.58	0.05
N3	0.08	-0.26 - 0.41	0.31
N4	0.32	-0.01 - 0.65	0.01
N5	0.39	0.16 - 0.61	0.01
N6	0.40	0.15 - 0.65	0.01
Mean for N	**0.28 (0.120)**		
Mean All	**0.21 (0.190)**		

Table 3. E = Experienced; N = Novice. Experienced and Novice therapist weighted Kappa statistics. Bold numbers indicate the mean weighted Kappa for the Experienced and Novice therapists, respectively, and then also the mean for all therapists. Statistics were run with a confidence interval of 95%. The P values are listed for each individual therapist.

DISCUSSION

Our results suggest that the TPT has poor intra rater reliability. Inter rater reliability statistics were not conducted, nor warranted, because of the poor intra rater reliability. We had originally hypothesized that if the clinicians all received the same training before performing the TPT, they would have good intra-rater reliability, and be able to consistently identify the same spinal level on a subject. However, our study suggested that the intra-rater results were fair at best, which did not support our first hypothesis (mean weighted Kappa= .21).

Our next hypothesis proposed that therapists would also pick a level that was similar to other therapists, and therefor have good inter-rater reliability. Our second hypothesis also

appears to not be supported. Since the intra-rater reliability was fair at best, there was no indication to run inter-rater reliability statistics.

The amount of years of experience did not improve the reliability of the TPT. Previous studies, including Ghoukassian et al 2001, have not accounted for this variable, but our research suggested that reliability did not differ between the experienced and novice clinicians.[19]

The results from this investigation indicating poor reliability of the TPT are in agreement with previous studies that have examined the reliability of spinal palpation. Ghoukassian, Nicholls, and McLaughlin[18] found interrater reliability of the TPT was not dependable while utilizing similar methodology as our current investigation . Binkley et. al[3] observed poor interrater reliability of lumbar accessory motion mobility utilizing posterioranterior mobilizations, and similarly Maher et al[14] found poor reliability for stiffness judgments in the lumbar spine using posteroanterior mobilizations without a report of a Kappa value. Haas et al[26] found similar reliability values to our investigation when examining interrater reliability of thoracic spine palpation.

In contrast, there have been few passive manual therapy assessment techniques that have found significantly higher interrater reliability compared to the current study. Brismee et. Al[4] examined a 3-dimensional thoracic spine PPIVM assessment and found fair to substantial interrater agreement. They identified differences in methodology and different test performance compared to the current study. Christensen et al.[17] found increased reliability when examining palpation of the thoracic spine between two chiropractors, however they identified limitations in their study of poor methodology, power, and they also examined different assessment methods than our current study.

Another factor that plays a role in all manual therapy and may have played a role in the performance of our research is the possible presence of "palpatory pareidolia" while performing manual techniques.[23] Pareidolia is a type of illusion that occurs when a vague or indistinct stimulus is perceived as clear and certain. Pareidolia can occur with auditory, visual, and palpatory stimuli. In essence, palpatory pareidolia is the brain interpreting vague information through palpation and seeing what it wants to see in a familiar framework even with unfamiliar stimuli. This could have impacted our research in the sense that increased experience with the TPT may have increased the likelihood of palpatory pareidolia when performing the test and the therapist would feel/hear a change in the thoracic paravertebral resonance when none may have been present. This would in turn, have inadvertently increased confirmation and perceptual bias within our research and could not have been controlled for.

The evidence suggests that the TPT was not reliable for our therapists, despite years of experience utilizing it. This is consistent with the reliability of many other manual techniques used on the spine, including Pas.[11] However, this is in disagreement with the 3-dimensional PPIVM technique assessed by Brismee et. Al.[12] The TPT may need to be investigated further for its efficacy in practice, with different study methods. In the absence of evidence to the contrary, we would recommend that the TPT be used only with other assessment tools. It should not be used alone to diagnose or treat patients. However, since it was found to have similar efficacy as the PA mobilization, which is currently used frequently in manual therapy, perhaps it may serve as an adjunct when assessing the thoracic spine. Our results found that clinical experience did not increase the reliability of the thoracic tap test, and the argument that practice and clinical experience will improve reliability, in this particular case, appears flawed.

Due to significant amounts of evidence indicating minimal reliability with palpation and musculoskeletal assessment utilizing manual therapy, the future of manual therapy may lie less in improving examination techniques and more in improving the methods by which we assess examiner concordance.[20] In addition, a lack of agreement and poor validity with these clinical tools make it difficult to create and test clinical prediction rules and determine a gold standard of care for differing patient presentations.

Limitations:

Like all research studies, our study has limitations that need to be considered. The fact that we only recruited novice UNLV graduates could have affected the outcome since they likely had similar training while attending UNLV. It is possible that other curricula could have taught different clinical tests and tools. Our brief teaching of the TPT procedure could have been interpreted differently by each individual. Because there is no universally recognized or standardized terminology in use for manual therapy, the results of clinical trials and systematic reviews may be interpreted differently by different clinicians in the same way that clinicians may have interpreted the TPT differently.[24] Even online in scholarly articles, when describing manual therapy, research paper authors and indexers are not always consistent when choosing titles and keywords. Online database can be inadequate in locating all articles that meet inclusion criteria. Depending on where a person learned his or her manual therapy, terminology may be unique, and make it difficult to relate to another person's experience.[25] It is an area that we as researchers should become more consistent with in order to create a standardized terminology to base our research upon.[26]

Another limitation could be that we recruited mostly healthy individuals. This may not represent the general population, especially because most patients who receive physical therapy have pain, and this test is usually associated with individuals who are experiencing pain or have an underlying pathology that leads them to seek therapy. These people may have a more obvious area on the spine that needs manual therapy, and perhaps therapists would have higher intra rater reliability if they had subjects with actual pain and other problems/pathology with their thoracic spine. A physical therapist, who, in their usual work commonly examines stiff spines, adapts to this situation and will have a different frame of reference than one who usually examines fewer and less stiff cervical spines.[27,28] Sensitivity and specificity in spinal assessment improve considerably if the patient's verbal report of pain reproduction is also included when locating the segmental level (Phillips & Twomey 1996).[29] Studies that utilize feedback on "pain" show higher reliability and validity than those who do not utilize pain as subjective feedback.[16] The lack of subjective feedback from our subjects may have negatively impacted the reliability of therapists.

We also used an upright percussive examination technique. In a sitting position, one must use anti-gravity muscles for support in order to maintain an erect sitting position. The lack of ability to control for slouching postures or exaggerated erect postures by the subjects should be considered. Perhaps there would be improved reliability if the TPT was performed in the prone position, where the subject would be allowed to rest passively.

Another study limitation is that 6 therapists assessed 18 subjects and 4 therapists assessed a different set of 18 subjects, and it may have improved statistically if all 10 therapists were able to assess all 36 subjects. This was an unanticipated limitation.

CONCLUSION

Passive assessment of thoracic spine stiffness using the TPT is not reliable within testers. The utilization of the TPT should not be recommended for clinical use until further studies are performed. Future research assessing reliability of the TPT on subjects with spinal dysfunction and increased study power is suggested.

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CURRICULUM VITAE

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Education

2014-2017 *University of Nevada, Las Vegas* *Las Vegas, NV*
- Doctor of Physical Therapy (3.80 GPA)

2010-2014 *University of Nevada, Reno* *Reno, NV*
- Bachelor of Science in Community Health Sciences (3.92 GPA)

Experience (clinical rotations)

2017 *Renown Rehabilitation* *Reno, NV*
- Provided therapy to geriatric, neurologic, and orthopedic patients
- Focused on functional rehabilitation in hopes of returning to prior level

2016 *VA of Reno Acute Care* *Reno, NV*
- Provided therapy to Veterans in acute care facility

2016 *Saint Mary's Outpatient* *Reno, NV*
- Provided therapy to a variety of orthopedic, geriatric, and neurologic populations

2015 *Ruby Mountain Physical Therapy* *Elko, NV*
- Provided therapy to rural population
- Provided Home Health to cardiopulmonary, neurological and orthopedic patients

Research

2015-2017 *Inter and Intra Rater Reliability of the TPT*
- Student investigator
- Developed research methods and assisted in subject recruitment
- Performed data analysis
- Assisted in writing a scientific research paper

Professional Development

2014-2017 *Professional Conferences and Courses*
- Combined Sections Meeting 2016
- Therapeutic Neuroscience Education: Adriaan Louw 2015
- Member of APTA since 2014
- CPR Certified since 2012
- UNLV Distinguished Lecture series 2014-2017
- Class Social Coordinator

Personal

Proficient in Microsoft Word, PowerPoint, and Excel

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EDUCATION

University of Nevada- Las Vegas May 2017
Doctor of Physical Therapy (GPA 3.80)

University of Nevada-Reno December 2013
Bachelor of Science Degree in Community Health Sciences (GPA 3.67)

PROFFESIONAL EXPERIENCE

Select Physical Therapy- Clinical Internship January 2017 to March 2017
Outpatient Clinic
Las Vegas, NV

Sunrise Hospital- Clinical Internship October 2016 to December 2016
Rehabilitation Facility
Las Vegas, NV

Spring Valley Hospital-Clinical Internship July 2016 to September 2016
Acute Care Facility
Las Vegas, NV

Affiliated Physical Therapy-Clinical Internship June 2015 to August 2015
Rural Outpatient Clinic
Pahrump, Nevada

-Performed numerous patient initial evaluations and reevaluations over the course of a 6 week period.

-Exposed to a diverse patient population including pediatrics, vestibular, wound care, geriatrics, orthopedics, cardiopulmonary, and home health.

-Worked cooperatively with Physical Therapists, and assumed leadership role with Physical Therapist Assistants, and Physical Therapy technicians to ensure a professional and safe environment for patients.

RESEARCH EXPERIENCE

Reliability and Validity of the Thoracic Percussion Scan in Orthopedic Manual Physical Therapy August 2015 to May 2017

-Student investigator assisting in the setup and performance of the study

-Assisted with statistical analysis, data collection, and writing the proposal for the IRB

PROFESSIONAL DEVELOPMENT

-Therapeutic Neuroscience Education by Adrian Louw- 2015 & 2016

-UNLV Distinguished Lecture Series 2014-2016
-Member of APTA since 2014

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Education

2014-2017 University of Nevada, Las Vegas Las Vegas, NV
· Doctor of Physical Therapy (3.?? GPA)

2007-2011 University of Nevada, Reno Reno, NV
· Bachelor of Science in Community Health Sciences (3.78 GPA)

Experience (clinical rotations)

2017 Summerlin Hospital Las Vegas, NV
· Provided therapy to patients in the acute care setting

2016 Comprehensive Therapy Centers Pahrump, NV
· Provided therapy to a rural population
· Provided therapy to a variety of orthopedic, geriatric, and neurologic populations

2016 Health South Rehabilitation Las Vegas, NV
· Focused on functional rehab in order to facilitate a return to their prior level

2015 Renown Outpatient Physical Therapy Reno, NV
· Provided therapy to geriatric, neurologic and orthopedic patients
· Focused on developing manual techniques

Research

2015-2017 Inter and Intra Rater Reliability of the TPT
· Student investigator
· Developed research methods and assisted in subject recruitment
· Performed data analysis
· Assisted in writing a scientific research paper

Professional Development

2014-2017 Professional Conferences and Courses
· Combined Sections Meeting 2016
· Therapeutic Neuroscience Education: Adriaan Louw 2015
· Member of APTA since 2014
· National Student Conclave 2014
· CPR Certified since 2011
· UNLV Distinguished Lecture series 2014-2017

Personal

Proficient in Microsoft Word, PowerPoint, and Excel
Enjoy physical activity including volleyball, basketball, swimming, strength training, soccer and biking.