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La recherche en ostéopathie

Les objectifs de la recherche en ostéopathie sont de mieux connaître, mieux comprendre et mieux expliquer notre pratique notamment au monde scientifique et universitaire; elle participe à enrichir notre savoir et à le légitimer.
La recherche au CEESO, intégrée dans notre ingénierie de formation en ostéopathie, permet à nos étudiants d'acquérir les compétences pour réévaluer les idées établies au regard des connaissances actuelles et leur permet d'analyser de façon critique de nouvelles idées, compétences qu'ils utiliseront tout au long de leur carrière professionnelle. C'est la démarche de tout type d'enseignement universitaire d'une discipline de santé.




M. Edouard-Olivier Renard DO MROF, M. Rafaël Zegarra Parodi DO MROF, M. Pierre de Chauvigny de Blot DO MROF et M. Luke Rickards DO MROF

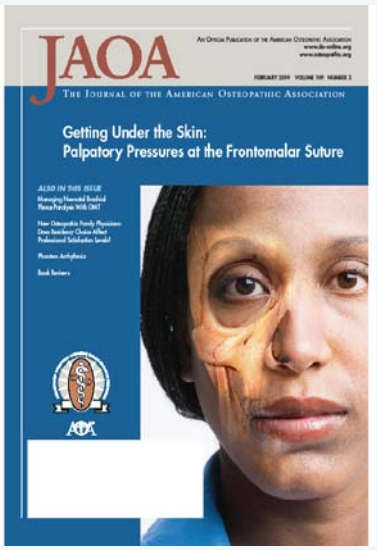
L'ostéopathie crânio-sacrée

Il s'agit d'une pratique controversée dans le monde médical du fait du manque actuel de validations scientifiques des modèles physiologiques décrivant les tests, les techniques et leurs effets sur la santé. Ceci est paradoxal compte tenu de son innocuité et du plébiscite obtenu auprès du grand public, plus particulièrement auprès des nouveaux-nés en France.

Publication des travaux du CEESO dans le JAOA

Messieurs Rafael Zegarra-Parodi, Pierre de Chauvigny de Blot, Luke Rickards et Edouard-Olivier Renard, ostéopathes exclusifs membres du Registre des Ostéopathes de France, ont souhaité étudier les tests utilisés dans la pratique crânio-sacrée selon les méthodologies d'évaluations actuelles et plus particulièrement sous un angle biomécanique.
Il s'agit en effet de la première étude publiée mesurant les pressions de palpation utilisées lors de la pratique crânio-sacrée, ce qui permettra à terme de faciliter l'enseignement de ces techniques de palpation subtile, d'offrir la possibilité de les reproduire et de les mesurer afin de conforter la place de ces techniques dans les compétences de base d'un ostéopathe.

Leur travail de recherche intitulé *« Pressions de palpation crânienne utilisées par des étudiants en ostéopathie : effets d'un protocole d'enseignement »* vient d'être publié dans la plus ancienne et la plus prestigieuse revue d'ostéopathie, le JAOA – The Journal of the American Osteopathic Association, publication de référence au sein de la profession ostéopathique, la seule dont les articles sont indexés dans Medline, la principale base de données médicales. C'est la première fois que le JAOA publie un article réalisé par des ostéopathes exclusifs français.



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Getting Under the Skin: Palpatory Pressures at the Frontomalar Suture

ALSO IN THIS ISSUE

JAOA EDITORIAL

New Horizons for Research and Education in Osteopathic Manipulative Medicine

Brian F. Degenhardt, DO

Methods for evaluating and quantifying manual techniques using modern scientific standards must be established to advance and more fully understand the practice of osteopathic manipulative medicine. I applaud Rafael Zegarra-Parodi, DO (England), MEd, and his colleagues for initiating such research in the field of cranial osteopathy, as described in this month's issue of *JAOA—The Journal of the American Osteopathic Association* (2009;109:79-85).

The goal of this month's cover article was to demonstrate that instructional methods are effective in ensuring adequate replication of cranial palpatory techniques learned by osteopathy students at the European Center for Osteopathic Higher Education in Paris, France.

In their prospective, unblinded observational study, Zegarra-Parodi and coauthors used a flexible force transducer to evaluate the pressures generated during palpation of the frontomalar suture by 24 fourth-year osteopathy students with 2 years of training in cranial osteopathy. Twelve student practitioners randomly assigned to the study group participated in a single 40-minute training session consisting of description, demonstration, and practice of established methods for evaluation of the frontomalar suture. The 12 student practitioners in the control group did not receive training. A third group of 12 students acted as subjects.

Results showed that the mean pressure used during each test ranged from 0.27 N/cm^2 to 0.98 N/cm^2. The mean palpation pressure recorded by the study group was 0.55 N/cm^2 and by the control group was 0.53 N/cm^2. The authors concluded that the training protocol was ineffective in improving the precision of cranial palpation.

To identify potential reasons why the training session was ineffective, the current recommendations for teaching palpatory skills must be reviewed. Typically, students obtain cognitive knowledge from didactic presentations in anatomy, biomechanics, and dysfunction and combine that information with the subjective assessment of observing an expert apply the technique. The trainee then performs the technique by attempting to mimic the demonstrated movements[1,2] and receives verbal feedback from an expert, ideally soon after the technique was performed so the student can easily compare the feedback to the memory of performing the technique. This feedback is considered critical for a student to learn which component of a technique was not adequately applied.[3-5]

From that moment on, students generally repeat the technique in unmonitored settings. Theoretically, this process creates skilled and safe clinicians who have developed preprogrammed patterns of action—or *engrams*—to reduce the need of high mental effort during skill performance so interventions can be accurately and efficiently applied within the clinic setting.[6,7]

In the two primary environments where most nonresidency training in manipulation occurs—colleges of osteopathic medicine or osteopathy schools and continuing medical education programs—there is often only one or a limited number of instructors overseeing numerous trainees. As a result, timely individualized verbal feedback and adequate time for technique repetition and refinement are routinely compromised. With only one instructor for 12 students in a 40-minute training session in the study by Zegarra-Parodi and coauthors, it appears that students' time for feedback and practice was extremely limited, which is inconsistent with current recommended training standards.

Another assumption made in this study was that the students were "untrained." Both cohorts had 2 years of training in osteopathy in the cranial field. Two years is a substantial amount of time to establish a particular style, pattern, or engrams for cranial palpation. It seems unlikely that a single instructional event would modify the patterns developed in 2 years of training and experience palpating and treating lab partners, family, and friends.

The underlying physiologic processes involved in manual diagnosis and osteopathic manipulative treatment (OMT) are extremely complex, requiring high levels of sensory and motor processing and coordination.[8] By comparing the complexity of skill performance to the subjective observational aspects of the current model for teaching manual skills, one can see how the educational process may be layered with substantial ambiguity or variation in perception between students and instructors.[9]

To teach and assess manual diagnostic and OMT skills in a manner that would allow students to consistently interpret the complex sensory input and motor control necessary for the performance of techniques from a scientific perspective is unrealistic at this time. Yet by using the scientific reductionist model, modern instrumentation could revolutionize the teaching and performance of palpatory skills by being able to give timely, repetitive objective feedback within the training process.

As noted by Zegarra-Parodi and coauthors, four "components of cranial manipulation may be amenable to [monitoring and thus] standardization," there-

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fore making them useful parameters for modern palpation research. These components are as follows:

- direct vs indirect approach to modifying dysfunctions
- palpation pressure
- localization of practitioner hand contact
- treatment duration

At the A.T. Still Research Institute of Kirksville (Mo) College of Osteopathic Medicine-A.T. Still University, we have used instrumentation to objectify all four of these components. Our experience[10-13] indicates that the last three of these four components are ripe for research in osteopathic manipulative medicine.

However, the remaining component—stipulating or measuring direct versus indirect approaches—relates to complex forces applied to the patient by the examiner to achieve a therapeutic response. While newly developed technology consists of sensors to quantify the amount and direction of shear-type forces, which are used clinically in both direct and indirect OMT techniques, our experience indicates that this technology is not refined enough to capture the nuances of OMT techniques. Although this level of refinement may soon be available, sensors that measure "general pressure" or unidirectional pressure perpendicular to the surface of the sensors are the best tools currently available to assess palpatory force.

Two items are needed to assess skill development: (1) a reliable system to measure technique performance, and (2) a common definition, understanding, and quantification of the elements of performance that are considered skillful.[14] While most commercially available instruments have been developed and validated within a certain accuracy range, technology cannot establish the elements of performance that are required to demonstrate skill.

The instrument needs to be used numerous times to define the characteristics of the intended palpatory parameter and to determine what is considered skillful. For example, in the area of high-velocity, low-amplitude techniques, this process was first used more than a decade ago.[9]

Zegarra-Parodi and colleagues did not assess this portion of skill development, which substantially limits the value of the study's outcome. Therefore, even though instrumentation exists for use in osteopathic palpation research, parameters that determine skill are required and can be defined through collecting normative data. One source of limited yet normative data that could have been used by Zegarra-Parodi and coauthors was the evaluation of the instructor's technique on the subjects. Such an evaluation would have provided a "gold standard" for the degree of pressure used and its level of variability.

While the outcomes of the study did not support their hypothesis, Zegarra-Parodi and coauthors suggest that quantitative measures could improve student palpatory training. Research[1,2,9,14-19] has shown value in using instrumentation to provide objective feedback to students during manual therapy training. For example, objective feedback for a high-velocity, low-amplitude technique to the lumbar, cervical, and thoracic areas has demonstrated that several biomechanical parameters can be consistently modified during a routine trimester of chiropractic training compared with the standard curriculum.[1,14]

One explanation of why feedback from quantitative measures appears to improve palpatory skills comes from the field of motor learning. It has been reported that trainees must characterize both kinematic and kinetic components to coordinate complex skill performance.[20] Instrumentation can provide this type of feedback for students immediately at the initial training session but also recurrently as students practice techniques. Within the current teaching model, feedback, which is crucial to successful education, is often compromised as a result of a deficient number of trainers and limited time.

Yet quantitative data that define optimal parameters for the performance of OMT techniques is not available. Likewise, it is unknown if the focus on the development of certain parameters may hinder other aspects of the palpatory process.[2] Consequently, osteopathic researchers need to use modern instrumentation to observe current practices and learn what aspects of techniques have or have not been correlated to success in clinical practice. This process must be completed before suggesting change in palpation techniques based on assumptions that certain parameters (eg, pressure) need to be standardized just because they can be measured. Only through unbiased, serial observations can we learn more about the important aspects of palpation that have established the value of osteopathic diagnostic and therapeutic palpation since their inception.

This process will not be quick or easy. There are many issues that need to be addressed, some noted by Zeggara-Parodi and colleagues in their study's discussion. Here are further basic questions:

- Does variation in the amount of pressure result in variation in the interpretation of tissue characteristics?
- Can variation in the amount of pressure result from changes in subject and examiner characteristics?

Perhaps change in pressure is necessary because of differences in the size of the subject's head and the examiner's hand. The mechanics of palpation, such as changes in practitioner position (eg, angles of the fingers, wrist, and elbow joints with each examination), may influence pressures used but not necessarily the important diagnostic conclusions being made. Perhaps a variation in force is required for the examiner to internally standardize sensations when diagnosing in varying positions.

While it is assumed that standardized pressures are clinically beneficial, the ability to vary pressures, even in the

diagnostic process, may be necessary to achieve insightful diagnoses that aid in determining which OMT techniques will most likely generate a therapeutic response.

To illustrate this point, I can think of two extremely successful and revered osteopathic physicians: Robert Fulford, DO, and Viola Frymann, DO. Although equally successful, both physicians applied their skills differently, particularly on the level of forces. In training courses I attended, Dr Frymann would stress avoiding heavy handedness, while Dr Fulford would encourage getting in there and getting the job done instead of floating on the surface of the mechanism until something happens.

In the study of motor performance, Scully and Newell[20] have suggested that the focus of observational learning should be on *what* is perceived rather than *how* it is perceived (or performed). Therefore, osteopathic researchers should be cautious when assuming that standardization of technique is required for the scientific study of palpation and manipulation. Otherwise, we might not capture those aspects of palpation that contain the potency of the osteopathic approach.

Consequently, it is important for osteopathic researchers to observe how palpation and manipulation are practiced using instrumentation before requiring modifications to those skills, particularly when the only rationale for standardization is the assumption that such modifications are required for the scientific method.

Science has overcome the challenges of understanding variability in measurements. For example, blood pressure always fluctuates. Yet through unbiased systematic observations over time and correlating those observations with meaningful patient-oriented outcomes (eg, headache, stroke rate), a meaningful, scientifically based diagnostic tool and outcome measure was developed.

Osteopathic palpation has been and currently is an art. Transitioning art into science must be done cautiously and conscientiously. It is critical for osteopathic researchers to begin our work where the scientific process begins—through systematic, unbiased observations. Current instrumentation allows osteopathic researchers to generate large data sets with relative ease. The challenge is interpreting the data so they have relevance to the clinical outcomes that have sustained the osteopathic medical practice for more than a century.

The scientific process can overcome the challenges of understanding variability. It requires answering what may seem to many as unnecessarily small questions, but through disciplined, sequential, and thorough research with unbiased questions and observations, a strong scientific foundation for research and education in osteopathic manipulative medicine can be achieved.

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JAOA ORIGINAL CONTRIBUTION

Cranial Palpation Pressures Used by Osteopathy Students: Effects of Standardized Protocol Training

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Context: Descriptions of subtle palpatory perceptions in osteopathic cranial palpation can be misperceived by students. Thus, adequate dissemination and replication of cranial palpatory techniques is challenging for osteopathy students.

Objective: To evaluate the effects of standardized protocol training on cranial palpation of the frontomalar suture.

Methods: Fourth-year osteopathy students from the European Center for Osteopathic Higher Education in Paris, France, were recruited and randomly divided into three groups. Students in the study group received instruction in a standardized protocol for palpatory assessment of the frontomalar suture; students in the control group did not receive instruction; and the remaining students acted as subjects. A specialized force sensor was placed on the skin covering the left frontomalar suture of each subject. Student practitioners were instructed to palpate subjects' left frontomalar suture using the customary pressure described for evaluation and treatment of somatic dysfunction of the cranium. Pressure measurements were exported to a laptop computer.

Results: Twelve students were in each group. Student practitioners' palpation pressures ranged from 0.19 to 1.12 N/cm^2, while mean palpation pressures for each test ranged from 0.27 to 0.98 N/cm^2. The mean (SD) palpation pressure in the study group and control group was 0.55 N/cm^2 (0.16 N/cm^2) and 0.53 N/cm^2 (0.15 N/cm^2), respectively. There was no statistically significant difference in mean palpation pressures used by the two groups. Substantial variation in test performance was noted in both groups.

Conclusion: Palpatory training was ineffective in improving student practitioners' precision of cranial palpation performance. Quantitative feedback of palpation pressures during training may improve outcomes. To our knowledge, data on palpation pressures used during osteopathic cranial manipulation have not been reported previously in the medical literature.

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Cranial manipulation, or craniosacral therapy, is a widely practiced technique used by osteopathic physicians, foreign-trained osteopaths, chiropractors, physical therapists, and massage therapists.[1-5]

The osteopathic cranial technique was first described in the 1930s by William Garner Sutherland, DO.[6] According to the treatment model, intrinsic rhythmic movements of the central nervous system, termed the *primary respiratory mechanism* (PRM), create pulsations of cerebrospinal fluid and specific relational oscillations of the dural membranes, which can be directly palpated via corresponding articular motions of the cranial bones and the sacrum.[6]

The therapy uses palpation and gentle manipulation to evaluate and modify the many parameters of this system to improve patient health.[3] In particular, movement restrictions at the cranial sutures are believed to negatively affect the rhythmic impulses conveyed through the cerebral spinal fluid, which in turn may result in diminished physical function, psychological function, or both.[1,5,7]

Researchers[1,5] have claimed that cranial manipulation can benefit patients with various conditions, including autism, birth trauma, infantile colic, learning difficulties, musculoskeletal problems, neurologic disorders, sinusitis, and stress and emotional disorders. However, evidence of the effectiveness of cranial manipulation in treating these conditions is yet to be established.[1,5,8,9] Further, current scientific evidence does not support the commonly accepted explanatory models of osteopathic cranial manipulation.[1,3,5,9]

Nevertheless, many practitioners interpret the extent of anecdotal evidence supporting the descriptive model and clinical outcomes as sufficiently compelling to justify continued use of cranial manipulation in clinical practice.[9] However, in the absence of substantiating evidence for the various components of current cranial diagnostic and treatment models, practitioners of cranial manipulation have been challenged to demonstrate a relationship between the therapy and its positive clinical outcomes.[8-10]

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Clinical outcome studies of cranial osteopathy present researchers with a number of challenges. Ideally, the selection of participants for a clinical research study should include the use of valid and reliable diagnostic tests in order to ensure homogeneity of the study population. Because there is no reference standard for the diagnosis of PRM dysfunctions and because interrater reliability of cranial diagnostic palpation has not been established,[3,11-13] data from outcome studies will likely be affected by participant heterogeneity.[12] For example, a trial examining the effectiveness of cranial manipulation for sinusitis may include participants whose sinusitis is caused by a condition other than dysfunction of the PRM (as proposed by the cranial model) and thus may lead to an apparent failing of an effective treatment.

The applicability of data from clinical research of cranial osteopathy also requires that the components of a diagnostic test or treatment intervention are precisely described and standardized.[14] However, cranial osteopathy models propose that effective intervention is dependant on corrective modifications to the individual expression of the PRM for each patient.[7] Although exact standardization of cranial manipulation methods may not be possible, some components of cranial manipulation (eg, direct vs indirect approach to modifying dysfunctions, palpation pressure, practitioner hand contact, treatment duration) may be amenable to standardization.

Precise information regarding technique application is also essential to ensure correct transmission of palpation techniques. Practical instruction in osteopathic cranial palpation is reliant on descriptions of highly subtle palpatory perceptions, which can be misperceived by students. Substantiation and standardization of some parameters using quantitative methods may aid the transmission and perception of technique application and therefore ensure adequate dissemination and replication of cranial palpation techniques learned by osteopathy students.

The objective of the present study was to evaluate the effects of training in a standardized protocol for the palpatory examination of the frontomalar suture on palpation pressures used by osteopathy students. The training protocol aimed to minimize variations in students' applications of a palpatory test.

We hypothesized that pretest training would be associated with statistically significant differences in applied palpation pressures compared with nontrained osteopathy students—specifically, less force magnitude and lower interrater variation.

The present study also served as a feasibility analysis for further research using quantitative methods to examine cranial palpation parameters with experienced practitioners.

To our knowledge, quantification of palpation pressures used in cranial osteopathy has not been reported to date.

Methods

The study protocol was approved by the scientific council of the Centre Européen d'Enseignement Supérieur de l'Ostéopathie (European Center for Osteopathic Higher Education, CEESO) in Paris, France.

Participants

Participants were recruited from the fourth-year osteopathy student body at the CEESO. Participants gave verbal consent after receiving verbal notification of the study procedure.

Participants were randomly divided by consecutive allocation into three equal groups: a study group, control group, and subjects. Students in the study group received training in a standardized protocol for osteopathic palpatory assessment and treatment of the frontomalar sutures. Students in the control group did not receive palpatory instruction. The third group consisted of students who acted as subjects.

Because the participants were acquainted with each other, student practitioners' familiarity with subjects' clinical history, as well as prior cranial palpatory experience with the subject, could not be ruled out. No attempt was made to blind student practitioners to the identity of the subject during the palpatory test.

Pretest Training

Before the experimental test, the study group was taken into a separate room by an experienced instructor of osteopathic cranial manipulation. The instructor (P.C.B.) had 9 years experience in the practice of osteopathic cranial manipulation and 3 years experience in teaching.

The protocol was based on palpation techniques taught at the CEESO and the clinical experience of the instructor (P.C.B.). Several models for cranial manipulation have been described that require different levels of perception skills for diagnosis and treatment approaches.[15] In the present study, student practitioners were taught to diagnose cranial somatic dysfunction in an "osseous" approach, where normal and abnormal levels of tonus in extracranial muscles must be appreciated, as well as tissue texture changes around the bony landmarks.

Therefore, pretest training for the present study consisted of description, demonstration, and practice of established methods for clinical identification of the relevant anatomy, application and adjustment of palpatory pressures, and "engagement" of motion at the frontomalar suture. Each student received individual guidance by the instructor.

The training session lasted approximately 40 minutes. During this time, the control group commenced the palpatory test.

Equipment

Data on palpation pressures used during the study were obtained using a FlexiForce tactile force sensor device (Tekscan Inc, South Boston, Mass). FlexiForce consists of an ultra-thin, flexible force sensor connected to force measurement software installed on a standard personal computer. The sensor used in the present study had a measurement range of 0 to

11.43 N/cm^2, occurring in gradations of 0.09 N/cm^2. The surface area was 0.71 cm^2 with a thickness of 0.2 mm.

Because palpation of the PRM is often executed through clothing, the thickness of the sensor was not considered capable of interfering with the palpation process. To minimize error from the FlexiForce system, the sensor was calibrated on the day of data collection according to manufacturer instructions. Under these conditions, the manufacturer-evaluated error margin was less than 5%.

The equipment was previously tested by the primary investigator (R.Z.P.).

Palpatory Test

All measurements for both groups were made on the same day under identical environmental conditions.

Three treatment beds were arranged in the same room, with a subject positioned supine on each bed. The FlexiForce sensor was placed on the subject's left frontal bone adjacent to the frontomalar suture by the same operator (R.Z.P.) for all measurements (*Figure 1*). The student practitioner was positioned in a chair at the head of the bed. The fingertips of the practitioner's left hand contacted the frontal bone at the superolateral portion of the orbit, with the index finger positioned over the force sensor. The fingertips of the practitioner's right hand contacted the malar at the inferolateral portion of the orbit.

When the student practitioner signaled that psychophysical "engagement" with PRM movements at the suture had been achieved, a 2-second pressure measurement was recorded via the FlexiForce system into a laptop computer. All students were blinded to the pressure reading.

Three randomly chosen student practitioners from the control group performed the test once on each of the first three subjects. Next, another three student practitioners and subjects were selected, following the same testing process. This procedure was repeated two more times, each with a new set of practitioners and subjects, resulting in three pressure measurements from each of the 12 practitioners, and thus a total of 36 measurements for this group.

The number of practitioners palpating each subject was limited to three in compliance with recommendations from the International Federation for Manual/Musculoskeletal Medicine.[16] These guidelines[16] suggest that contact with each subject during manual diagnostic procedures should be minimized to avoid possible confounding from alteration of the subject's tissue physiology or response.

A 1-hour interval was provided before commencing the same procedure with the study group. We considered the length of this break sufficient given the short duration of the test (2 seconds). A total of 72 pressure measurements were recorded.

Data Extraction and Analysis

FlexiForce records one pressure measurement every 0.125 seconds, thus giving a total of 17 pressure measurements for each test recording from 0 to 2 seconds (*Figure 2*). The measurements were expressed as grams-force (gf). The raw data were exported to Microsoft Excel software (version 2007; Microsoft Co, Redmond, Wash) and then converted to N/cm^2 in accordance with the International System of Units. Pressure measurements from each 2-second test were converted to a mean, which were used to calculate the mean palpation pressure for each group.

A *z* test was used to determine if statistically significant differences existed between the mean palpation pressure of each group. The coefficient of variation was also calculated to assess intragroup differences in test performance.

Results

A total of 36 students (14 men, 22 women; mean [SD] age, 24.6 [4.4] y) were enrolled in the study. All students had completed

Figure 1. *Positioning of the subject, student practitioner, and force sensor during the palpatory test. Although this photograph shows finger positioning on the subject's right frontomalar suture, the palpatory test applied in the present study occurred on the left frontomalar suture.*

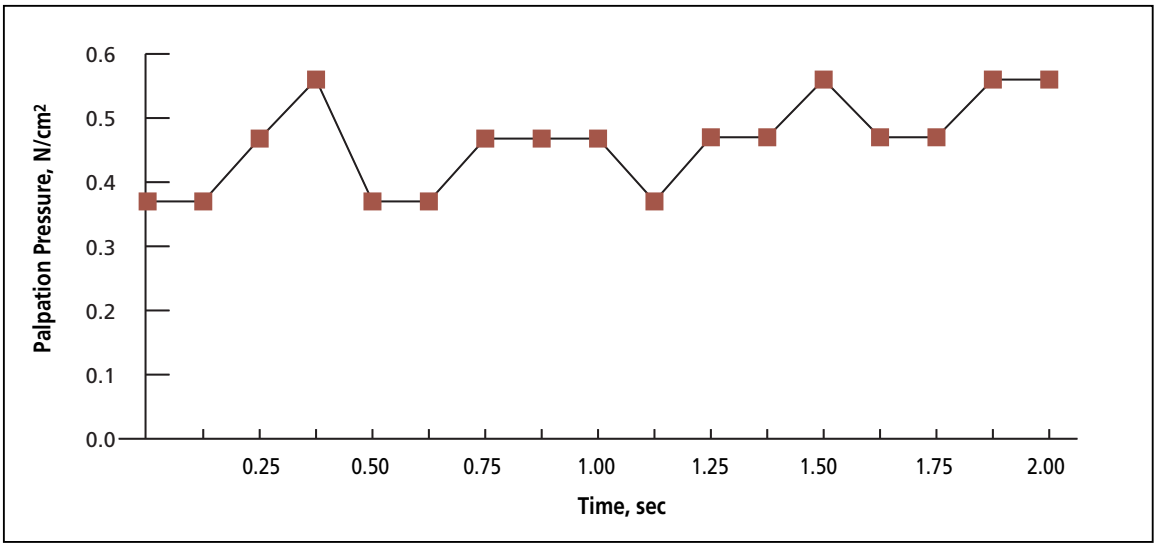

Figure 2. *Example of pressure measurements taken by FlexiForce sensor device (Tekscan Inc, South Boston, Mass) during a 2-second test. FlexiForce records the pressure measurement every 0.125 seconds, thus providing 17 pressure measurements for each test.*

approximately 2 years of training in osteopathic cranial manipulation. Complete data were recorded for all 72 tests. The mean palpation pressure used by each student practitioner during each 2-second test is represented in *Figure 3*.

The palpation pressures recorded throughout the study procedure ranged from 0.19 to 1.12 N/cm^2, with mean pressures of the 2-second tests ranging from 0.27 to 0.98 N/cm^2 (*Table*). The mean (SD) palpation pressure recorded by the control group was 0.53 N/cm^2 (0.16 N/cm^2) (95% confidence interval [CI], 0.48-0.58 N/cm^2). The mean (SD) pressure recorded by the study group was 0.55 N/cm^2 (0.15 N/cm^2) (95% CI, 0.5-0.6 N/cm^2). The coefficient of variation for the control and study groups was 29% and 28%, respectively, indicating substantial variation in test performance within both groups. Comparison of the mean palpation pressures using the z test indicated no statistically significant difference between the two groups (z=0.55, P=.58).

Discussion

The results of the present study suggest that training in a standardized protocol was ineffective in improving the precision of cranial palpation performance by osteopathy students. Determining the specific relevance of this result, however, is difficult in the absence of normative data from experienced cranial manipulation practitioners. If similar pressure measurements were evident for experienced practitioners, then the lack of a statistically significant difference between the two groups may simply reflect adequate dissemination of the cranial technique among both groups of students. However, variance of recorded palpation pressures among experienced practitioners would need to be examined and justified.

Alternatively, it is possible that descriptions of cranial manipulation are not effective in conveying precise instruction regarding the application of palpatory pressure. In other words, students may not be able to judge how much pressure they are using from description and subjective experience of the technique alone. Cranial manipulation training using quantitative feedback of palpation pressures may convey more precise information regarding technique application.

In the absence of normative data, it is also difficult to determine the clinical significance of the substantial variation in palpatory pressures recorded during the study. It is possible that experienced practitioners would demonstrate similar variation in palpation pressures, perhaps reflecting the poor interrater reliability demonstrated in several studies on palpation of the cranial rhythmic impulse (CRI).[3,11-13,17] The variation may also reflect disparate levels of skill among osteopathy students or different interpretations of instruction.

Alternatively, PRM "entrainment" models propose that palpation of expression of the PRM at varying levels is dependent on a complex interaction of multiple biological oscillators between the patient and the practitioner.[18,19] In other words, as practitioners engage with the PRM at different levels, palpation pressures may also vary according to specific physio-

Figure 3. *Mean palpation pressures of each 2-second test for each student practitioner in the study group (A) and each student practitioner in the control group (B). Each student practitioner applied palpatory pressure to three different subjects. The coefficient of variation was 29% for the study group and 28% for the control group, indicating substantial variation in test performance.* ▶

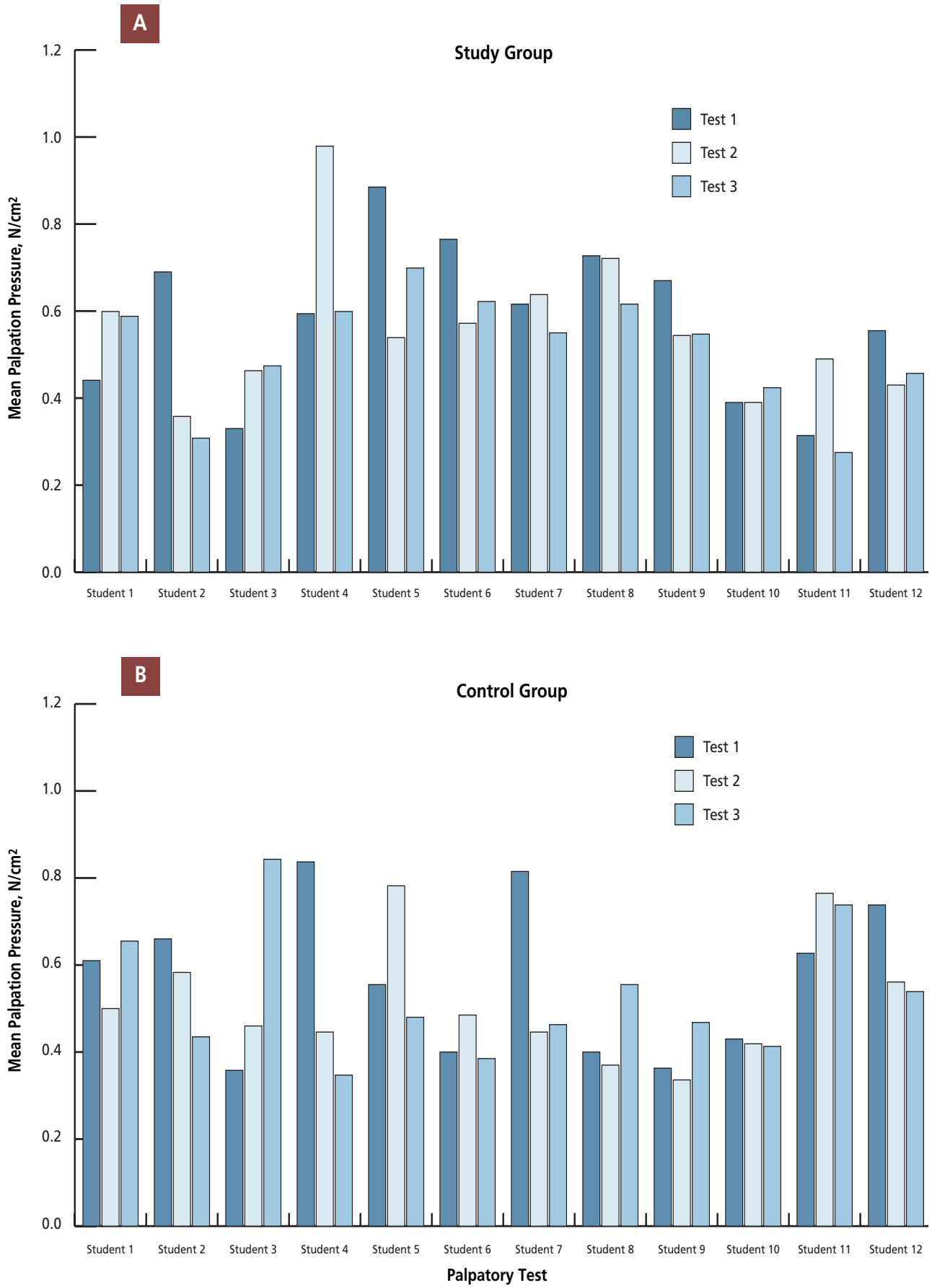
A
Study Group
Test 1
Test 2
Test 3
Mean Palpation Pressure, N/cm²
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
Student 7
Student 8
Student 9
Student 10
Student 11
Student 12
B
Control Group
Test 1
Test 2
Test 3
Mean Palpation Pressure, N/cm²
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
Student 7
Student 8
Student 9
Student 10
Student 11
Student 12
Palpatory Test

Table
Student Practitioner Palpatory Pressures of the Frontomalar Suture: Study Group vs Control Group

	Group	
Palpation Pressure, N/cm²	Study (n=12)	Control (n=12)
Mean	0.55	0.53
Standard deviation	0.16	0.15
Minimum	0.27	0.34
Maximum	0.98	0.84
Median	0.55	0.48
Coefficient of Variation	29%	28%

logic or tissue targets of palpation.[19-21] Therefore, different subject-practitioner matching may result in a distinct application of palpation pressure.[22]

To our knowledge, the present study includes the first quantitative data on palpation pressures used in osteopathic cranial manipulation. The mean palpation pressure used by student practitioners in the study group was 0.55 N/cm², which was calculated from a raw measurement mean value of 40 gf. This force is substantially greater than the 5 to 10 gf commonly recommended for cranial manipulation.[23] In addition, the minimum 2-second mean pressure recorded during the study (0.27 N/cm²; 20 gf) was two to four times greater than the recommended palpation pressure.[23]

As stated earlier, interpreting these measurements is difficult in the absence of data from experienced practitioners. It is possible that the students misinterpreted instructive descriptions of cranial manipulation or that practitioners of cranial osteopathy in general have underestimated the magnitude of force generally applied during cranial manipulation. Further research is need to resolve this issue.

Practitioners of osteopathic cranial manipulation claim that very small manual forces are sufficient to produce specific movement across cranial sutures. Downey et al[5] examined this hypothesis using a rabbit cranium model, which has considerable similarity to human cranial sutures. Distraction forces from 5 to 20 gf were applied across the coronal suture to simulate a craniosacral "frontal lift" technique using the range of manual force commonly recommended in osteopathic texts.[23] No sutural movement was recorded until distraction forces of 500 gf or more were applied. Similar data were reported by Lorsken et al.[5,24]

A maximum force of 81 gf was recorded during the current study. Although this force is many times greater than the speculative range applied by others,[23] it is substantially lower than the forces required to produce objective movement across cranial sutures.[5,24]

Limitations

The methodology of this study did not include pretest measurements of palpation pressure. Without such data, it is impossible to confirm that the training protocol had no effect on test performance of student practitioners in the study group.

In addition, the study population was relatively small. Thus, it is possible that the analysis lacked sufficient power to demonstrate a statistically significant difference between groups.

The precision of the data recorded and reported in the present study must be evaluated with caution. The flexible sensor used in the current study measures palpation forces in gradations of 0.09 N/cm². Considering the recorded mean palpation pressure of 0.55 N/cm² in the study group, the resolution of this sensor may be inadequate for measuring precise palpation pressures applied during cranial manipulation.

The variations in pressure recorded within the 2-second tests may also reflect inadequate sensor resolution. As noted in *Figure 2*, oscillations of a single 0.09 N/cm² gradation around a stable mean were recorded, suggesting a pressure variation range of 0.18 N/cm². However, the sensor may have inflated or deflated variations in pressure within its resolution range. Continued research on cranial palpation pressures should be conducted with a higher resolution sensor.

Data demonstrating adequate reliability of the various components of cranial palpation are critical to the validity of claims that positive health outcomes after treatment are caused by specific correction of PRM dysfunctions. Reliability is dependant on the ability of practitioners to reproduce the various technical parameters of a test.[25,26] If a theoretical clinical phenomenon has sufficient validity to be accessible to a specific test, standardizing the execution of each technical parameter of the test may increase its reliability.[25]

The execution of palpatory tests may achieve maximum reproducibility when conducted with the same kinematics (position and movement) and the same kinetics (force and pressure).[25] However, the specific variables of a test may be more or less active in producing test reliability.

For example, standardization of the kinematics of a test for vertebral fixation using cervical motion palpation was associated with improved interrater reliability despite a large variation in the kinetics applied by each examiner.[26] Because contemporary cranial models, which predict poor interrater reliability for the CRI rate, may be dependent on palpation pressure as an essential variable, standardization of palpation pressures may be a crucial measure in demonstrating interrater reliability of other components under these models.

The complete reliance on highly subtle palpatory perceptions inherent in osteopathic cranial palpation may predispose it to misinterpretations and inadequate dissemination of manipulative technique. Considering that psychophysical conceptions can strongly influence sensory experiences, differing palpatory preconceptions will substantially affect the consistency of technique application.[11,27-29]

Although cranial palpation may be considered necessarily variable in response to individual patients, substantiation of some parameters using quantitative methods may aid

in the initial conception of technique application and also improve interrater reliability. Further research is necessary to determine the variables of osteopathic cranial palpation that are amenable to standardization and to evaluate their relative effect on technique performance and interrater reliability.

Conclusion

The present study is the first, to our knowledge, to provide specific data on the palpation pressures used during osteopathic cranial palpation. However, the results indicate that pretest training in a standardized protocol for osteopathic cranial assessment of the frontomalar suture was ineffective in improving the precision of cranial palpation pressure performance by osteopathy students.

Training using quantitative feedback of palpation pressures may convey more precise information regarding technique application and improving practitioner precision. We have planned further research to test this hypothesis. In addition, a study examining palpation pressures used by experienced practitioners is currently being prepared for publication.

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