JAOA ORIGINAL CONTRIBUTION

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

Rafael Zegarra-Parodi, DO (England), MEd; Pierre de Chauvigny de Blot, DO (England); Luke D. Rickards, MOsteo (Australia); and Edouard-Olivier Renard, DO (France), MEd

**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]

From the Research Department at Centre Européen d'Enseignement Supérieur de l'Ostéopathie in Paris, France (Mr Zegarra-Parodi, Mr de Chauvigny de Blot, and Mr Renard), and from private practice in Adelaide, Australia (Mr Rickards).

Address correspondence to Rafael Zegarra-Parodi, DO, MEd, Centre Européen d'Enseignement Supérieur de l'Ostéopathie, 175 Boulevard Anatole France, 93200 Saint Denis, Paris, France.

E-mail: rzp@ceeso.com

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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

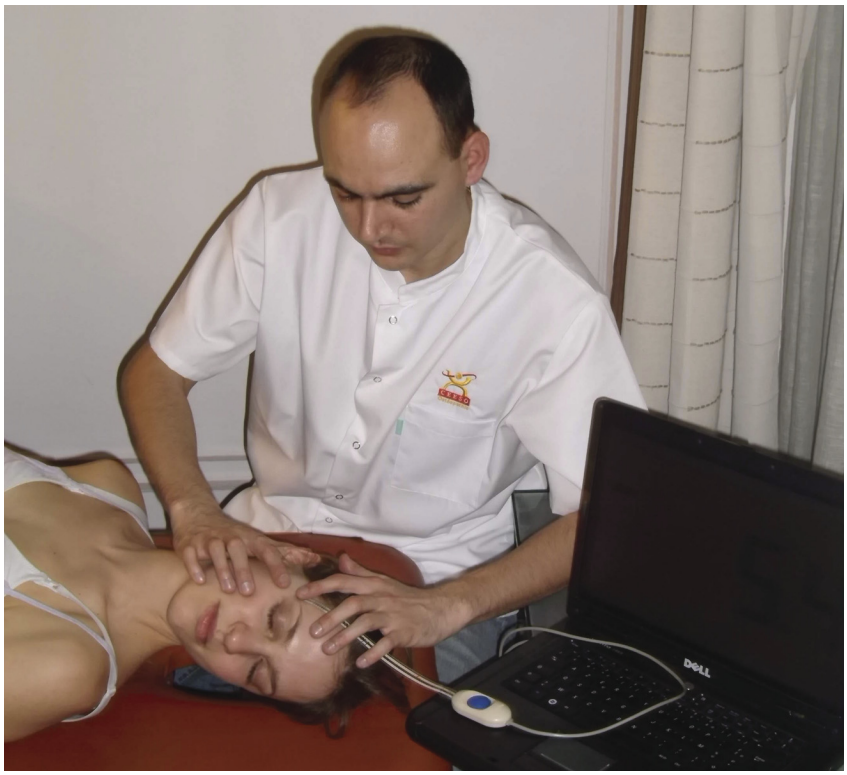


**Figure 1.** *Positioning of the subject, student practitioner, and force sensor during the palpatory test. Although this photograph shows finger positioning on the subject's right frontomalar suture, the palpatory test applied in the present study occurred on the left frontomalar suture.*

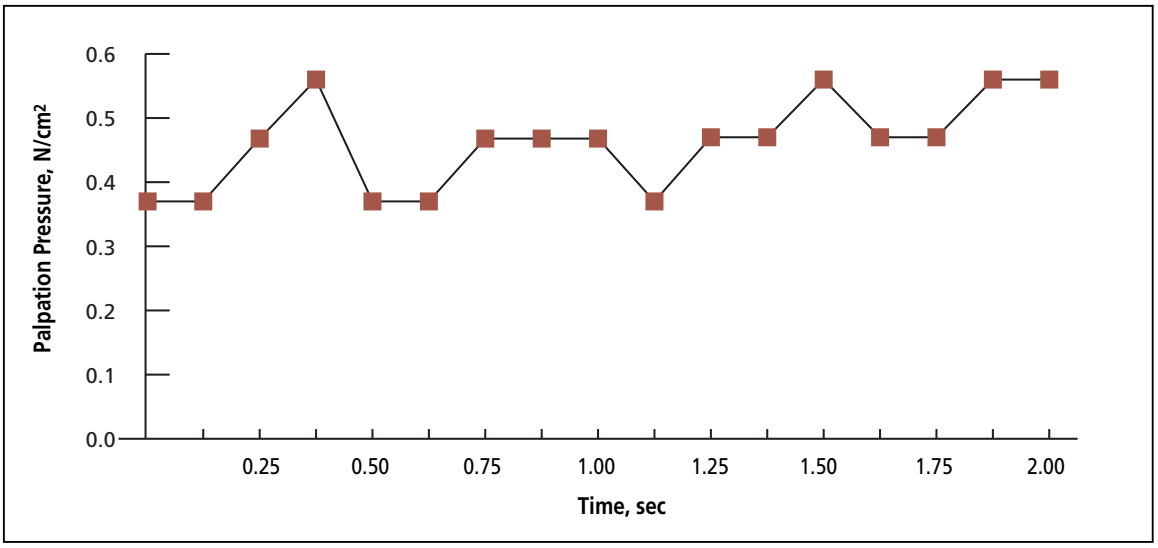


**Figure 2.** *Example of pressure measurements taken by FlexiForce sensor device (Tekscan Inc, South Boston, Mass) during a 2-second test. FlexiForce records the pressure measurement every 0.125 seconds, thus providing 17 pressure measurements for each test.*

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.* ▶

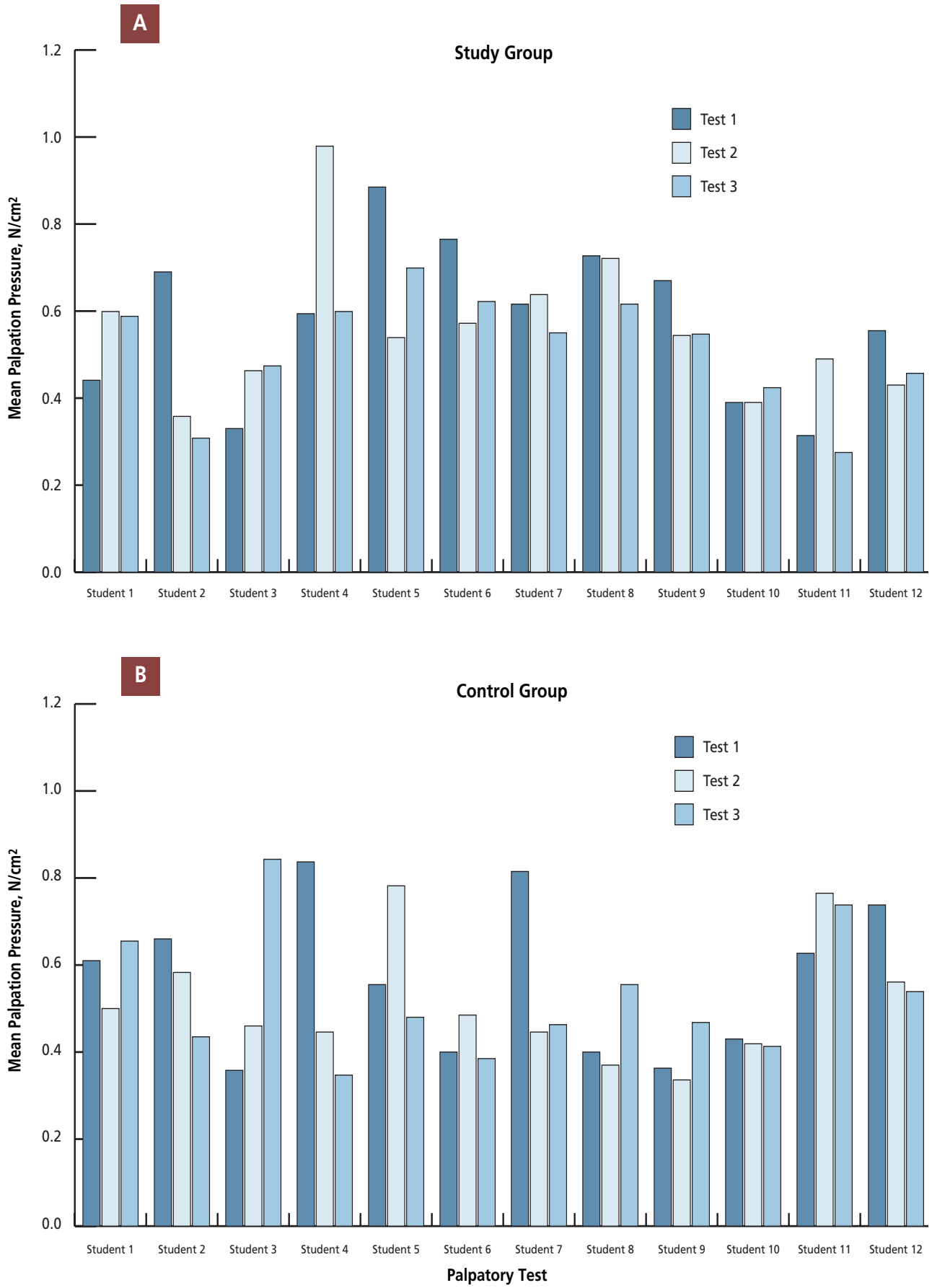
A
Study Group
Test 1
Test 2
Test 3
Mean Palpation Pressure, N/cm²
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
Student 7
Student 8
Student 9
Student 10
Student 11
Student 12
B
Control Group
Test 1
Test 2
Test 3
Mean Palpation Pressure, N/cm²
1.2
1.0
0.8
0.6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