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ORIGINAL CONTRIBUTION

Recording the Rate of the Cranial Rhythmic Impulse

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The rate of the cranial rhythmic impulse can be obtained by both palpation and instrumentation. However, the literature has reported higher rates obtained by instrumentation compared with palpation. The cranial rhythmic impulse has been demonstrated to be synchronous with the Traube-Hering oscillation, measured in blood flow velocity. The current study demonstrates that physicians tend to palpate the cranial rhythmic impulse and Traube-Hering oscillation in a 1:2 ratio. This finding provides an explanation for the difference between palpated and instrumentally recorded rates for the cranial rhythmic impulse.

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The most distinctive contribution that osteopathic medicine has made to contemporary medical practice is the diagnosis of somatic dysfunction and its therapy using osteopathic manipulative treatment (OMT).[1] The techniques associated with osteopathy in the cranial field are possibly the most controversial forms of OMT.[2,3] The core premise of cranial osteopathy, the primary respiratory mechanism, was first described more than 70 years ago.[4] The primary respiratory mechanism is said to function in an oscillatory manner with inspiratory (flexion, external rotation) and expiratory (extension, internal rotation) phases. When palpated on the head, the primary respiratory mechanism is referred to as the cranial rhythmic impulse (CRI). Because of its low frequency and amplitude, the CRI is imperceptible to most untrained observers. Consequently, the sensitivity of palpation necessary to perform cranial diagnosis and manipulation, and the failure of its practitioners to demonstrate interrater reliability,[3,5] has led many to question its validity. Yet, the topic is taught in all colleges of osteopathic medicine, and the American Osteopathic Association's textbook, *Foundations for Osteopathic Medicine*,[6] devotes an entire chapter to it.

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In our endeavors to objectively study cranial osteopathy, we have considered the CRI in the context of other known low-frequency oscillations in human physiology, such as blood flow velocity, also referred to as the Traube-Hering (TH) oscillation. We have demonstrated a statistically significant correlation between the palpated CRI and the 0.10 to 0.15 Hz Traube-Hering (TH) oscillation measured by laser-Doppler flowmetry,[7] and have further demonstrated that cranial manipulation specifically affects the TH rate.[8,9] Moskalenko and Kravchenko[10] reported that cranial manipulation exerts a comparable effect on similar-frequency oscillations (0.12–0.15 Hz) in intracranial fluid measured through transcranial bioimpedence.

The current study compares CRI rates obtained by laser-Doppler flowmetry with those obtained by palpation performed by osteopathic physicians skilled in cranial osteopathy. We sought to elucidate the common discrepancy in data obtained between the two methods when assessing interrater reliability in these measurements.

Methods

Palpation of the CRI by osteopathic physicians skilled in the methods of cranial osteopathy was compared with simultaneously recorded laser-Doppler flowmetry.

Participants

All subjects signed an informed consent form approved by the institutional review board of the Midwestern University/Chicago College of Osteopathic Medicine in Downer's Grove, Ill. Participants were recruited through a sign posted at the Osteopathic Diagnosis, Treatment and Education Service area at the American Osteopathic Association Convention, October 7 to 11, 2002, in Las Vegas, Nev, and at the American Academy of Osteopathy Convocation, March 19 to 23, 2002, in Norfolk, Va. All participants were volunteers, and each participant was used only once during the study.

Examiner participants were osteopathic physicians, and each was asked (1) "Can you palpate the CRI?" and (2) "Would you be willing to compare palpation with laser-Doppler flowmetry?" Each examiner palpated a different subject. Subject participants were osteopathic physicians and osteopathic medical students. Subjects tended to be younger individuals (<35 years) because such persons often demonstrate greater amplitude in the TH component of the flowmetry record,[11-13] facilitating visual comparison between the concomitantly obtained flowmetry and palpation records.

In this study, no consideration was given to the presence or absence of specific dysfunctional cranial patterns in subjects. Because of the ubiquity of these findings, it was felt that such categorization would add an unnecessary layer of complexity to the study protocol and limit the availability of subjects.

Conditions and Protocol

The examinations were conducted in a quiet, curtained-off area (10 × 10 ft) in the Osteopathic Diagnosis, Treatment, and Educational Service provided by the American Academy of Osteopathy at the respective meetings. Before each examination, an adhesive flowmetry probe was attached to one of the subject's earlobes. Following this step, the subject lay quietly on the examination table. It was essential that the probe and leads were free of tension so that earlobe blood flow was not compromised. Relative blood flow velocities were measured by laser-Doppler flowmetry.[7]

Examiners were seated at the head of the examination table and were blinded to the flowmetry recordings. Using light touch,[6] with hands in a contact position of their preference, examiners palpated their subject's CRI and enunciated the letter *f* to indicate a perception of the flexion/external rotation phase of the CRI, or the letter *e* to indicate a perception of the extension/internal rotation phase of the CRI, which was entered into the computer record by the recording technician (T.G.). Continuous recordings lasting 5 to 15 minutes were recorded for each examination, with the recording length determined by the examiner.

Laser-Doppler Flowmetry

The perfusion monitor determines the Doppler velocity change of the erythrocytes in circulating blood, and this measurement is digitized for subsequent data reduction. The device has an optic fiber probe that rests on the skin surface, causing no discomfort to the subject. The flowmeter, data reduction, and statistical methods used in this study have been described elsewhere.[7]

Results

The CRI rate was computed from the records of 44 different examiners, who each palpated a different subject. Flowmetry records were selected for analysis if they demonstrated a strong TH so that the relationships between the palpation events and the flowmetry readings were easily discernable. The portion of each record during which the CRI was palpated consistently, without large gaps in readings, was selected for this computation. The mean rate calculated for the palpated CRI was 4.54 cpm (range, 1.25–8.51 cpm). The SD was 2.08; SE, 0.313; and variance, 4.32.

Comment

Palpation vs Instrumentation

The palpated rate of the primary respiratory mechanism/CRI for normal adults was first reported in 1961 by Woods and Woods[14] as 10 to 14 cpm, and this is the accepted rate described in most osteopathic medical textbooks.[6,15–18] However, since then, studies documenting the rate of the CRI have reported lower rates obtained by palpation[19–22] than by instrumentation[23–26] (*Figure 1*). This discrepancy occurs independently of the method of instrumentation used. Upledger and Karni[23] used plethysmography applied to the arm. This method is also used to record the TH.[28–33] Zanakis et al[24] measured the rate of motion of acupuncture needles implanted in the frontal and parietal bones of human subjects, monitoring reflected infrared light. Lockwood and Degenhardt[25] analyzed data obtained by Fryman,[27] who used a pressure transducer placed on the head. Moskalenko et al[26] measured the fluctuation of intracranial fluid using transcranial electrical bioimpedance. The TH has also been demonstrated in intracranial fluid.[34,35]

The palpated rate of the CRI in the current study (4.54 cpm) is consistent with the lower rates obtained by palpation and reported by previous investigators.[3,19,20,22] If instrumental measurement of the CRI is instead a measurement of the TH, then the discrepancy between the lower rate of palpated measurements and the higher instrumental measurements is explained. The inconsistency between palpation and instrumentation may also be explained by the observation that most examiners in the current study tended to palpate the CRI so that a flexion event was perceived coincident with one TH, and an extension event was perceived coincident with the next TH (*Figure 2*). (Palpation and flowmetry recordings, however, maintained a precise register.) This method resulted in a ratio of palpated CRI to recorded TH of 1:2.

The higher palpated rate (10–14 cpm) reported by Woods and Woods[14] and identified in osteopathic medical textbooks[5,14–18] is consistent with the rates obtained by instrumentation. It is worthwhile to note that, infrequently, an examiner will consistently palpate the CRI at a 1:1 ratio to the TH (*Figure 3*). The reason for this difference in palpation among individual examiners is unknown.

Interrater Reliability

During the recording process for this study, occasional irregularities were observed, resulting in gaps in both the palpatory and flowmetry records. These gaps, in some instances, were reported by the palpating examiners as still points (*Figure 4*), a phenomenon known in the practice of cranial manipulation.[36] When calculating the rate of the CRI, it was necessary that we select the portion of each record where the CRI was palpated consistently, without large gaps between measurements that occurred when examiners had difficulty following the

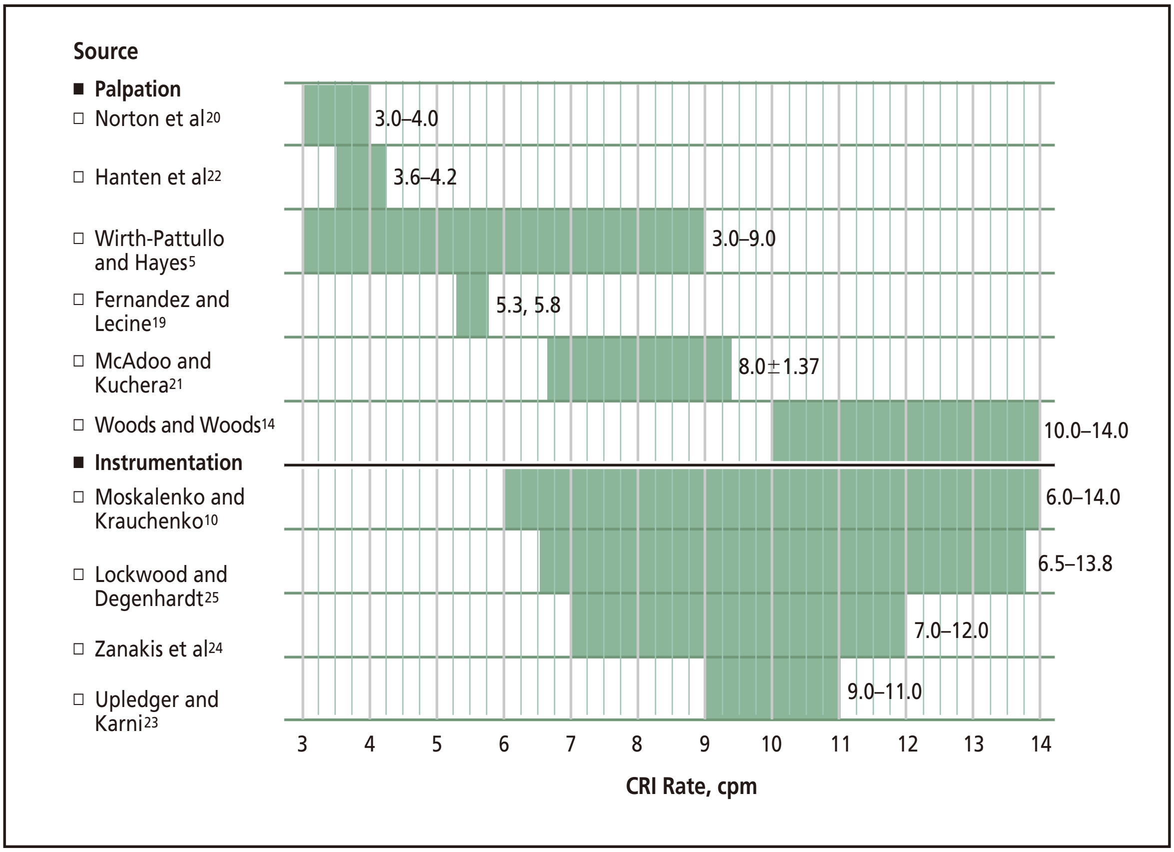

Figure 1. *A graphic representation of quantified rates for the cranial rhythmic impulse (CRI) reported in the literature over the past 45 years. With the exception of Woods and Woods,[14] when palpation is used to obtain data, the reported rate tends to be lower (3–9 cpm) than data obtained by instrumentation of any type (7–14 cpm).*

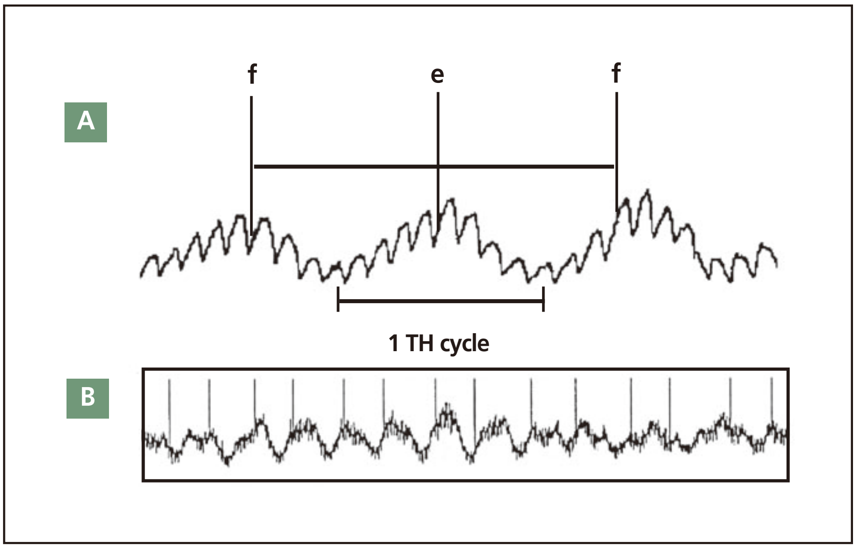

Figure 2. *Palpation of the cranial rhythmic impulse (CRI) compared with the laser Doppler flowmetry (blood flow velocity record) of the Traube-Hering oscillation (TH).* **A**, *The CRI palpation of flexion (f) and extension (e) (vertical event marks) and the TH (oscillating trace) in a 1:2 ratio.* **B**, *Compressed flowmetry record demonstrating the 1:2 ratio. This is the most frequently encountered CRI/TH ratio demonstrated by skilled examiners.*

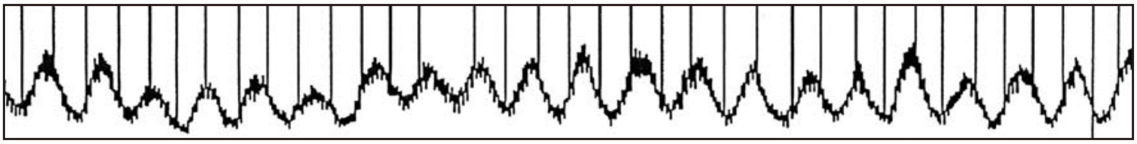

Figure 3. *Traube-Hering oscillation and cranial rhythmic impulse (palpation of flexion/extension) in a 1:1 ratio.*

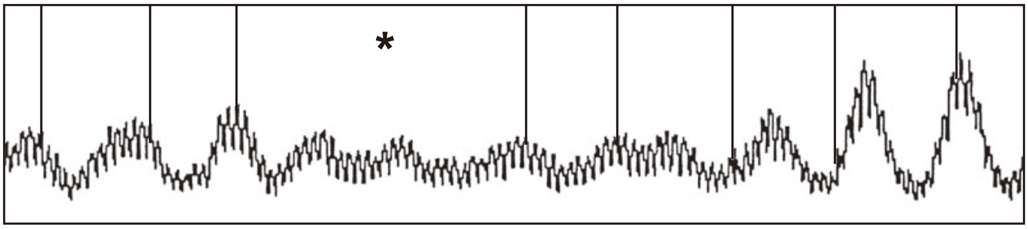

Figure 4. *A decrease in Traube-Hering amplitude coincidental with a gap in the palpation record. Examiners have reported a still point (marked with an asterisk [*]) at such times.*

CRI in a continuous manner. In addition, two sets of researchers[7,25] have noted that the CRI demonstrates a significant frequency modulation that causes the rate to vary rhythmically by approximately 20%.

The irregularity of the palpatory records, the presence of still points, and a frequency modulation of 20% in the rate of the CRI will all contribute to variability in the sequential palpatory records of two individuals tracking the CRI. Thus, sequential interrater reliability becomes virtually impossible to establish. This explanation addresses the inability to demonstrate interrater reliability between sequential examiners but not between two examiners palpating subjects at the same time.

Conclusion

Many low-frequency oscillations in the 6 to 9 cpm (0.1–0.15 Hz) range are found in the human body, such as blood pressure,[28,29,31–33] blood flow velocity (TH),[37] heart rate (R-to-R interval) variability,[38] sympathetic tone in muscle,[38] and intracranial fluid oscillations.[34] These phenomena can be directly or indirectly linked to oscillations in the autonomic nervous system, particularly the sympathetic nervous system. The CRI, with reported rates ranging from 4 to 14 cpm (0.06–0.23 Hz), shares the spectral frequency band with these aforementioned physiologic oscillations. The CRI has been shown to correspond to the low-frequency TH in blood flow velocity.[7] In addition, it has been demonstrated that manual cranial techniques affect TH[8,9] and similar low-frequency oscillations in intracranial fluid.[10] It is naive, however, to therefore draw the conclusion that these measurable phenomena are expressions of the primary respiratory mechanism or even the CRI. Rather, these phenomena offer points of access through which researchers may study the elusive aspects of cranial osteopathy.

Using such access with laser-Doppler flowmetry, we have provided insight into previously unexplained discrepancies in the reported rates of the CRI. In addition, by observing the relationship between the palpated CRI and TH, we have been able to offer possible explanations for difficulties encountered when attempting to sequentially compare palpated CRI rates to establish interrater reliability.

These studies represent only the beginning of the work that needs to be done. Although examiners palpating the CRI maintain precise register with blood flow oscillations measured instrumentally, we cannot explain why most of the osteopathic physicians we studied palpated the CRI/TH at a 1:2 rate, while a small number of osteopathic physicians palpated the CRI/TH at a 1:1 rate. This observation, plus the recognition of palpatory irregularities by examiners and a significant frequency modulation in the rhythm of the CRI provides possible insights into the illusiveness of positive interrater reliability studies. While the impact of cranial manipulation on the TH and the low-frequency oscillations in intracranial fluid have been previously demonstrated,[8–10] the therapeutic value of these changes in fundamental physiology has, however, not yet been demonstrated. It is imperative that this work continue at multiple sites, by multiple researchers using as many different methods of instrumentation as possible if researchers are to answer the questions posed above and quantify the contribution that cranial osteopathy brings to the practice of osteopathic medicine.

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