A Preliminary Single Case Magnetic Resonance Imaging Investigation into Maxillary Frontal-Parietal Manipulation and Its Short-Term Effect upon the Intracranial Structures of an Adult Human Brain

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ABSTRACT
Objective: To investigate the hypothesis that external cranial manipulation can change within the structures of the human brain.
Setting: Single subject.
Participant: An 8-year-old man.
Intervention: MRI scan was administered without manipulative pressure but with the investigator's contact on the subject's maxillary palate and frontal-parietal region surrounding the region.
Outcome: Measurements were taken along the superior border of the corpus callosum, the width of the fornix corpus, the exposed anterior/superior wall of the lateral ventricle posterior to the fornix, the angular surface of the cerebellar central lobule and the posterior surface of the inferior colliculus.
Results: Results from the second MRI (administered during the application of external cranial pressure) demonstrated elimination of a 5-mm peak along the superior border of the corpus callosum and a 4-mm reduction in the width of the fornix corpus. The exposed anterior/superior wall of the lateral ventricle posterior to the fornix corpus increased 1 degree cephalad with manipulative application. The angular surface of the central lobule altered by minus 2 degrees, and the posterior surface of the inferior colliculus varied by minus 7 degrees. The subject experienced no change in his asymptomatic condition as a result of the study.

Conclusion: The current study supports the theory that external cranial manipulation affects the structures surrounding the cerebellum. It also suggests support for the theory regarding suture mobility. (J Manipulative Physiol Ther 1994; 17:168-173.)

Key Indexing Terms: Cranial Manipulation, Cranium, MRI.

INTRODUCTION
Cranial manipulation began with the investigations of the osteopath Dr. William G. Sutherland in the early 1900s [1]. It was Sutherland's hypothesis that the cranial bones functioned independently upon each other and that this mobility was influenced by the alterations of hydraulic pressure generated within the sinuses of the skull. According to his theory, this disruption would affect the environment of the brain and possibly render it unable to function optimally.

In 1933 Dr. Major Delaromte (osteopath, successor and founder of Sacro Occipital Treatment) began his investigations of cranial analysis and manipulation under the condition that, Dr. Delaromte developed the “category system” of analysis and treatment, further enhancing the methodology of cranial manipulation by developing specific manipulative therapeutic approaches appropriate to the different structural categories of the patient. In 1982, Dr. Delaromte (3) first published his manipulation cranial technique and thus began one of the first major integrations of cranial therapy into the field of osteopathy. Since that time, cranial manipulation has gained both favor and controversy within the chiropractic profession.

A major source of controversy is the question of whether cranial manipulation can actually initiate change within the intracranial environment. Dissection observations with the application of external manipulation force, studies utilizing oscillators with electric multipolar transducers to the skull, and evidence from functional magnetic resonance imaging scanning were selected because it is objective, diagnostically accurate and produces a qualitative record. Inspection of the intracranial structures before and during the application of cranial manipulative pressure was thus mapped and recorded on film.

MATERIALS AND METHODS
A 43-year-old asymptomatic male subject, 167 cm tall and weighing 65.3 kg with no prior history of cranial surgery or neurological disorders, was chosen for the study. The subject was informed in compliance with the Helsinki declaration of 1975. The subject was informed of the available risks and benefits prior to the study and gave his consent to participate. A low-field MRI was chosen for its cost effectiveness and easy access to the subject's criterion. A vital element of the magnet's design is its high absolute field homogeneity which renders that of the conventional superconducting magnets useless. Rothschild et al. (7) note that at this field strength, the Ti for soft tissue is considerably shorter than its radio frequency (RF) power deposition and susceptibility artifacts are diminished. Motion and flow artifacts are also reduced. Sagittal MRI images were performed using a First Generation Toshiba Imaging System operating at 2.6 T (Tohiba American Medical Systems, 280 Utah Avenue, So. San Francisco, CA 94080). Data were acquired with a 192 x 256 matrix and two-dimensional Fourier transform. The subject was positioned comfortably in a standard TomTec head coil and the thickness was 10 mm, and a single slice was acquired. Scans were performed with one of the excitation (1 NEX). An echo time (TE) of 30 msec was used. The repetition time (TR) was 150 microsecond, and the total scan times were 0.29 min.

Two investigators were implemented in the study. Investigator “A” gained access to the subject’s parietal/ frontal region through the cephalad opening in the TH. A general contact involving the four metacarpal phalangeal joint regions of the investigator’s left hand was made. Investigator “B” gained access through the cephalic opening of the TH to contact the center of the subject's hard palate with his right thumb. Two mid-sagittal scans were performed. Scan 1 was matched with the investigator's contacts in position. The contacts were light and absent of pressure application. Upon completion of the first scan, the investigators were instructed to apply firm pressure through the contacts toward the opposing contact point. Pressure application was then maintained during the entire duration of the second scan (Figure 1).

Measurements were acquired through the aid of the MRI computer grid which overlays the anatomically correct grid image of the MRI film. The grid overlay on the magnification (MAG) 3.50 images divides the images into three units of measurement. The largest unit is divided into 5 square centimeters. The midrange unit is 1 square centimeter, and the smallest unit of measurement is divided into 2-mm increments overlaying the square centimeter grid. The images set at MAG 1.60 were divided into square decimeters, 2 square centimeters and 1 square centimeter. To measure structures, a single-straight edge paper sheet was placed on the photographic film image and aligned to two prominent points related to the structure in question. A compass needle was utilized to puncture the outer edge of the paper adorning the two points of interest. The puncture points along the paper edge were then aligned to the film grid for dimensional evaluation. Although the MRI grid is considerably smaller than a conventional anatomically correct and measurements are taken from two dominant structural points within the brain, a ±1 mm standard error of mean is considered with each measurement.

RESULTS
In the first scan (performed without pressure application) but with the investigator's hands in contact
Figure 1. Midcortical MRI performed at magnification 1.60; the arrows depict areas of investigation. A. First MRI scan performed with the investigator's hands positioned but without the application of cranial manipulative force. B. Second MRI scan performed during the investigator's application of firm manipulative pressure toward the opposing contact point.

Figure 2. Midcortical comparative measurements of the brain's internal structures taken from images developed in sagittal T1 and T2. A. MRI performed without application of cranial manipulative force: (a) A 5-mm peak is present along the calcarine sulcus of the corpus callosum, midway between the genu and the splenium (Figure 2A). In the second scan (performed during pressure application), the 5 mm peak is absent (Figure 2B).

The right lateral ventricle is exposed anterior and posterior to the column of the fornix. In the first scan, the ventricular opening posterior to the fornix is 8 mm caudal to the posterior apex of the anterior/lateral ventricular opening (ALVO). The posture between the two ventricular openings appears as an anterior to posterior caudal step (Figure 2A). The MRI from the second scan confirms the posterior lateral ventricular opening (PLVO) has elevated to create a visible step in the caudal step in the first scan to a continuous level in the second scan (Figure 2B). The fornix column between the two openings shows a reduction in the length of the fornix column by 4 mm when cranial manipulative pressure is being applied (Table 1). The PLVO appears to have diminished its anterior/posterior passage during the second scan, creating a superior/ inferior elongation appearance when compared with a first scan. A comparative assessment of the PLVO's anterior wall demonstrates an increased length of 2 mm in the application of manipulative pressure (Table 1). Comparative angular measurements of the PLVO's anterior/superior wall demonstrates a cephalad increase (3 degrees) with the application of manipulative force (Table 2). The superior aspect of the great cerebral vein measured 28 mm from the posterior apex of the ALVO in the first scan. Its general appearance is that of flexion toward the fornix column (Figure 2A). In the second scan, the great cerebral vein's superior aspect appears to have extended superior/posterior. However, upon measurement of the distance from the same intercalation mark as utilized in the first scan, the distance increased 28 mm (Figure 2B). The superior cistern and fourth ventricle appear to be well hydrated with CSF in the first scan as some-what dehydrated in the second scan (Figure 2). Investigation of the anterior/posterior walls that make up the inferior region of the superior cistern reveals a change occurring with the application of cranial manipulation. Angular calculations of the anterior wall adjacent to the cerebellar central lobule and the corpora quadrigeminal posterior wall (adjacent to the inferior colliculus), reveal the anterior aspect of the central lobule as altered by minus 26 degrees and the posterior surface of the inferior colliculus as altered by minus 7 degrees (Table 2).

**DISCUSSION**

To support the theory that cranial manipulation will affect the structures of the brain, consideration must be given to the contention supporting suture and independent cranial bone mobility. Without this mobility, the concept of specifically altering the structures of the brain would seem improbable. However, many anatomi- nists are skeptical of this hypothesis because in the traditional theory, the adult cranial sutures are so completely ossified that no movement of the individual bones relative to each other should be considered a physical impossibility (8, 9). Gray's Anatomy 33th British edition went so far as to report that it was clearly necessary that sutures should cease to function as mobile joints as rapidly as possible after birth (10). Despite the traditional theory's acceptance, numerous investigations have accumulated data to support an opposing viewpoint (5, 6, 11–17). Pritchard et al. (18) suggested that sutures possess the mechanics for motion. He also claimed the existence of five distinct layers of tissue present within the sutural system and that the middle layer housed vascular structures. Partially based on Pritchard et al.'s findings, Retzlaff and Michael (5, 6) conducted several investigations into the study of independent cranial bone movements. Although their studies were conducted on squirrel monkeys, they did favorably reflect the theory of natural mobility and independent cranial bone motion. In 1971, Baker (19) cited a case study of an adult male in which he recorded cranial bone motion along the sutures from laterally expanding the maxillary arch. It would appear from these studies that sutures should remain mobile in a healthy individual to allow for protective stress management of the intracranial environment.

The attachment of the dura to the brain structure through anastomosis with blood vessels and cranial nerves is generally accepted. Subordinating this interconnection with the theory that cranial sutures allow for independent cranial bone motion, it would therefore appear plausible that an external application of manip-
This suggests the possibility of altering the volume of CSF and blood through cranial manipulation. The results of both intercranial manipulations play a major role in attaining the functional harmony of the brain, such modifications may even lead to the alteration of neuron function. It is even hypothesized that cranial manipulation is a significant factor in improving a broad number of neurological disorders.

In the present study, further investigations into the validity of gross changes in the brain yield must be established. Further investigations are to be conducted on the functional significance of specific procedures upon the intercranial CSF and blood volume systems. These investigations will open the door to the chiropractic management of diseases as diverse as scoliosis, epilepsy, and hypertension.

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References


