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Cranial Bone Mobility

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Motion of the Cranial Bones

Cranial bone motion has been the most controversial phenomenon of the Primary Respiratory Mechanism (PRM), but there is ample evidence that the cranial bones do rhythmically move a small but definite amount.

Historically, cranial bone motion was considered an anatomic impossibility. Respected scientists, anatomists, and anthropologists have always assumed that the cranial bones fuse and cannot move.

- Most often cited are the works of Bolk,[3] Melsen,[4] Perizonius,[5] Cohen,[6] and Sahni et al.[7]

However, a thorough examination of the experimental data gives a totally different point of view.

- Todd and Lyon's[8,9] study is sited as a precedent for *all* of the aforementioned anthropologists and anatomists (with the exception of Bolk[3]), assuming that cranial bones normally fuse and are therefore immobile.

Upon examination of Todd and Lyon's data, the conclusion that cranial bones normally fuse is certainly in question.

- Dart[10] states, "In interpreting this data, it must be noted that Todd and Lyon were attempting to establish a pattern for 'normal' sutural closure, and they discounted [eliminated] data, due to prolonged sutural patency [non-closure]."
- Singer[11] gives further evidence to doubt the concept of universal sutural fusion. He found a high percentage of specimens with much less closure than Todd and Lyon's.
- Pritchard et al.[12] commented in the 1950s that obliteration of sutures and synostosis (total closure) of adjoining bones, *if it happens at all*, occurs usually after all growth has ceased. In man and most laboratory animals sutures may never completely close.
- Sabini and Elkowitz[13] reviewed 36 human cadaver skulls ranging in age from 56 to 101 years of age, all well above the age when bone growth is complete. Their findings of a significant amount of sutural patency (non-fusion) challenge the theory that all cranial sutures are fused and cannot move.
- Retzlaff et al.[14,15] identified sutural elements contradicting ossification and demonstrated the presence of vascular and neural structures in the sutures. The study stated, "…sutures remain as

clearly identifiable structures even in the oldest samples."

- Retzlaff et al[16] also showed the presence of nerve and vascular tissue large enough to supply connective tissue in the sutures. Nerve endings were traced from the sagittal suture (in the top of the head) to the neck. The existence of these structures within the cranial sutures strongly supports the idea that these sutures remain patent and mobile.

Cranial bone motion in animals is well documented:

- Michael and Retzlaff[17] demonstrated cranial bone (parietal) mobility in the squirrel monkey.
- Heisey and Adams[18-20] demonstrated cat parietal bone motion, in the range of 200-300 microns, induced by laboratory controlled changes in the Cerebro-Spinal Fluid (CSF) volume.
- Jaslow[21] demonstrated in goat skulls (*Capra hircus)*, that patent (non-fused) cranial sutures in adult animals may play a role in shock absorption and re-distribution of forces directed against the skull.

Cranial bone motion in humans is also well documented:

- Frymann[22] developed a non-invasive apparatus for mechanically measuring the changes in cranial diameter. On the basis of her extensive recordings, she was able to conclude that a rhythmic pattern of cranial bone mobility exists and occurs at a rate that is different than that of thoracic respiration. This work was later cited by NASA scientists.
- Heifetz and Weiss,[23] using a strain gauge device, demonstrated cranial vault (bones of the top of the head) expansion associated with a rise in intracranial pressure (ICP) in two comatose patients.
- Oleski and Smith[24] measured pre- and post-treatment changes in cranial bone position utilizing x-ray technology. The percentage of subjects with identifiable changes are:

- 66.6% with the mastoid process
- 91.6 % for the atlas, sphenoid and temporal bones.

There are plans to expand this research utilizing a larger number of subjects.

Russian Space Research

Assessment of cranial bone motion carried out by the Russian cosmonaut programs used various types of radiographic (x-ray) and ultrasound equipment.

- Moskalenko[25,26] first published research on cats in space that described wave phenomenon similar to earlier discussions of "third order waves" in glial cells.

After being introduced to OCF, Moskalenko and associates carried out several studies which illustrated cranial bone motion:

- Moskalenko[27] demonstrated, via NMR tomograms, cranial bone motion between 380 microns to 1 mm, and cranial cavity volume increases by 12-15 mL, with a rhythmicity of 6-14 cycles per minute.

- Moskalenko[28] used Bioimpedence measurements and Transcranial Ultrasound Doppler Echography to show slow oscillations (back and forth motion) of the cranial bones at 5-12 cycles per minute. Moskalenko demonstrated that these oscillations, "…were of intracranial origin and were related to the mechanisms of regulation of the blood supply to and oxygen consumption by cerebral tissue, as well as with the dynamics of CSF circulation."

Together, Moskalenko and Frymann[29] carried this work toward the formulation of a theory that explains the physiology of the PRM.

US Space Research

In the mid-1990s NASA carried out research and developed an ultrasound device using pulse-phase locked loop (PPLL) technology with sensitivity to 0.1 μm, to more precisely assess intracranial anatomy and physiology.[30-34]

- Ballard,et al.[31] carried out a study on two fresh cadavers. Saline was manually pumped into the internal spaces of the brain (ventricles) at a rate of one cycle per second, increasing the Intra-Cranial Pressure (ICP) by 15 mm Hg, and expanding the skull 0.929 mm. These findings were interpreted by the authors as similar to those found by Heisey and Adams,[18] Hiefetz and Weiss,[23] and Frymann.[22]
- Ueno, et al.[32] utilized the PPLL device to demonstrate that "when intracranial pressure increases, arterial pulsation produces a higher amplitude ICP pulsation [stronger]. Increased amplitude of ICP pulsations will be manifested by larger fluctuations in distance across the skull."

In their summary, the NASA research team stated, "Although the skull is often assumed to be a rigid container with a constant volume, many researchers have demonstrated that the skull moves on the order of a few μm in association with changes in intracranial pressure." [33,34]

Recent Osteopathic Research on Cranial bone Motion

When palpatory assessment of cranial bone motion is compared with simultaneous Laser Doppler Flowmetry technology, striking correlations have been found.

- Nelson, Sergueef and Glonek[35-38] report that Traube-Hering and Meyer oscillations can now be assessed. They describe oscillations which occur about 4 to 6 cycles per minute. These oscillations occur at the same time the osteopathic physician reports a certain phase of the cranial bone motion.

Instrument recordings of physiologic activity which correspond to clinical palpatory experience provide strong support for the concept of cranial bone motion and the PRM in general. This line of research is continuing.

Summary

Substantial support for life-long sutural patency and mobility of cranial sutures in healthy human beings is well established within the scientific and medical literature. Cranial bones can move small amounts, and do posses inherent rhythmic motion.

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