Dynamic Chiropractic

SENIOR HEALTH

Craniocervical Syndrome: Its Potential Role in Alzheimer's, Parkinson's and Other Diseases of the Brain

PART I: CRANIAL HYDRODYNAMICS AND THE SUTURES

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The human brain has two drainage routes: one is through the transverse/sigmoid sinus system and into the internal jugular veins; the other is through the occipital marginal sinus system and into the vertebral *venous plexus* (VVP) inside the spinal canal. The internal jugular veins primarily drain the brain in the recumbent position. The VVP on the other hand is preferentially used to drain the brain in the upright position. Some authors refer to this system as the accessory drainage system.

The reasons why the accessory drainage system should be of interest to the chiropractic profession are:

1. The VVP is located inside the spinal canal and stenosis, degeneration and abnormal curvatures of the spine have been shown to affect blood flow in the VVP.

2. The craniocervical spine is the link between the accessory drainage routes and the VVP.

The hypothesis of this paper is that:

1. Less effective designs, aging and injuries of the craniocervical spine and accessory drainage system can lead to chronic normal pressure hydrocephalus (NPH).

2. Chronic NPH can lead to degenerative diseases of the brain, such Alzheimer's disease.

This article covers four parts: 1) sutures of the neurocranium and the role of the craniosacral primary respiratory rhythm (CSPR) in cranial hydrodynamics; 2) upright posture and the accessory drainage system and their role in cranial hydrodynamics; 3) how less effective designs, aging and injury of the craniocervical spine and accessory drainage system can lead to cranial hydrodynamic failure and chronic NPH; 4) how chronic NPH can lead to the type of pathology seen in Alzheimer's disease.

It has been shown that when fish are placed in solutions containing different concentrations of narcotics,respiratory rhythm, pectoral fin and body tail movements become more and more aligned. Eventually, as they approach deep narcosis, the movements become one. Craniopaths refer to a similar fundamental rhythm in humans as the craniosacral primary respiratory rhythm (CSPR).

CSF is driven through the brain by the motility of the nervous system and arterial pulsations. These forces are further amplified by respiratory pressure waves transmitted to the neurocranium. The CSPR is the combination of these three forces working together. Among other things craniopaths maintain that the fluctuations in intracranial pressure (ICP) arising from the CSPR cause the sutures of the human crania to rhythmically expand and contract and that a lack of movement in the sutures is detrimental to human health. This is what prompted my research, so the first part of this article begins with a discussion of the sutures of the neurocranium in humans and other mammals, and the role of the CSPR in cranial hydrodynamics.

I started my research on craniopathy over 15 years ago after a friend referred the late Dr. Harry Shapiro to me. Dr. Shapiro was the former curator of the department of physical anthropology at the Museum of Natural History in New York. I had been studying craniopathy for several years and was eager to discuss what I had learned with such a renowned expert in cranial morphology. While he was fascinated with craniopathy, Dr. Shapiro disagreed with certain beliefs regarding the sutures and deformation of the cranial base.

During one of our many conversations Dr. Shapiro told me that although they showed a high degree of variability, sutures of the neurocranium invariably close with age and tended to follow a general pattern of closure from the front of the skull toward the back, and from the inside out. As far as deformation of the cranial base was concerned, he had published a monologue on artificially deformed crania. He gave me a copy of the monologue and invited me to use the museum's vast collections and resources to do my own investigation. I accepted his invitation and visited the museum regularly over the next several years.

During my time at the museum I had the opportunity to study sutures in hundreds of normal crania. I also studied hydrocephalus, cleidocraniodysostosis, arthritis, and Padget's disease, and artificially deformed crania from Peru and Bolivia. What I observed was contrary to what I had been taught in craniopathy. Not only was it apparent that the sutures of the neurocranium closed with advancing age in healthy human crania, but more importantly, they were open in all the diseased and deformed crania I examined.

In addition to human crania, I also looked at sutures in other mammals. There were many variations, but two mammals were particularly interesting to note. One was the male ape; the other was the whale. Male apes have nucal and sagittal crests of bone that cover their occipital and sagittal sutures. In whales, the bones of the neurocranium tend to telescope over each other, fuse and obliterate the sutures. These findings negated the premise that sutures need to move in order for the CSPR to work effectively, at least in other mammals.

Despite the fact that eventually they do close with age, the sutures in healthy human crania nonetheless tend to stay open, at least on the outside well into adulthood. What set the diseased and deformed crania apart from the healthy crania, however, was that their sutures tended to be open all the way through. What I suspected was that open sutures in the diseased and deformed crania were due to chronic hydrocephalus. Conversely, because healthy crania close on the inside first, it seemed unlikely that they stayed open on the outside as a result of fluctuations in ICP. But it also seemed unlikely that they stayed open on the outside as a result of extracranial stress from neck and facial muscles. If anything, muscular stresses cause bones to develop tubercles, bosses and crests. This raised questions then about what causes the sutures to remain open on the outside while closing on the inside.

Bone is living tissue comprised of a granular substance that models and remodels itself throughout life. Granular substances tend to soften as they deform until the stress is relieved. The outcome of deformity is stress relaxation or creeping, that is, the final shape of the bones causes the stress to drop, but the stress that caused the strain remains and is reflected in the shape of the bone.

In whales, extreme extracranial pressure from deep dives causes the bones to telescope over each other and fuse. In male apes, powerful neck and jaw muscles cause crests of bone to form over the sutures. Both of these types of deformities are caused by extracranial stress. Humans, however, are exposed to much weaker extracranial stresses, so the sutures can stay open longer on the outside and remain unmasked. The wavelike appearance of the sutures of the neurocranium in humans, however, is uncharacteristic of musculoskeletal forces from neck and jaw muscles. Typically these types of forces would cause the type of deformities seen in the male ape. So the next question for me was "What type of stress could cause this type of strain in humans?"

In contrast to adult crania, the sutures and fontanels of the neurocranium in fetuses and infants are wide open and the membranous bones of the neurocranium are completely enveloped by dura mater. More importantly, both the inner and the outer surfaces of the sutures are smooth. This is significant because the CSPR doesn't begin until the first breath is taken. Until then, only the motility of the nervous system and arterial pulsations move CSF through the brain. The CSPR thus has no impact on either the sutures or CSF movement in the fetus.

In contrast to fetuses and infants, the shapes of the sutures in the mature neuocranium are similar to EEGs taken over the same area. That is the occipital-mastoid-lambdoidal suture (which for the sake of brevity I will refer to as the occipital suture), tends to have high amplitude and low frequency compared to the coronal suture, which tends to have relatively high frequency and low amplitude. The sagittal suture, on the other hand, is mixed. For the most part, it typically shows high amplitude and low frequency, but as it approaches the coronal suture it changes to high frequency and low amplitude. The amplitude of the coronal suture on the other hand increases slightly as it gets lower on the skull.

The reticular activating system is the pacemaker of the nervous system and has two parts. One part sends signals down to the body; the other sends signals up to the brain. Together they set the rate and rhythm of the brain, body and cardiorespiratory systems. In lower vertebrates, such as fish, this would be equivalent to pectoral fin, body-tail, and respiratory rhythm mentioned in the beginning of this article. The reticular activating system is thus the pacemaker of the CSPR, and the source of the motility in the nervous system that drives CSF through the brain.

In addition to the effect of the motility of the nervous system on the musculoskeletal system, respiration also causes rhythmical movement in the musculoskeletal system. This movement causes the thoracic cage to expand and contract, and the head and pelvis to nutate. The combined musculoskeletal forces emanating from the motility of the nervous system and respiration are transmitted to the neurocranium.

Respiration also causes pressure waves that are transmitted through the vertebral venous plexus to the dural sinuses. These respiratory pressure waves cause fluctuations in ICP called B waves. It seems likely that these pressure waves are also transmitted to the diploic veins. This would cause fluctuations in intracortical pressure. Because of the curvilinear surface of the cranium, the rhythmical increases in intracortical pressure would cause the sutures to pivot around the inner surface and expand more on the outer surface.

The occipital sutures are most likely a reflection of body and respiratory rhythms driven by the lower portion of the reticular activating system. The coronal sutures on the other hand are most likely affected by higher levels of brain activities such as consciousness and REM sleep whose rate and rhythm are determined by the upper portion of the reticular activating system. These activities typically use fast-twitch eye and facial muscles. The forces coming from both the head and body portions of the musculoskeletal system are then superimposed on intracranial and intracortical pressure fluctuations arising from the CSPR. Together, these forces cause the sutures to develop their characteristic wavelike shape.

The reason why the occipital and sagittal sutures have higher amplitude than the coronal suture is due to the fact that they cover the major drainage routes of the brain. The sagittal suture is over the superior sagittal sinus. This is where blood and CSF are first absorbed by the arachnoid granulations in the dural sinuses to exit the brain. On the other hand, the occipital bone holds the sigmoid sinus and occipital marginal sinus systems, and contains many of the outlets to the accessory drainage system as well. Being located at the top and bottom of the brain in the upright position causes greater hydrodynamic stresses on both of these sutures.

In addition to the effects of posture on cranial hydrodynamics, fluctuations in both intracranial and intracortical pressures further increase the hydrodynamic stresses acting under and within the sagittal and occipital sutures. Moreover, respiratory pressure waves and fluctuations in ICP are most likely responsible for the large-amplitude waves of the sutures. Therefore, the motility of the nervous and musculoskeletal systems, along with fluctuations in ICP arising from the CSPR, are the stresses that cause the strain that results in the characteristic wavelike shape of the sutures of the neurocranium.

In summary, arterial pulsations and the motility of the nervous system are the primary means of moving CSF through the brain prior to birth. The sutures of the neurocranium at this time are smooth on both the inside and the outside. The motility of the nervous system and the arterial pulsations are later amplified by respiratory pressure fluctuations, called "B waves," which begin with the first breath. The CSPR is the combined effect of these forces and is what moves CSF through the brain, beginning with the first breath. The effect of respiration on the amplification of these forces is evident in the sutures of the mature neurocranium, which are a mix of high-frequency, low-amplitude waves and high-amplitude, low-frequency waves. These are especially large in the occipital and sagittal sutures, which are located over the main drainage routes of the brain. This increases the hydrodynamic stress acting on them.

In addition to the CSPR, CSF flow is further enhanced by upright posture. This creates a waterfall effect that siphons both blood and CSF out of the brain. The benefit to both CSF and blood flow from upright posture is further enhanced by an improved drainage plan in humans, namely the accessory drainage system. According to anthropologists, the accessory drainage system is preferentially used to drain the brain in the upright position. Some anthropologists further believe that it contributed to the large size of the human brain by improving both brain blood flow and brain cooling. The question is, what happens if it becomes obstructed?

Obstruction of the accessory drainage system should be of interest to the chiropractic profession because three of the drainage routes used by humans are proximal to the occipital condyles. It is possible then that craniocervical syndromes can lead to obstruction of the accessory drainage system. Furthermore obstruction of the accessory drainage system may lead to chronic NPH, which may lead to the type of pathology seen in AD. This would make the relationship between craniocervical syndromes and chronic NPH in causing AD similar to the relationship between stenosis of the iridocorneal angle, and glaucoma in causing blindness.

Part II of this article will be on the role of the accessory drainage system in stabilizing ICP and brain blood flow in humans and other mammals, with similar hydrodynamic stresses such as whales, bats and giraffes.

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