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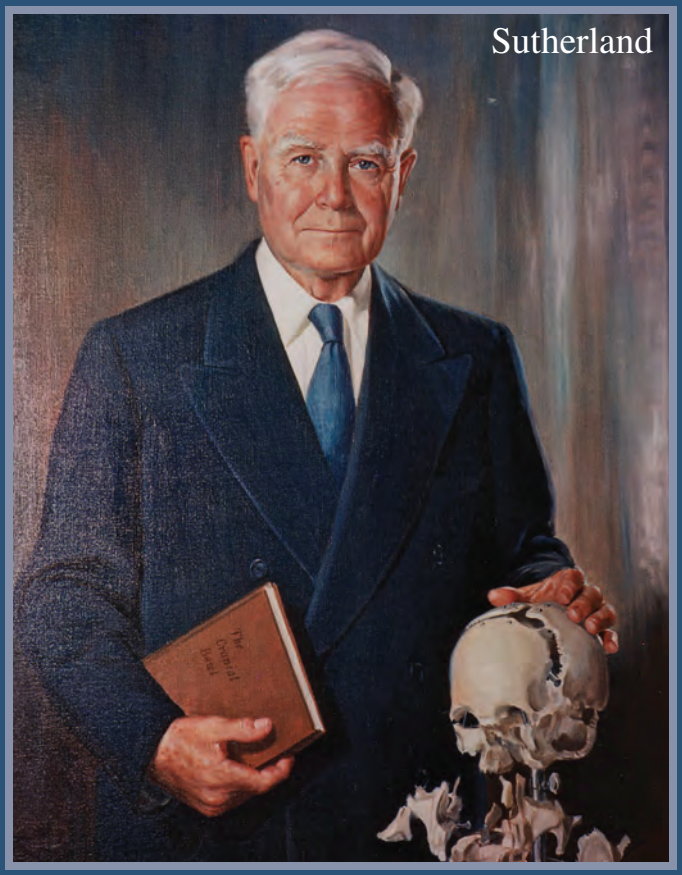

A Comparison of Swedenborg's and Sutherland's Descriptions of Brain, Dural Membrane and Cranial Bone Motion…

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A PEER-REVIEWED JOURNAL

The Mission of the American Academy of Osteopathy® is to teach, advocate, and research the science, art and philosophy of osteopathic medicine, emphasizing the integration of osteopathic principles, practices and manipulative treatment in patient care.

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Dr. Swedenborg's picture:
Courtesy of The Swedenborg Library, Bryn Athyn, Pennsylvania
Dr. Sutherland's picture:
Courtesy of The Cranial Academy

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What is the mechanism of action of the Primary Respiratory Mechanism? Is the Cranial Rhythmic Impulse driven by a plunger mechanism? The author analyzes this system and explores its action. She carefully reviews the anatomy and embryology to further our understanding of this mechanism. **(p. 9)**

David B. Fuller, DO, FAAO, A Comparison of Swedenborg's and Sutherland's Descriptions of Brain, Dural Membrane and Cranial Bone Motion

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Christine Lerma BS, OMS V, Michael Mesisca BS, OMS IV, and Raymond J. Hruby, DO, FAAO, MS, A Case of Recurrent Urinary Tract Infection

The authors discuss the musculoskeletal component of visceral disease as exemplified by a patient with urinary infections. They explore the benefits of a multifaceted approach and the role of traditional osteopathic care in this patient group. **(p. 30)**

Regular Features

DIG ON. Thomas McCombs, DO, Sarah Towne, DO of Touro University-California, and Michael Treece, MD of St. Lukes Hospital, San Francisco, CA look at the work of Poiseuille (1846) who described the variables that affect the flow of fluid through a tube. They propose that a change in diameter of chest cage will change the diameter of airways and blood vessels within the chest. These changes in diameter may be achieved by OMT and as a result, will have changes on airflow and blood flow. **(p. 5)**

FROM THE ARCHIVES. Thomas L. Northup, DO, was one of the founders of the AAO. He is honored each year by the T. L. Northup Lecture. The most recent lecture given by Hollis King, DO, FAAO, was published in the previous issue of the AAO Journal. Dr. Northup wrote about several areas of clinical interest. In this issue we read about the importance of the feet in *Modern Foot Problems.* This article was written in 1942, published in the *Journal of the American Osteopathic Association* and reprinted in *The Northup Book* published by the AAO in 1983. **(p. 6)**

BOOK REVIEWS: Bernard Rimland, PhD, was one of the first modern researchers in Autism. In this book, *Dyslogic Syndromes,* he reviews the increase of Autism and explores the causes of the disorders that constitute Dyslogic Syndromes. He presents his recommendations for treatment at the individual and societal levels.

Bottom Line's *Ultimate Healing World's Greatest Treasury of Health Secrets Volume II* and *More Ultimate Healing* are two books from Bottom Line Books® targeted to the general public. They explore a variety of topics of interest in our patients. See what their assembly of experts advise! **(p. 37)** ❒

View from the Pyramids

Robert C. Clark

This is the first issue in which we try our experiment of not defining selected abbreviations and acronyms. The first article to do so is the student paper: A Case of Recurrent Urinary Tract Infection. The box shows the terms selected for this experiment. Readers are invited to advise the editor if this is a worthwhile endeavor.

Commonly used abbreviations and acronyms in *The AAO Journal:*

American Osteopathic Association (AOA)
American Academy of Osteopathy (AAO)
Osteopathic Manipulative Medicine (OMM)
Osteopathic Manipulative Treatment (OMT)
Osteopathic Principles and Practices (OPP)

This is a peer-reviewed journal. Readers might like to know who does the peer review and what is subjected to peer review. The Editorial Advisory Board is the primary group of peer reviewers. The editor will ask other AAO members to do peer review of selected articles if he feels the invited reviewer has special expertise in content realm of the article.

The AAO Fellowship Committee reviews all papers that are submitted by the applicants for the Fellowship in the American Academy of Osteopathy. This review constitutes peer review. However, these papers are still subject to the same editing process that all other articles and papers receive.

Beginning with this issue, student articles will be peer-reviewed by members of the Editorial Advisory Board. At the AAO convocation, the Publications Committee considered this issue. The committee felt that peer review of student papers is in keeping with the long term goal of progressively improving the quality of the AAO Journal.

Some parts of the journal do not receive peer review and they are: View from the Pyramids, Dig On, Book Reviews, From the Achieves and Elsewhere in Print. These items are editorial or reportage in nature and do not necessitate peer review. ❒

Dig On

"Poiseuille's Panacea": a New Direction in Osteopathic Manipulation of the Thorax

Thomas M. McCombs, Sarah Towne, Michael Treece

Poiseuille (1846) described the variables that affect the flow of fluid through a tube. While most variables (tube length, fluid pressure, viscosity) affect the flow in a linear relationship (double the tube length and the pressure must double, or the flow will cut in half), one variable stands out: **the radius of the tube affects the flow to the 4th power. If the radius is doubled, the same flow can be maintained with *one-sixteenth* of the pressure**. This identifies the radius as the pre-eminent factor to address in a broad variety of clinical diseases: Asthma, Hypertension, Pulmonary Hypertension, Atherosclerosis and Chronic Obstructive Pulmonary Disease. Pharmacotherapy for these conditions emphasizes the dilation of blood vessels and airways. We propose that increases in the radius of blood vessels and airways can also be obtained through manipulation: specifically by manipulation that expands the anatomic structure containing the vessels/airways. An expansion of the thorax, therefore, should translate to proportional increases in all the vessel and airway lumens within the thorax. This would result in measurable improvements in airflow & blood flow. We suggest that the benefits of this approach go beyond those obtained by traditional OMT directed to restore costo-vertebral motion.

A treatment protocol was devised and a preliminary trial was conducted on students recruited from the Touro University College of Osteopathic Medicine – class of 2010. Measurements of thoracic circumference were made at the 10th thoracic segment/xiphoid process. Peak Expiratory Flow was measured with a hand-held Peak Flow Meter.

The OMT protocol was first given by experienced practitioners. This resulted in an increase of the first subject's thoracic excursion by 4.5 centimeters (cm), and his "easy normal" by 2.8 cm. His peak flow increased by 10 liters/minute. This is considered clinically insignificant in an asymptomatic subject. One week later, the subject had lost 1.1 cm of "easy normal" circumference, maintaining 1.7 cm of the 2.8 cm increase gained through OMT.

When students treated each other, gains in thoracic circumference were less than those obtained by practicing clinicians. In some cases, the students' treatment reduced thoracic circumferences. The greatest gains were obtained by those students most practiced in the techniques.

The 3.3% increase in "easy normal" circumference would, if proportionally translated to increases in the lumens of his thoracic vessels & airways, reduce the pressure within them (or increase the flow through them) by 13%. In a patient who is ill, such a change could make a critical difference in the patient's flow rate and volume. The clinical experience at St. Lukes Hospital supports the view that these structural changes are both possible and beneficial.

Measurements of thoracic circumference are less reliable than expected. Further studies will be monitored by spirometry and this should more reliably document the benefits of OMT for thoracic expansion, especially in the ill.

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From the Archives

Modern Foot Problems

Thomas L. Northup

In the two or three decades just passed, there has been a gradual but definite change in the problems of foot health.

The public long since has begun wearing a great variety of footwear instead of the old custom of one pair of Sunday shoes kept for "best" to go with the dress-up clothes, and a pair of everyday shoes that once were new and shiny.

A generation ago, Dr. Marshall of Boston, an outstanding orthopedic foot specialist, required that his patients have six pairs of shoes, all correct, but all slightly different, and that they should change their shoes three times a day. This gave the foot a variety of footwear that prevented fixation, which often developed from the continuous use of one pair of shoes.

Dictates of fashion are stronger than the admonition of any group of doctors and there are two things, which have had much to do in bringing about this change. One is the trend to sport activities and the use of suitable footwear adapted to each sport, and the other is the modern tendency to wear comfortable clothing in place of the conventional clothing of former times.

Corns, calluses, and bunions are giving way gradually to this program of more comfortable shoes, and while they are still with us in our older patients as a result of former abuses, I am sure that the coming generation of elderly people will suffer less from these conditions on account of our better knowledge of correcting first causes. No single factor is more important in the preservation of normal feet than comfortable footwear of a wide variety and selected for the various activities.

There are many conditions of foot weakness that are the direct result of low-back troubles which so weaken the muscular supports of the arches of the feet that they sag and the feet become painful. While the pain and symptoms of fatigue are in the feet, the real cause of the trouble is in the low-back region. This possibility should be called to public attention frequently so that the condition may be remedied before pathologic changes in the foot structure have taken place.

Probably one of the best safeguards of public health would be the periodic examination by school physicians, preferably osteopathic, of the children's posture and body mechanics. This would bring to light trouble in the feet and the lower spinal segments. Painful feet certainly may cause many conditions of malfunction in other parts of the body through the reflex nerve connections with remote organs. An eyestrain, for instance, may be due to fallen arches.

The public is being reminded constantly in one way or another of the advantages of periodic examinations, but I submit that the most effective argument for osteopathic foot care is the examination of every pair of feet that comes into our office. The detection of failing foot function in its beginning stages, perhaps before the patient is aware of symptoms, and an explanation of the tie-up between foot health and general well-being, often will demonstrate the superiority of an osteopathic physical examination.

Now let us take up the more practical discussion of these early symptoms of modern foot trouble. We may pass by the consideration of local traumatic foot injuries as indicating their own treatment and start with a consideration of the relaxed foot which, if neglected, will develop progressively into a completely broken-down foot. To do this we first should review briefly the mechanics of the foot and leg.

Probably the best order to follow in making a practical check-up is to examine the patient with shoes off, standing, forward bending, walking, sitting, and lying on the back. Every abnormal condition, lesion, limited motion, malformation, and every evidence of strain or irritation should be written on the case record.

A very careful analysis of the framework of the body from the level of the sixth thoracic vertebra down is essential, including notation of any imbalance originating in the lower torso. A contracted psoas or quadratus lumborum muscle will so twist the pelvis out of alignment as to change the balance of the weight supported by each leg and foot and greatly influence conditions developing in either foot. The heavy muscles at the hip may have an influence on posture equal to those of the low-back region. The adductor muscles under the influence of the oburator nerve also can so disturb the balance that in the standing position more weight is carried by one leg than by the other. The muscles of the leg below the knee require very special study in connection with the foot, since every leg muscle except one ends in long tendons, which extend beyond the ankle and attach to hones of the foot.

When the patient is standing in the first examination we should notice the condition of the arches and the position of the feet. If the feet have a tendency to eversion and pronation, the trouble may be in the feet alone or it well may include trouble at the knee and hip with contributory influence coming from as high as the lower thoracic segments. Body posture may be an important consideration.

When we come to structural examination of the feet

themselves, the stockings should be taken off and the feet examined under good light so that the skin texture may be observed. Dry skin as well as perspiring feet suggests disturbance in the sympathetic centers in the lower thoracic and upper lumbar region and should be noted. Every articulation in the bony structure of the feet and legs should be tested for motion and tenderness. The tone of the soft structures should be noted. It is possible only in a general way to describe abnormal conditions, but by careful examination and palpation of each pair of feet that comes into our offices may we become capable of making a reasonably accurate evaluation of foot conditions. A careful examination of the muscles of the legs, which by their long tendons support and control the feet, is very important. A hypotonic condition may account for continually recurring foot lesions and certainly would indicate either prolonged strain from weight imbalance or insufficient muscle tone due to impaired sympathetic nerve supply.

The normal tone of the leg muscles which through their tendons support the foot structures, if in perfect balance, will maintain a perfect arch construction and if we study the direction of the forces applied we will find that they all tend to bind the foot into a single arch of flexible construction with the long and short plantar ligaments acting as a check on the spreading of this arch. A study of the size and strength of the bones of the feet will give us a good idea of which is less capable of bearing the load and a longitudinal section of the bones will show the lines of force that pass through it. A thorough study of the anatomy and the mechanics of the muscles of the leg and foot is necessary, particularly of the muscles that work against each other in pairs, as the extensor longus digitorium and the flexor longus digitorium controlling flexion and extension of the four outer toes.

The tibialis anticus, the tibialis posticous and the peroneus longus act as a combined support for the tarsus. The tendon of the peroneus longus extends under the cuboid and passes forward and across under the cuneiform bones to attach to the base of the first metatarsal and internal cuneiform. It acts with the tibialis anticus as a swing support and binder for the transverse arch. The tibialis posticous, through its tendon which passes behind the internal malleolus, is inserted directly to the tuberosity of the navicular, to the under edge of the anterior portion of the sustentaculum tali, and to the tinder surface of all the tarsal bones except the talus, as well as to the under surface of the base of each metatarsal.

The strongest flexor muscle of the foot is the flexor halluces longus, which arises from the lower two thirds of the posterior surface of the fibula. Its tendon passes down a groove on the posterior surface of the distal end of the tibia, enters a groove on the back of the talus and winds under the sustentaculum tali in such a way as to exert the most positive support for the tarsus; it then extends forward to be attached to the base of the last phalanx of the great toe and also sends slips to the tendons of the flexor digitorum longus which go to the second and third toes. It is interesting to note that this muscle to the great toe is a larger and stronger muscle than the flexor longus digitorum, which serves all of the outer four toes.

General relaxation with loss of muscle tone and impaired nerve function is the first step in the gradual breakdown of the foot. The structures involved, in addition to the bony framework, are the plantar fascia, the plantar ligaments and the inferior calcaneonavicular ligament, as well as the muscles controlling the inner side of the foot. These are all stretched by the excessive strain thrown upon them. This is generally a bilateral condition, although the degree of strain and discomfort will seldom be the same in both feet. Gradually and progressively the ligaments and muscles supporting the foot structure become too weak to carry the load of the body weight.

The degree of collapse varies according to the degree of disproportion between the strength of the weight-bearing structures of the foot and the weight imposed upon them. At first upon the removal of the weight the foot regains its normal outline, but as the condition progresses the foot will he held in the deformed position by accommodative changes in bones, muscles and ligaments.

From the beginning the leg is displaced and rotated inward and the foot rotated outward and everted so that the weight is thrown upon the inner side of the foot and the line of body-weight falls mesially to the great toe, instead of through the center of the foot. The changed line of weight-bearing causes the os calcis to tilt inward, carrying with it the talus whose head rotates and slips downward and inward, forcing the navicular in front of it, which, in turn, forces the three cuneiforms downward, inward and forward resulting in a general depression and bulging of the inner side of the foot.

The cuboid follows the changed position of the os calcis and rotates on its long axis and approaches the ground, lowering the outer portion of the transverse arch. As the tarsus rolls inward and flattens, the metatarsals and phalanges are still further abducted, increasing the already abnormal condition. This strained condition does not end in the foot, but is carried from the ankle and foot up to the head of the fibula, which is usually found to be posterior. It is evident that any one or all of the tarsal articulations will be in a state of mechanical derangement.

In the normal foot each metatarsal head is a point of contact acting as a shock absorber or as a spring under a car, and the fleshy pads under these points correspond well in action to the air-inflated tires on which we ride.

Weight-bearing points should make way in our thinking for weight-bearing surfaces, for really the most pathological condition we have to deal with in foot troubles consists of points of positive weight-bearing, unyielding on account of some fixation at some articulation in the foot or due to some constant muscle pull, or the weakening of some muscular supports throwing extra strain on others.

In normal walking and running all mechanical principles are employed to carry the body load smoothly without any jar from the contact of the feet with the ground. The flexed knee suspends the weight on the tonically contracted muscles of the thigh and leg, and the flexible foot carrying the load smoothly forward is suspended from the muscles of the leg by their tendons attached to the bones of the foot which support the arches' yet maintain them in a flexible condition. The posterior pillar of the foot, and tuberosity of the os calcis, is suspended from the gastrocnemius and soleus muscles by the tendo Achillis.

→

The entire tarsus is supported on the tendons of the tibialis posticous, flexor digitorum longus, flexor halluces longus and peroneus longus. The foot yields slightly as the knee straightens and the body load is carried forward and then with increasing rapidity the heel is raised and the foot flexed with a sharp propulsive force as the weight is transferred to the other foot. One may best understand foot mechanics by noting the action of his own feet. With light slippers or in stocking feet one should try the various steps and notice where he feels-the forces in his own feet.

Weight distribution through the bony structure of the leg and foot is fairly easy to trace. The tibia rests on the talus; the talus in turn rests on the calcaneus and articulates with the navicular or scaphoid through which forces are transmitted to the first three metatarsals through the three cuneiform bones. Other lines of force flow through the calcaneus to the cuboid and the fourth and fifth metatarsals.

Forces originating in muscle tissue and applied to the bony structure by tendons are not so easy to trace. There are two principles to be kept clearly in mind. First, fixed position is maintained only by an exact balance between two or more opposing forces. Second, results when unequal forces are opposed and the strength of the movement is governed by the degree of difference in these forces.

Muscle tone is controlled by the autonomic nervous system and muscular activity is governed by the motor nerves. Normal nerve and muscle vitality and strength are requisite to normal feet and normal foot function.

One of the most efficient ways of guarding the feet of the present generation is to see that nothing interferes with their normal activity. One of the most often overlooked restrictions of normal foot functions is a high spot in the inner sole of the shoe under the base of the fifth metatarsal. Like a boulder in the edge of a stream it deflects the current. In the stream the water is forced to the opposite bank. In the foot the whole foot is tilted to the inside, throwing unnatural weight on the inner side of the foot. The foot is forced out of balance and the muscles that support the transverse and longitudinal arches are put continuously on excessive strain. The first metatarsal pulls away from the second for a better balance and the restraint of the shoe causes a buckling of the first toe joint. The result is a beginning hallux valgus or bunion.

Marvelous improvements have been made in footwear in recent years and I am convinced that as the shape of the last approaches the shape of the foot, particularly on the bottom or weight-bearing surface, and the public becomes willing to allow competent shoe men to fit their feet correctly and with shoes that are large enough to allow free flow of weight through the foot, it will not be necessary to make shoes so heavy or to put so much bracing material into them. The public is demanding lighter shoes and they are buying cheaper shoes to get them. The shoes made in cutout patterns are doing much to correct the tread base of the last for these shoes must balance the foot evenly or the girls would fall off their high heels.

Conclusion

Every patient who comes into our offices should be checked for foot troubles and body imbalance. If it does not seem wise or expedient to follow up this part of the examination on the first visit, it should be mentioned as advisable and noted on the case record for further consideration.

The importance of all this is well summed up in the statement of the late Dr. Carl P. McConnell who said, "Physiologic equilibrium depends on the wholeness of structure-all parts and functions being interrelated. Therefore we should make sense of the whole body, not of a part." We should consider feet as important units of the body structure and worthy of our constant consideration.

Like the cracks in a great building, irritating nerve impulses, produced in feet by fallen arches or trauma, extend upward, and reflexly may affect the function of any other structure.

If those of us who are in general practice are convinced that feet are worthy of our attention, is it enough to learn the anatomy of the foot from books and take a few courses in foot manipulation? The answer is, obviously, no. We must, of course, know the anatomy, but that must be followed by knowledge that only comes by palpation of many feet and by learning the feel of the tissues.

We must know the feel of the tissues, both normal and pathologic, and we must know the normal motion and be able to detect any limitation or exaggeration of motion in any of the many joints. We must have mastered enough good foot technic to make such corrections as are necessary. I do not believe any one set of foot manipulations will fit all cases any more than a set of prescribed brush marks will paint a beautiful picture. We must first visualize what is wrong and then apply the forces necessary for the correction, just as a painter must have a conception of a picture in his mind and then mix and blend his colors.

Proper foot balance in comfortable, well-fitted shoes, which allow normal foot activity will prevent the development of a very large percentage of foot ailments and greatly assist in the correction of those conditions, which already exist. Those of us in general practice cannot afford to neglect feet for they are in a large measure at least, "The Foundation of Health" and good shoes carefully selected and correctly fitted are "Guardians of Health."

The osteopathic physician who is going to do more than just give routine "treatments" on request, who is going to make a definite structural study of his cases, who is determined to get at first causes, whether he is dealing with general conditions or is in any one of the special fields of osteopathic work, should give the foundation of the body structure more than passing consideration. He should-learn to translate subjective symptoms by palpation into objective symptoms. He should learn to interpret the "feel of the tissues" as diagnostic information. He should be able to make a thorough osteopathic diagnosis. He should not forget the feet.

*Delivered before the General Sessions at the Forty-Fifth Annual Convention of the American Osteopathic Association, Atlantic City, June 27, 1941.

{Reprinted from the *1983 Yearbook of the American Academy of Osteopathy, The Northup Book, A Memorial Tribute to Thomas L. Northup, DO*, Indianapolis, IN. 1983. pp 99-101} ❐

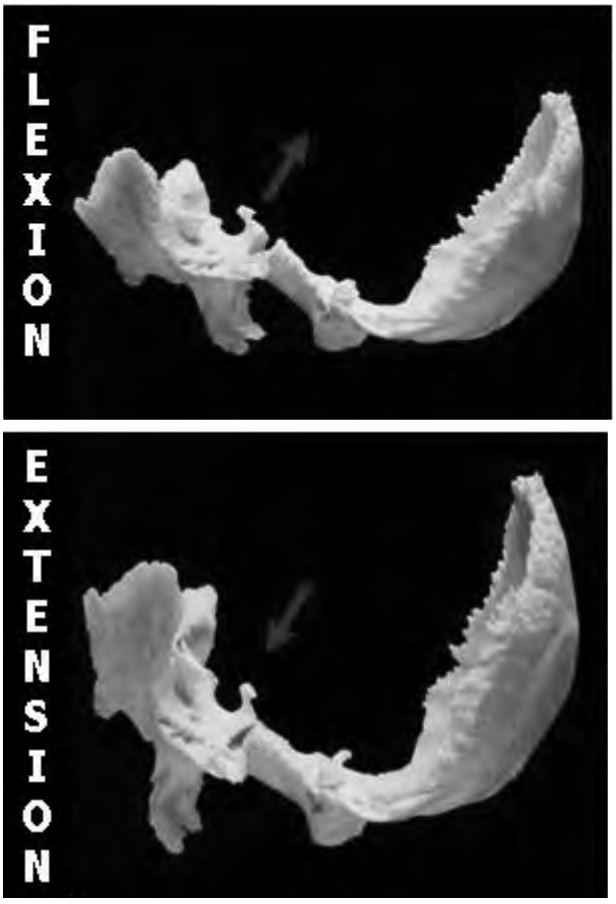
The Cranial Plunger Theory

Denise K. Burns

Osteopathy in the cranial field (OCF) is used for the diagnosis and treatment of disease. It is a form of fascial release that attempts to balance forces of the five elements, as proposed by William Garner Sutherland.[1] Dr. Sutherland was a student of Dr. Andrew Taylor Still at the American School of Osteopathy. His teachings are a direct extension of the principles of Osteopathy taught by Dr. Still himself. These principles are: the body is a unit, the body has self-healing and self-regulating properties, structure and function are reciprocally interrelated and rational treatment is based upon these principles. Dr. Sutherland noticed while observing a disarticulated skull, the beveled articular surfaces relative to the greater wings of the sphenoid and the squamous portions of the temporal bone. He surmised that the cranial sutures were conducive to motion and studied this concept over many years. Self-experimentation and countless hours of analyzing proved to be insightful in his quest for truth. Dr. Still named this cranial occurrence as the Primary Respiratory Mechanism (PRM).

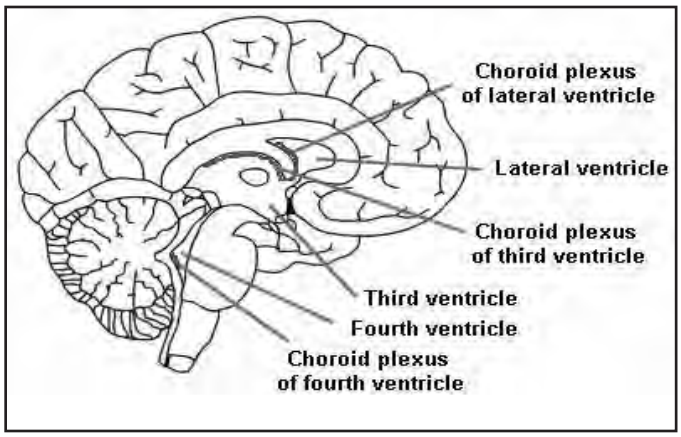
There are five involuntary components associated with this mechanism: cerebrospinal fluid motion, inherent central nervous system motility with membranous motion, cranial bone motion and sacral bone motion.[2] R.E. Becker summarizes in *Osteopathic Annals* that health requires that the PRM have the capacity to be an involuntary, rhythmic, automatic shifting suspension mechanism for the intricate, integrated, dynamic interrelationships of its five elements.[3] Numerous research studies have been done to support the existence of one or more of these cranial phenomena. Mobility of the cranial bones was studied by Heisey and Adams showing the role of cranial suture compliance in defining intracranial pressure.[4] Lassek et al described the brain as being "vibrantly alive, incessantly active, highly dynamic and mobile". Many scientists utilized magnetic resonance (MR) to analyze cranial motion. Greitz et al mounted definitive evidence on cranial motion presence offering diagrams of the brain movement and descriptions of small amounts of motion in certain areas of the cranium in the ranges of 1.0mm to 1.5mm.[5] Moskalenko and associates showed the subtle presence of cranial bone motion.[6] Poncelet and Wedeen studied brain parenchyma motion and found that brain motion appeared to consist of a single displacement in systole followed by a slow return to the initial configuration in diastole.[7] Feinberg and Mark did research on human brain motion and cerebrospinal fluid circulation. They reported that the velocity in the anterior cortex and corpus collosum as 0.4 ± 0.25 mm/sec and in the basal ganglia and foramen of Monroe as 0.63 ± 0.5 mm/sec.[8] Research by Hyden showed that glial cells contain actin and myosin which are capable of inherent contractile motility.[9] Nelson, Sergueff and Glonek's research linked the palpatory experience to actual physiologic activity of the central nervous system (CNS).[10] Frymann developed a non-invasive apparatus and mechanically measured cranial diameter changes.[11] Woolley and Shaw noted rhythmical contractions of the oligodendrites of the neurolglia.

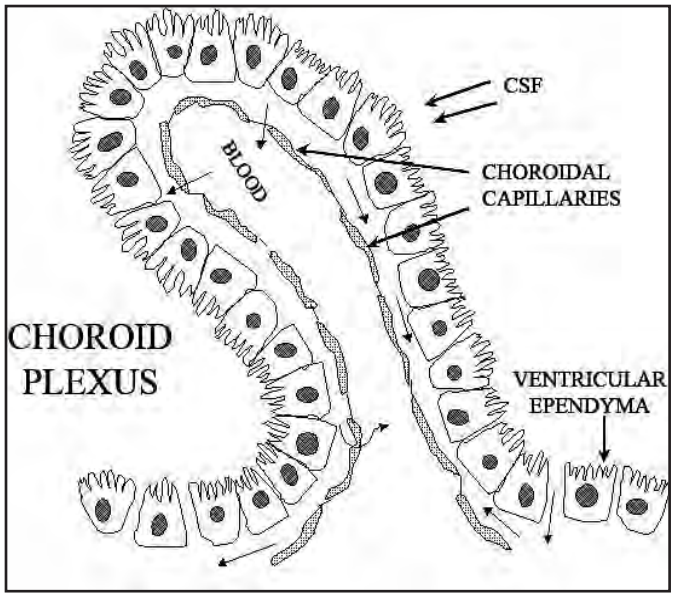
The PRM has been associated with two phases of cranial motion: cranial flexion, an inhalation or "expansive" phase of the cranium and cranial extension, an exhalation or "receding" phase of the cranium. These phases occur rhythmically, approximating 10-14 times per minute.[12] During cranial flexion there is a myriad of cranial anatomic dynamic changes that occur simultaneously. The midline skull bones flex and the paired bones externally rotate. The foramen magnum moves superiorly, drawing the sacral base posterior by means of a dural attachment at the second sacral segment.[13] A rise at the spheno-basillar-synchondrosis (SBS) occurs.[14] The transverse diameter of the skull increases with a decrease in the anterior posterior (AP) and vertical diameters of the skull.[15] The dural membranes alternate in shape.[16] With cranial exhalation, the reverse occurs. This intriguing process sustains a rhythmic contraction and expansion of the brain and spinal cord. This mechanism can be palpated throughout the entire body. From this mechanism, CSF flow can be altered

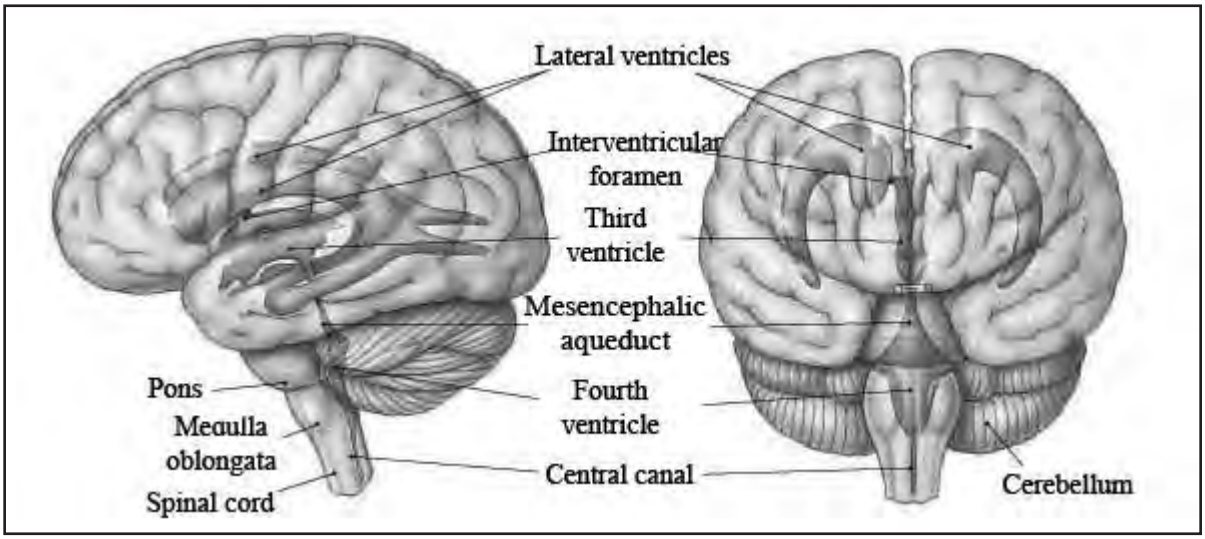


rhythmically with a "to and fro" fluid process occurring. This motion can be likened to the sea and its tide. Sutherland used the term "tide" to describe the inherent fluctuation of fluids in the Primary Respiratory Mechanism. "Tide" alludes to the concept of ebbing and flowing, but also the contrast between waves on the shore having one rhythm, with the longer rate of lunar tides below. The tide incorporates not only fluctuation of the CSF, but of a slow oscillation in all the tissues of the body, including the skull. The postulated intracranial fluid fluctuation has been described as an interaction between four main components: arterial blood, capillary blood (brain volume), venous blood and cerebrospinal fluid (CSF). The CSF brings the "breath of life" to the cells in the same manner as the rain brings life to all livings things. CSF is the "rain water" of the body. It showers the CNS with nutrients and sweeps away debris. Sutherland described the breath of life as an acknowledgement of this vital life force as a fundamental aspect of the osteopathic philosophy. CSF is a vital substance to sustain health and homeostasis.

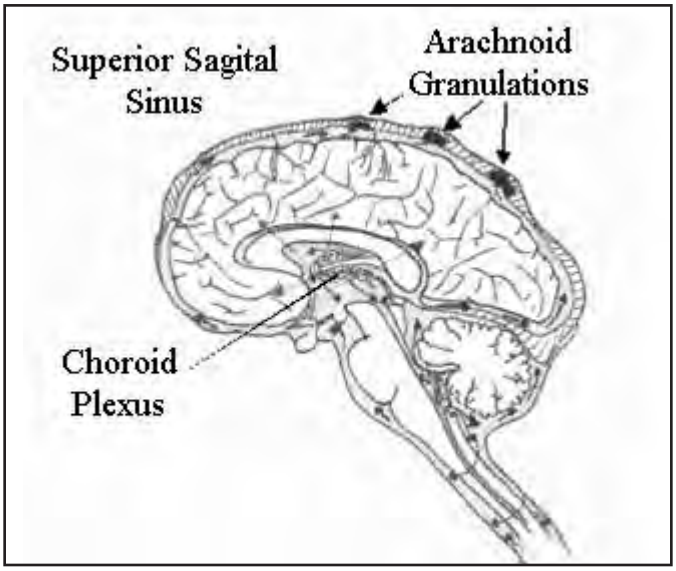
The choroid plexuses are responsible for the secretion of ventricular fluid that becomes CSF when additions are made to it from the surfaces of the brain, spinal cord, and pia-arachnoid layer of the meninges. These plexuses are made up of extensively wrinkled ependyma which lie adjacent to overlying connective tissue. The ependymal cells actively secrete CSF at a steady rate. These cells show metabolic activity.[17] There are folds of blood vessels within this area. This forms part of the CSF-blood brain barrier. This barrier screens the particles going into the CSF. Its protein content and white blood cell ratios are very low. It is believed that CSF flows under hydrostatic pressure generated by its production. The dependence of CSF absorption on the pressure differential between the CSF and the venous sinus compartments has received strong support from ventriculocisternal and ventriculolumbar perfusion experiments.[18] This mechanism sustains tissue respiration as per Best and Taylor. This brain fluid travels through the lateral ventricles and communicates centrally with the third ventricle, via the interventricular foramina (foramen of Monroe). The narrow cerebral aqueduct connects the third and fourth ventricles in the midbrain. The fourth ventricle is located between the pons, cerebellum and medulla. It communicates with the central canal of the spinal cord and the subarachnoid spaces which surround the CNS via the foramen of Magendie and Luschka. The dural venous sinuses are endothelium-lined spaces made up from the periosteal and meningeal layers of the dura mater. The brain's veins empty into these sinuses and all blood ultimately drains through them towards the internal jugular vein.[19] The large superior sagittal sinus lies on the convex, superior, midline, inner border of the skull surrounding the ventricles below it. It runs from the Crista Galli to the confluence of sinuses where it combines with the straight occipital





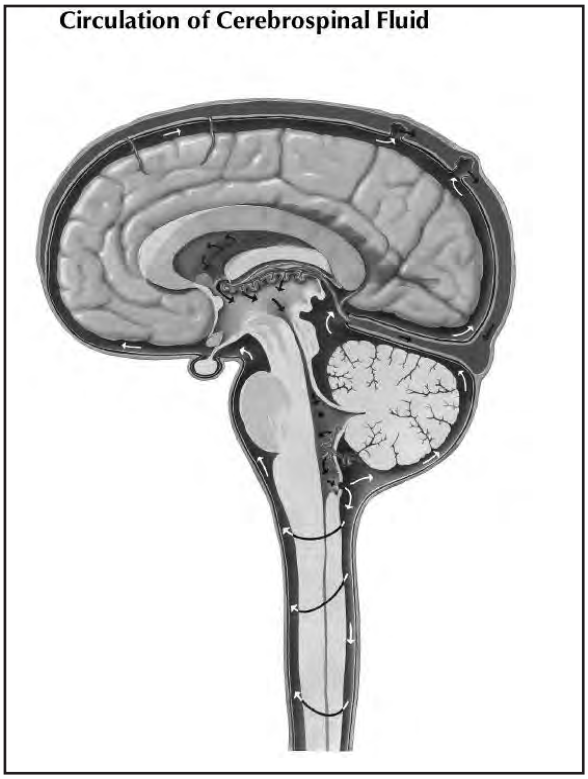


and transverse sinuses by the internal occipital protuberance. Arachnoid granulations are situated along this large sagittal sinus, the cavernous sinus and the exits of cranial and spinal nerve roots via dural lymphatic capillaries.[20] Arachnoid villi are tufted prolongations that protrude through the meningeal layer of the dura mater into the dural venous sinuses. These act as one way valves that absorb CSF which communicates with



the venous system. Cranial CSF emptying studies performed on fifty patients using external scintillation scans of the brain at varying time intervals, demonstrated that reabsorption occurs through the actions of the Arachnoid villi communicating with the large cranial venous sinuses on the superior skull. Major flow exited the skull from the convexity of the brain along the superior longitudinal sinus.[21] Normally, the venous sinus pressure is lower than that of the CSF pressure gradients. Von Durig and Andres, 1995, discuss the chemoreceptor and mechanoreceptor functions of these granulations and discusses their possible role in CSF volume and chemical composition. A percentage of CSF is drained from the CNS to the venous system by means of extra cranial lymphatics. It is believed that these lymphatic channels play a larger prenatal than postnatal role.[22]

Currently, the mechanism behind CSF motion has not been completely understood. This has remained an enigma. AT Still was intrigued by the CSF and its workings. Sutherland knew that CSF motion was present and sustained, but could not explain why it occurred. There have been several theories associated with cerebrospinal fluid circulation and fluctuation. In the 1930s, Sutherland described a fluctuation and circulation of CSF around the brain and spinal cord in a rhythmically pulsatile fashion. He said that the shape of the space that contains the CSF and the fluid itself are postulated to be affected by an alternating cranial pattern. He further elaborated that as the CNS shortens and lengthens in a biphasic rhythmic motion, the ventricles of the brain change shape slightly and the fluid moves concurrently.[23] O'Connell, who studied the vascular factors in intracranial pressure and maintenance of cerebro-spinal fluid circulation, suggested that the brain's expansion, by compressing the third ventricle, might constitute a CSF pump.[24] Some believed that the combined activity of the CNS and the CSF functions both as



a pump and as an electric generator.[25] Magoun stated that with cranial inhalation, the neural tube contracts its long dimension, the cerebral hemispheres move upward, shorten in their AP diameter and unfold laterally which changes their shape. He believed that a contraction of the long diameter and a comparative thickening at right angles to this caused compaction of the brain substance. This compaction is compared to a squeezed sponge with the area of the brain covered by pia mater as one surface and the lining of the ventricles and the cerebral aqueduct as the other. As these surfaces approximate, there is an increase in capacity of the CSF spaces, thereby accompanying a fluctuation of this fluid. As the brain changes its form, there is an alteration of the volume of fluid within it. The volume of the CSF in the subarachnoid space and ventricles is increased. With exhalation, the brain substance expands, compressing these fluid-containing compartments and creating a fluid wave that expands outwardly. Since the fluctuation of the CSF is a very fundamental part of the PRM, then the PRM must play a very essential and dynamic role in internal tissue respiration.[26]

It is hypothesized that an inherent "cranial plunger" of the brain exists as a hydrodynamic pump that propels the CSF rhythmically around the CNS. The concept is similar to that of a plunger and the way it works. The plunger consists of a rubber cup, analogous to the brain and its dural attachments with an attached "shaft"; the midbrain, spinal cord and associated dural attachments. As the container changes shape, the spinal cord rises. The cup approximates the drain; being the spheno-basillar-synchondrosis (SBS) during the flexion phase and compresses above it. A hydrostatic force is created and water flows. When the shaft is pulled out or recedes, the fluid moves in the reverse direction, analogous to cranial extension. This is pertinent to CSF flow and its forces. It is postulated that the hydrostatic forces generated by these pressure gradients causes fluctuation

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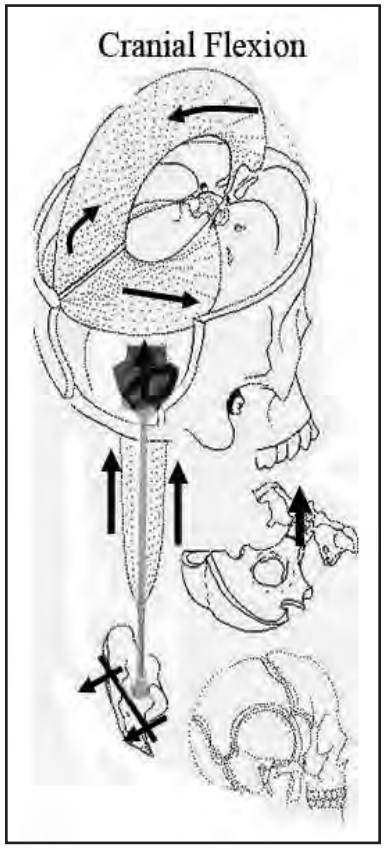
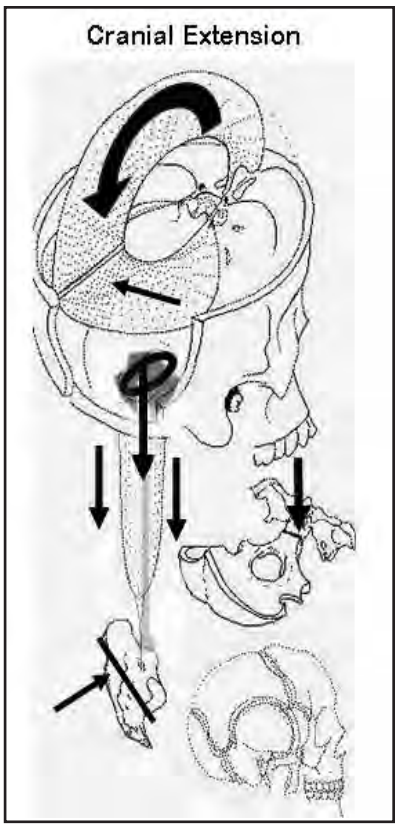
of the CSF.

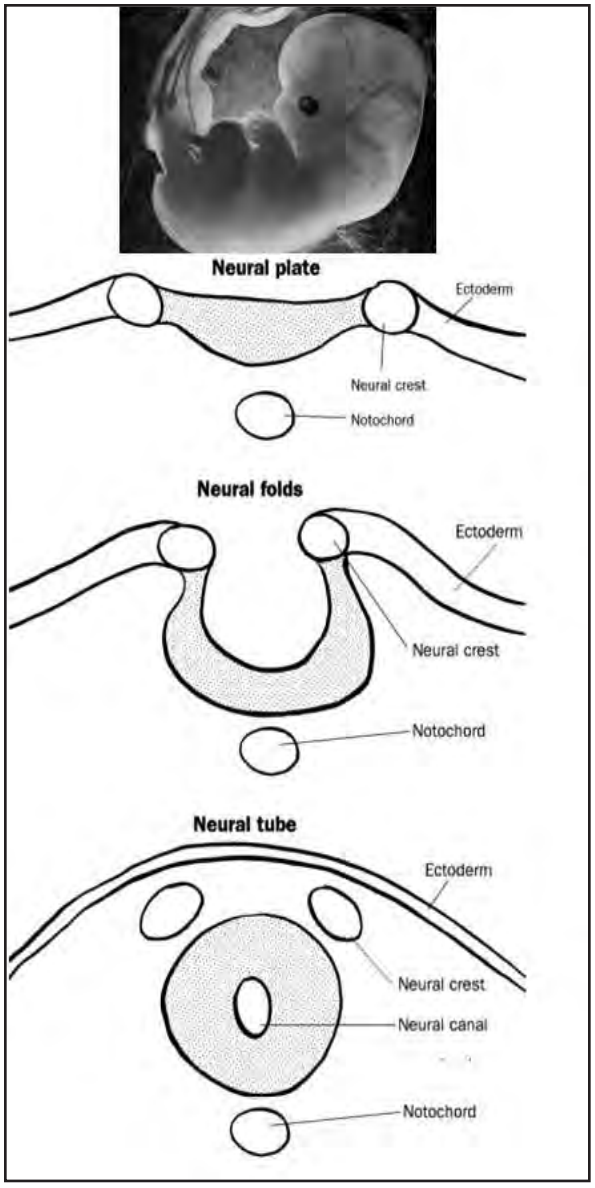
In detail, the "cranial plunger" is the central soft tissue structures of the CNS: the midbrain, Pons, Medulla Oblongata (brainstem) and spinal cord. These collectively form a cephalically bulbar, centrally located, elongated, slender shaped rod; likened to the shape of a plunger. During the inhalation phase, it is theorized that there is a cephalic "plunger" effect from the centralized, elongated cranial structures below that approximate the SBS allowing for a centralized superior and perhaps slightly anterior (based upon anatomic relationships) intracranial invagination to occur at the base of the brain. The cranial plunger is ideally situated for this, floating in cerebrospinal fluid to affect and be affected by the soft tissues and fluids around it; the cisterna basalis anterior and superior, cisterna pontis anterior and just inferior, the lateral and third ventricles situated above, cisterna superior situated posterior and superior to the plunger, the fourth ventricle posterior and just below this and the cisterna magna the most posterior and inferior of the cisterns.



During cranial flexion, these central structures are proposed to gently "thrust" superiorly and slightly anterior by the cranial plunger, which allows simultaneous movement of the SBS superiorly via dural attachments to this area. The foramen magnum likely rises as a result of this effect. As the cranial "plunger" exerts an upward force on the ventricular system, which approximates the pump, a hydrodynamic pressure change occurs transiently, compressing these ventricular cavities, further changing their shape (the container) and moving the contents within them. The tentorium cerebri flattens as the transverse diameter of the skull widens. Magoun explained that in cranial flexion, the walls of the third ventricle and lateral ventricles spread laterally, expand and increase their capacity. He stated that the cerebral hemispheres move upward and that the third ventricle is elevated. As the cerebral hemispheres widen and rise, the ventricular contents are expelled. This elevation pulls on the infundibulum which elevates the pituitary in the sella tursica of the sphenoid which is moving cephalad.[27] With the upward thrust of the cranial plunger, a stimulation or "pumping" of structures such as the delicate hypothalamic nuclei and the hypophysis positioned superior and anterior may occur simultaneously. Magoun explains that the CSF does carry within it, the secretions of the posterior pituitary. The venous channels in the cranium are devoid of elastic and smooth muscle tissue and a cranial "pumping" mechanism from the plunger action would be paramount to increase venous drainage through vulnerable areas (i.e. the cavernous sinus). Sutherland describes a cranial pulse that is independent and separate from the beats of the heart or the pressure changes of the lungs during respiration. It is a series of undulating pulsations which has not been identified clearly. He declared that because of these circumstances, the CSF is fluctuated, causing increased exchange between the blood stream and the CSF. Perhaps, the CSF flow is accelerated in one certain direction during the cranial flexion phase. The direction of the cranial structures would dictate this logically. The change of shape of the cranium during this process seems imperative. This structural change may create a vacuum effect lifting the spinal cord cephalad. As the skull's transverse diameter increases and its vertical diameter decreases during the expansion phase of the cranium (likened to the flattened cup of the plunger), the superior, central cranial structures approximate the centralized "plunger" pushing from below, further increasing the pressure on the large overlying ventricular cavities. This approximation of structures magnifies its effect. Perhaps as the cranial plunger rises and falls, there is a subtle change in CSF pressures that augments CNS and ultimately CSF flow. This may help to explain the palpatory observations during this expansive phase of the PRM. With exhalation, the "plunger" retracts inferiorly; a reversal of the expansion phase occurs. The CSF likely "recedes" reversing its flow. This intracranial receding of the



CSF from the cranial vault is a reflection of the contraction-type (extension) palpatory observations reported. During this cranial phase, pressure gradients are possibly restored or "reset" to pre-flexion levels. These processes are a component of the PRM. Magoun reiterates that the PRM is considered to include innate motility of the central nervous system, which coordinates with the observable fluctuation of the CSF under the guidance and restraint of the reciprocal tension membranes. Magoun emphasizes that cranial pressure changes may vary from 5-15mm with the pulse and respiration. He said that CSF pressure varies with the venous pressure directly, because the CSF-containing fluid system is partially vented by the venous system. The locations of these large venous sinuses with their associated Arachnoid granulations are ideal for a centrally mediated pumping mechanism. It would stand to reason that as the cranial plunger rises and falls, there is a subtle change in CSF pressures that also augments venous flow in addition to CNS motility. T.L. Peele found fluctuations of pressure occurring with fluctuations of volume in different parts of the cerebrospinal system.[28] A plunger is much more effective when there is water verses air in the pipe because water does not compress well and will thus transmit more of the applied force. Pascal's law seems to explain hydrostatic intracranial pressure changes. The formula explains that the difference of fluid pressure is due to a difference in elevation within a fluid column. The hydrostatic pressure is a result of the difference in pressure at two points within a fluid column such as we see in the CNS. Still described this inherent motion of the brain as an "electrical dynamo" which begins with the cerebellum.[29] Magnethydrodynamics studies the dynamics of electrically conducting fluids. CSF is similar to blood in osmolarity and sodium concentrations but contains more chloride, less potassium, calcium, magnesium and glucose. It is an electrically conducting fluid like plasma. This helps explain currents present in a moving conductive fluid like CSF. This has the potential to also create forces within the fluid. This fosters an environment of ionic exchange and changing electrical potentials within the fluid and the cellular tissues affected by the fluid. The "cranial plunger" mechanism may augment and/or initiate these forces. Sutherland studiously observed cerebrospinal fluid physiology in its own natural environment. He explained its actions as a physical potency or energy which acts as a hydrodynamic mechanism.[30] Sutherland proclaimed that a pumping action, similar to the pulsation known to exist in all organs existed, which moves tissue juices rhythmically within the brain substance.[31] The function of such a mechanism is postulated by Lee as being based on a fulcrum created by the root of the cerebellum and its hemispheres moving in opposite directions, resulting in an increase in pressure which squeezes the third ventricle. The pulsation is described as essentially a recurrent expression of the embryological development of the brain.[32] Magoun stated that the rhythmic coiling and recoiling of the CNS may have embryologic roots during the growth of the anterior neural tube. In the embryological beginning, "life's dance" of embryonic development occurs creating the human being complete with mind, body and spirit. This process is remarkable and humbling during the development of the CNS and its supporting structures. The nervous system develops in the third week of life from embryonic ectoderm called the neural plate during the process of neuralation. During gastrulation, the primitive streak and the notochord develop in the midline. Neural plate formation is induced by the developing notochord. The neural plate differentiates into the neural tube and the neural crest. Fusion of the neural folds proceeds in an irregular fashion in a cranial and caudad direction. The neural tube is temporarily open at both ends, freely communicating with the amniotic cavity at this time. The lumen of the neural tube forms a small central canal. The cranial end closes first, followed a few days later by the caudal end. In the fourth week of life, the neural tube further differentiates by thickening its walls to form the brain and spinal cord. The neural crest gives rise to most of the peripheral nervous system. Specifically, during the fourth week of development, the three primary brain vesicles develop; the forebrain (prosencephalon), midbrain (mesencephalon) and hindbrain (rhombencephalon). The brain grows rapidly during this week and bends ventrally with the head fold. The cranial flexures are formed and produce variation in the outline of transverse sections of the brain and in the position of the white and gray matter. The cervical flexure demarcates the hindbrain



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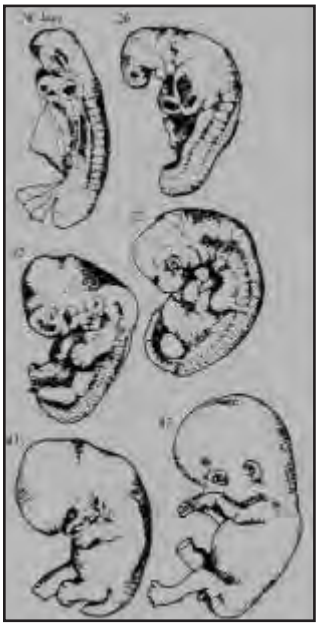
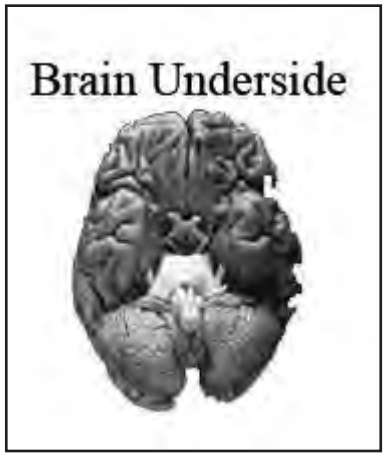
from the spinal cord. The pontine flexure divides the hindbrain into caudal and rostral parts. During the fifth week the forebrain partly divides into the telencephalon and the diencephalons while the hindbrain divides into the metencephalon and the myelencephalon. As a result, there are five secondary brain vesicles. In the hindbrain part, the metencephalon, gives rise to the pons and the cerebellum. Its cavity forms the superior part of the fourth ventricle. There is a thin ependymal roof of the fourth ventricle derived from mesenchyme which is covered by pia mater externally. This differentiates into the choroid plexus. The cavity of the hindbrain becomes the central canal in the caudal part of the medulla (myelencephalon). The myelencephalon becomes the medulla oblongata. The caudal part of this area resembles the spinal cord structurally. The rostral part of the myelencephalon is wide and flat. The roof is thinned. In the midbrain, the mesencephalon undergoes less change than any other part of the brain. In its caudal part, the neural canal narrows and becomes the cerebral aqueduct. The forebrain divides into two parts: the telencephalon and the diencephalon. The anterior part of the forebrain with the primordial of the cerebral hemispheres is called the telencephalon. The caudal or posterior part of the forebrain is called the diencephalon. The telencephalon gives rise to the telencephalic vesicles. They are the primordia of the cerebral hemispheres and their cavities become the lateral ventricles. The cavities of the telencephalon and diencephalon contribute to the formation of the third ventricle. The diencephalon contributes more to this cavity however. In the roof of this ventricle forms a choroid plexus. The roof of the cerebral vesicles is in wide communication with the cavity of the third ventricle through interventricular foramina. Subsequently, the part of the medial wall of the developing cerebral hemispheres becomes very thin. The choroid plexus of the lateral ventricle then forms at this site. The cerebral hemispheres expand covering the diencephalon and meet in the midline. The falx cerebri later forms here. The growth and curvature of the hemispheres causes a C-shape of the lateral ventricles. The hemisphere's curling shape has been referred to as a Ram's horn. The temporal lobe formation from the ventral curvature of the cerebral hemispheres carries the lateral ventricle and the choroid fissure with it, forming the temporal horn and the choroid plexus of the temporal horn. As the cerebral cortex differentiates, fibers pass to and from it through the corpus striatum. This divides into the caudate and lentiform nuclei. The caudate nucleus becomes elongated and horseshoe-shaped conforming to the outline of the lateral ventricle. Its pear shaped head and elongated body lie in the floor of the anterior horn and body of the lateral ventricle. Its tail lies on the roof of the temporal horn. Three swellings develop within the lateral walls of the third ventricle to become the thalamus, hypothalamus and the epithalmus. The pineal body develops from a recess of the third ventricle. The skeletal system develops from mesoderm. As the notochord and neural tube develop, the intraembryonic mesoderm lateral to these structures thickens to form two longitudinal columns which divide into somites. Each somite differentiates into three parts; sclerotome, myotome and dermatome. The sclerotome forms the vertebral column and the ribs. The skull develops from mesenchyme around the developing brain. It consists of two parts: the neurocranium (the skull) and the viscerocranium (the jaw). The base is initially cartilage and forms by fusion of several cartilages. The parachordal cartilage or basal plate forms around the cranial end of the notochord and fuses with the cartilages derived from the sclerotome regions of the occipital somites. This cartilaginous mass contributes to the base of the occipital bone; later, extensions grow around the cranial end of the spinal cord and form the boundaries of the foramen magnum. After the endochondral ossification of this cartilage forms the bones of the base of the skull. Intramembranous ossification occurs in the mesenchyme at the top and sides of the brain forming the cranial vault. In utero, the flat bones of the vault are separated by dense connective tissue membranes that constitute the cranial sutures. Ossification begins at the end of the embryonic period. The mesenchyme surrounding the neural tube condenses to form a membrane, called the primitive meninx. The outer layer of this forms the dura mater. The inner layer forms the pia-arachnoid layers, which together, are called the leptomeninges. Fluid filled spaces within the leptomeninges coalesce to form the subarachnoid space. Amniotic fluid becomes the primitive CSF and lies throughout this space. The spinal cord develops as a remainder of the neural tube.

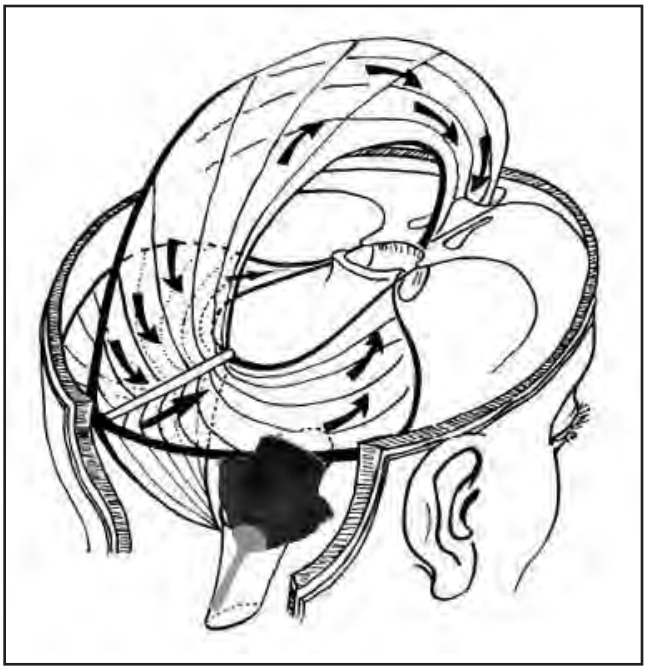


In summary, embryonic development dictates the resultant functional anatomy of the central nervous system. The anterior end of the neural tube becomes expanded to form the three primary brain-vesicles; the cavity of the tube is subsequently modified to form the ventricular cavities of the brain, and the central canal of the medulla spinalis. The nervous elements and the neuroglia of the brain and medulla spinalis are developed from the wall. The brain develops from the walls of the five fluid-filled vesicles which remain in the adult as the ventricular system. It matures in a pattern that reflects phylogeny. The more primi-

tive portions of the brain mature first and the highly specialized cerebral cortex later. In general, the lower portions of the CNS develop before the more cephalic portions. Initially, the young brain has the same basic structure as the developing spinal cord. The midbrain undergoes the least change of all brain areas and this may reflect an early functionality of the midbrain and spinal cord to drive later development and early cranial motion. Magoun reiterates that the rhythmic coiling and recoiling of the CNS may have embryologic roots during the growth of the anterior neural tube. The ventricular system and its supporting anatomy are reflective of these early processes. The anatomic relationships of the choroid plexuses are interesting; positioned in the roof and along the medial walls of the ventricular cavities and other parts. Perhaps this positioning is purposeful and reflective for a centrally mediated, hydrodynamic fluid mechanism. The final cranial shapes retain their origins of development from the lines of early functionality. The presence of a cartilaginous cranial base and its remnants later is strong evidence of the existence and continually varying degrees of motion in and out of the uterus. This motion is similar to costal cartilage motion that occurs at the attachment of the ribs to the sternum. If we focus attention on the anatomic shapes of the brain and their relationships to the cranial base, we see both a central bony relationship and a complimentary soft tissue component. Concaved-shaped recesses are evident when observing the most inferior parts of the cerebral cortex. The inferior parts of the temporal and occipital cortical lobes, the inner surfaces of the sphenoid and squamous temporal portions display a similar shape, which may preclude a possible central invagination from below. The bony basiocciput and the basisphenoid outline a similar shape. This shape compliments the theorized motion patterns present at the SBS. The lateral ventricles are C-shaped, concavity down, and would support an invagination from below. The cranial bones are formed from membrane and cartilage. With growth and motion, the edges of the plates develop sutures between them that allow for this motion and protection of the brain. This structural development is a prime example of Wolff's' Law which states that every change in form and function of a bone, or in its function alone, is followed by certain definite changes in its internal architecture and secondary alterations in its external conformations (Stedman's, 25th Ed). These cranial shapes may be the result of the early presence of centralized cranial motion during bony and soft tissue structural developments; to accommodate and complement these early in utero motion patterns. We see this example displayed when observing the clivus on the basal portion of the occipital bone that climbs from the foramen magnum to the dorsum sellae. Notice the concave indentation within this bone from the brainstem and this close structural relationship to the SBS.



Blechschmidt (1977) discussed several mechanisms by which fluids behave internally, creating function out of which structure emerges: contusion, distusion, corrosion, loosening and suction. These are driven by the metabolism of cellular tissues. Sheets of cells, tissues and organs grow at different rates. Growth differentials within the embryonic cranium create



cerebrospinal fluid patterns that later condense into mechanical tension zones or mesenchymal restraining bands known as dural girdles. They guide the ultimate shape and inner structure of the brain. Similarly, water flowing down a mountain bank creates the architectural surroundings that are complimentary and reflective of the forces within this fluid. Thickened bands of dura can be seen within the dural sheaths of the adult cranium as remnants of these precursors. These areas of thickening are believed to be areas of increased motion and stress within the cranium. Throughout embryonic development we see the importance of

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the midline and how it serves as an anchor and a catalyst for all other development to occur. Some describe the functional midline around which our bodies and health must organize. The lamina terminalis is described by some as the pivot point for all neural movement. It marks the closure of the cephalic end of the neural tube during embryologic development. This midline remains throughout our life and our structure and physiologic motion remain oriented to the midline.

Multiple studies have documented the inherent capacity of the CNS to move. Longitudinal oscillations of the spinal cord were observed by L. Levy and G. DiChiro using cardiac-gated MR phase imaging. They believed that transmission of the arterial pulse into the cerebrovascular system ultimately leads to systolic expansion, subsequent motion of the brain-spinal cord axis, and a pumping of the cerebrospinal fluid.[33] Their study revealed that in adult healthy subjects, the mean peak caudal velocity of the spinal cord was 12.4mm/sec (.028miles/hour). This was associated with early systole. This caudal cord motion usually coincided with the end of the cephalic CSF flow phase in the spinal canal, in the cervical subarachnoid space, and usually lasted 70m/sec. This would likely coincide with the end of cranial flexion and the start of cranial extension. The origin of the cord pulsations was found to be directly related to motion from the brain pulsations. The cervical cord velocities were greater in the upper cervical region and gradually decreased caudally along the spinal cord. In symptomatic study subjects with neurologic pathology, the velocities were significantly reduced with a mean of 2.1mm/sec. Echo-planar MR studies on 14 healthy subjects revealed an intrinsic pulsatile motion of the brain motion with rapid displacement in systole with a slow diastolic recovery. This motion occurred chiefly in the cephalocaudad direction with a small amount of anteroposterior and lateral motion observed. These longitudinal velocities increased with proximity to the foramen magnum. The lateral motion was a compressive motion on the thalami. Brain parenchymal velocities were as high as 2mm/sec in the brain stem and 1.5mm/sec in the thalami. The net pulsatile excursions were not greater than 0.5mm.[34] Other MR CSF flow studies suggest that the primary driving force behind intracranial and spinal canal CSF flow is expansion of the brain during vascular systole.[35]

Studies using a flow sensitive MR technique, demonstrated a CSF flow to be pulsatile in nature and vary with the phase of the cardiac cycle.[36] While the CSF motion appears to reflect primarily expansion of the choroid plexuses during cardiac systole, other factors such as generalized systolic cerebral expansion against the tentorium may also contribute to CSF motion.[37] To explain pulsatile CSF motion, visualized on cine pneumoencephalography studies, DuBoulay argued in favor of a third ventricle pump as a driving force of CSF pulsations and postulated a lateral squeezing of the thalamic nuclei on the third ventricles secondary to brain expansion.[38] Scientists, Feinberg, DA and Mark, AS at the University of California, San Francisco, developed a technique of Fourier velocity imaging that allowed in vivo measurements of CSF velocity (direction and magnitude) in the cerebral ventricles and passageways. They found that with the arrival of the systolic pulse wave, internal regions of the brain move caudad, imparting a compressive force on all three ventricles and initiating CSF ejection. It was demonstrated that it was ejected caudad (antegrade) through all passageways (foramen of Monroe, cerebral aqueduct, foramen of Magendie and Luschka and basal cisterns) moving into the ventricles and cranial vault. Later in the cardiac cycle, the CSF direction of flow reverses (retrograde), moving into the ventricles and cranial vault. CSF flow occurs under a pressure gradient created by the difference between the intraventricular pressure and the intracranial venous sinus pressure, specifically at the Superior Sagittal Sinus.[39] The caudad pull of the plunger may also foster further refilling of the tube and central fluid cavities in preparation for the next cranial flexion phase. Feinberg states in general, there appears to be a compressive motion of brain parenchyma on the lateral, third and fourth ventricles. He states that on MR velocity images, a pulsatile brain motion exists in vivo. Feinberg had an unexpected find from the study which displayed a downward motion of the brainstem, which appeared to drive CSF through the basal cisterns. Conservation of momentum was invoked to explain the amplified velocity of the lower brain regions.

Valves are seemingly absent within the intracranial CSF channels. Ironically, this would foster an internal environment suitable for antegrade/retrograde flow within the CSF pathways to occur. Antegrade motion was found to occur and documented through the cerebral aqueduct during cardiac systole while retrograde flow occurred during diastole in the aqueduct.[40] Studies demonstrated that the direction of CSF flow in the CSF pathways changes from caudal to cephalic in a continuous mixing of CSF between the ventricles and the subarachnoid space.[41] It is likely that the attached membranes and bony components follow simultaneously in recoil. Return of cranial and spinal structures allows a "reset" of the cranial fluid mechanisms to occur, preparing for the next cycle. This "thrusting" motion is most probably millimeters in nature based on the cranial anatomic dimensions and prior cranial research motion studies to date. Turbulent flow defined as random, non axial motion of fluid elements, has also been demonstrated in CSF flowing through the aqueduct.[42] This may correlate with a lateral flux cranial pattern by palpation.

"Cranial plunger" motion feasibly would be a catalyst for the palpatory fluid motion patterns and the bony and soft tissue phenomena that occurs within the central and peripheral soma that have been consistently reported by the osteopathic literature and others. Osteopathic physicians believe that the CNS displays inherent motility, mobility and sustenance. The CNS functional anatomy can be compared to other bodily relationships such as the heart's propulsion of blood by inherent cardiac muscle motility, the mobility of bowel contents by the motility of gastrointestinal (GI) smooth muscle cells and the movements of epithelial cilia of the respiratory tract. There are epithelial cilia which line the ventricular system and central canal of the spinal cord. These cells are a remnant of neuroectoderm which once formed the neural tube. Many have cilia and are involved in the mobilization of CSF in the directions of bulk CSF flow.[43] CSF contacting neurons have dendritic processes and have been found, in mammals, to have a mechanoreceptor effect similar to the inner ear cells.[44] The involuntary, automatic, centrally mediated bellow-like excursions of another central fluid pump; the thoraco-abdominal diaphragm propels venous and lymphatic fluid throughout the body by change in pressure gradients generated by container shape change. Experts believe

that deep respiratory inhalation, actually augments the inhalation phase of the cranium, perhaps by augmenting the upward "thrust" of the midline brain anatomic structures.[45].The "cranial pump" would be synergistic in its mechanism of action to other body pumps. The anatomic structures surrounding all "body pumps" are dependent in part or in total for their support for fluid propulsion, nutrient delivery and toxin removal. Each pump can have profound effect on homeostasis and augmentation of function. These functional relationships demonstrate the body's inherent ability to circulate fluid involuntarily, automatically, and rhythmically in an ideal, efficient manner. These relationships reinforce the osteopathic precedent of the relationship between structure and function.

Simply, this seems to be no different for the CNS. The anatomic relationships evident in the CNS are deliberate, purposeful and biomechanically sound adaptations to allow for yet another inherent, self-sustaining fluid propulsion mechanism of the body; sustaining life itself. Dr. Sutherland's work exemplifies this point. More research is needed in osteopathic medicine. More targeted study of osteopathy in the cranial field is necessary to shed light and greater understanding of this complex and yet seemingly simple cranial phenomenon. More MR imaging studies showing in vivo measurements of intracranial pressure changes that are phase dependent with cerebrospinal fluid/venous flow patterns throughout different CNS areas would be ideal. Multiple real time intervals would foster more information about this enigma. Experimentation with cranial motion characteristics around and within the brain and spinal cord can be pursued. This is an exciting challenge for future investigational studies. Animal models have shown definitive lymphatic flow characteristics in past research.[46] More human studies are needed.

The Cranial Plunger Theory gives the Osteopath a means to an end for further explaining the origins and maintenance of CNS irrigation and sustenance. It may further the meaning and regard for the five involuntary cranial phenomena. The Primary Respiratory Mechanism is vital to health and represents a crucial, functional part of the physiologic whole; a living being. As such, the CNS displays a self-propelling, self-regulating and self-sustaining mechanism in all capacities. Respect for this eluding and delicate mechanism must forever be maintained. Remembering the words of Andrew Taylor Still; "the cerebrospinal fluid is the highest known element in the human body. He who is able to reason will see that this great river of life must be tapped and the withering field irrigated at once or the harvest of health is forever lost."

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The purpose of the quiz found on the next page is to provide a convenient means of self-assessment for your reading of the scientific content in the *"The Cranial Plunger Theory"* by Denise K. Burns, DO. Answer each of the questions listed. The correct answers will be published in the September 2008 issue of the *AAOJ*.

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Answer sheet to June 2008 AAOJ CME quiz will appear in the September 2008 issue.

CME QUIZ

1. Which of the following phenomena is not associated with the Primary Respiratory Mechanism?
   A. The sacrum moves with cranial flexion and extension
   B. Cerebrospinal fluid motion
   C. Central nervous system motility
   D. Cranial bone motion
   E. Cardiac systole

2. In which of the following gestational week does the human nervous system develop?
   A. 1st week
   B. 2nd week
   C. 3rd week
   D. 4th week
   E. 5th week

3. During embryonic development, the forebrain divides into which of the following?
   A. Mesencephalon
   B. Telencephalon
   C. Diencephalon
   D. A and C
   E. B and C

4. From which of the following is the human skeletal system derived?
   A. Ectoderm
   B. Mesoderm
   C. Endoderm
   D. Lidoderm
   E. Scleroderm

5. Which of the following is not a known function of CSF?
   A. Secretion of renin
   B. Provides buoyancy to the brain and spinal cord
   C. Provides nutrients to the nerve cells
   D. Removes waste products
   E. Electrolyte balance

6. Which of the following best describes the "cranial plunger "of the central nervous system?
   A. An inherent hydrodynamic pump that propels the CSF rhythmically around the CNS
   B. A systolic pressure change that is transmitted to the cranium during cardiac diastole
   C. A lymphatic pump technique that moves cranial fluid and lymphatic fluid
   D. The Pons and the medulla that propels Cerebrospinal fluid
   E. The intrathoracic diaphragmatic motion

7. The functional motion characteristics of the central nervous system are likened to which of the following anatomic structures?
   A. Heart motion
   B. Lung motion
   C. Thoracoabdominal diaphragm motion
   D. pelvic diaphragm motion
   E. Gastrointestinal motility

A Comparison of Swedenborg's and Sutherland's Descriptions of Brain, Dural Membrane and Cranial Bone Motion

"We may sweat a thousand years and only scratch the surface of knowledge about the brain and how it works." (Swedenborg 1882, 104k)

David B. Fuller

Abstract

Two hundred years before Sutherland's introduction of the cranial concept, Emanuel Swedenborg described a sophisticated and unique model of brain and body function, which contained some ideas similar to those found in Sutherland's cranial concept.

This paper will review a portion of Swedenborg's paradigm of the brain and central nervous system as described in his scientific works, particularly "The Brain". It will focus on Swedenborg's description of inherent motion of the brain, the reciprocal motion of the dura mater, and cranial bone motion.

These concepts will be compared and contrasted to the areas of William Garner Sutherland's cranial concept that deal with brain motion, dural motion and cranial bone motion. Historical connections between Sutherland and Swedenborg's ideas will also be explored.

Introduction

1.1 Brief Biography of Swedenborg

Emanuel Swedenborg (1688-1772) was an 18th century Swedish scientist and philosopher who later developed into a theologian (Dole 1997, 31-40). He wrote on a wide range of topics during his long and productive life, culminating in over 40,000 pages (Rose 2005, 388). Today, Swedenborg is most remembered for his later writings which were predominantly theological. Much of his pre-theological, scientific and philosophical writings were far ahead of his time, containing concepts not recognized until centuries later (Finger 1994, 29-30, 32, 194). His scientific and philosophical writings, particularly his works relating to anatomy and physiology, contained ideas that later became fundamental to his theological works. His works were written in Latin and later translated into English.

Swedenborg was initially a scientist who became a philosopher in search for the soul. He studied anatomy extensively trying to discover the soul's manifestation in the body. His studies of human anatomy were exhaustive and led to a focus on the brain and its influence throughout the body. During his anatomical writings from the late 1730s to the middle 1740s he described, in great detail, the structure, function and motion of the brain. During 1738-1740, he wrote a preliminary work on the brain titled, "The Cerebrum". His most comprehensive work on the subject was one of his last scientific works, titled "The Brain". It was written in 1743-1744, although left unpublished during his lifetime. Starting around 1745, Swedenborg underwent a series of profound and on-going spiritual experiences. He dropped all of his scientific writings and moved on to a study of the Bible and a new interpretation of the scriptures. He developed a unique, comprehensive cosmology and theology. He wrote on theological topics for the next three decades until his death in 1772. Interestingly, many of the ideas developed in his scientific works permeate his theological writings.

1.2 Overview of Sutherland and Osteopathy in the Cranial Field

William Garner Sutherland, DO (1873-1954) developed a system of diagnosis and treatment known as cranial osteopathy. He gave credit to Andrew Taylor Still for discovering and developing the philosophy, principles and practice of Osteopathy (Sutherland 1998, pp.143, 188, 214). Sutherland applied these in a new and sophisticated fashion to the head and rest of the body utilizing this new cranial concept. He taught fellow osteopathic physicians this new system of cranial diagnoses and treatment from the 1930s until his death in the mid 1950s.

Sutherland's system of diagnosis and treatment was called, among other names, cranial osteopathy. It is now officially known as Osteopathy in the Cranial Field (OCF). Osteopathy in the Cranial Field, along with other types of osteopathic manipulative medicine, is taught in all of the more than twenty osteopathic medical schools in the United States and in many other countries throughout the world. It is used to help many patients worldwide.

Sutherland's system of cranial osteopathy is based on the cranial concept which includes, five major principles: 1) the inherent motility of the brain and central nervous system, 2) the fluctuation of the cerebrospinal fluid, 3) the mobility of the intracranial and intraspinal membranes, 4) the articular mobility of the cranial bones, and 5) the involuntary motion of the sacrum between the ilia. The first, third, and fourth components will be the focus of this study.

Swedenborg's Paradigm of the Brain

2.1 Introduction

There are many important concepts that are fundamental to Swedenborg's development of ideas in "The Brain" and elsewhere. While some of his ideas relating to the brain have been discussed over the years, there has not been any summary of his paradigm of the brain (Woofenden 2002, 196-237). The majority of references to Swedenborg in this study are from his book, "The Brain", although other scientific works are also cited, especially "The Cerebrum". The following summarizes Swedenborg's ideas related to motion of the brain, dura and cranial bones. It is beyond the scope of this study to include all of Swedenborg's ideas related to the brain.

Following the custom of Swedenborgian scholars, all references to Swedenborg's works are numbered by paragraph rather than by page number.

2.2 Brain Motion

Swedenborg described in great detail the motion or "animation" of the brain (Swedenborg 1882, 43, 46, 48, 350, 104r). The concept of a cyclic brain motion is found throughout his anatomical writings involving all body systems, and is fundamental to his description of brain anatomy and function. In a rare moment of humorous writing, he wrote the following to illustrate the importance of knowledge of brain motion:

> "Without a knowledge of the motion of the brain we should remain in doubt as to the various diseases, especially of the head, and we should not know how to point out their causes, and on seeing and observing the changes in the opened brains we should stand agape and wondering, as a donkey before a machine set in motion by the wind or water. Without this knowledge [of brain motion] also we should know nothing whatever in psychology; we should not know what the soul is, what the mind, the understanding, the will, and what the exercises of each are; for in order that the soul may live corporeally or by a body, the brain or everything organized must be moved or animated in alternate periods." (Swedenborg 1882, 59)

Swedenborg described brain motion as a subtle alternating expansion and contraction of the brain. He often referred to this motion as an alternating diastaltic and systaltic motion, or as animation of the brain. He clearly believed that knowledge of the motion of the brain is necessary to understand its structure and function (Swedenborg 1882, 59).

Swedenborg saw evidence for brain motion throughout the anatomy of the brain, spinal cord and nervous system. He saw evidence of this intrinsic brain motion in the structures of the dural and other intracranial membranes, as well as the cranial bones and the sutures uniting them (Swedenborg 1882, 260, 277). He stated that this animatory motion is found throughout the entire nervous system and in fact the whole body. Swedenborg described every artery, vein and nerve fiber as "in the very current of motion of the brain" (Swedenborg 1882, 43). He also wrote, "…for the universal body, with its powers, forces, and actions, lives entirely or chiefly under the motion or the auspices of the brain" (Swedenborg 1882, 59). This motion is perpetual throughout the life of the body (Swedenborg 1882, 43).

2.3 Characteristics of Brain Motion

Swedenborg described the subtle alternate expansion and constriction of the brain as a global movement occurring throughout the brain. He stated that there is animatory motion of the individual parts of the different areas of the brain, however, these different structures move together in a "harmonious variation" so that the brain contracts and expands in a simultaneous fashion (Swedenborg 1882, 104r, 46, 48). This is accomplished by a spiral quality to the movement of discrete areas of the brain, which can be described as a "spiral fluxion". This spiral fluxion allows each part to move without obstruction of contiguous structures (Swedenborg 1882, 43, 48). This activity helps to understand the structure and shape of the cortical gyri (Swedenborg 1882, 48). He stated that this motion is subtle and not obvious to the senses (Swedenborg 1882, 350).

2.4 Ventricular Motion

Swedenborg describes the ventricles of the brain undergoing a similar phasic motion with the cerebrum, cerebellum and brainstem (Swedenborg 1882, 466). During the contraction phase of brain motion, each lateral ventricle lengthens and narrows, and the brainstem lengthens. The posterior and descending cornua of the lateral ventricles (which he also calls Ram's horns) subside and close up with the upper, broader parts of the lateral ventricles becoming narrow and contracted (Swedenborg 1882, 469). This overall brain and ventricular motion correlates with a subtle narrowing and lengthening of the cranium during the contraction phase of cranial motion. The opposite is true during the expansion phase when a subtle widening and shortening of the cranium occurs.

2.5 Brain Motion is Primary to Lung Motion

Swedenborg described the animation, or expansion and contraction, of the brain as usually coinciding with the ventilation of the lungs. This motion, however, is primary to lung motion. (Swedenborg 1882, 53, 281) He states quite clearly that while brain motion may coincide with that of the lungs, it is primary to respiratory motion.

2.6 Brain, Intracranial Membrane and Cranial Bone Motion

Swedenborg described the motion of the brain as part of a complex system of inter-related systems. Not only does brain motion affect all structures of the body that are continuous with the brain, it also interacts with contiguous structures in a very sophisticated and complex fashion. Brain motion is intimately tied in with the structure and function of its surrounding membranes and the cranial bones.

Swedenborg described the brain as the prime activating, moving force. He recognized the surrounding membranes, particularly the dura mater, as serving as a passive elastic reciprocating mechanism that transmit this motion to the cranial bones, causing cranial bone motion. (Swedenborg 1882, 260, 277)

2.7 Reciprocal Dura Mater Motion

Swedenborg states that the cyclic animatory motion of the brain causes corresponding motion to occur in all three layers of the intracranial membranes, pia, arachnoid and dura mater. All of these three membranes are interconnected in a wonderful way so that each of them is involved in activities throughout the

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central nervous system, especially the brain (Swedenborg 1882, 247). The most significant role, however, is played by the dura mater. The dura connects and regulates brain and cranial bone motion. The dura has the characteristics of elasticity and reaction. It helps to sustain the regular intervals of motion between the soft highly active brain and the hard and less active cranium (Swedenborg 1882, 260).

Swedenborg described the dural motion as reciprocal with brain motion. Dural motion is passive, following the motion of the brain, yet also, "that by virtue of its elasticity, and in its capacity as a muscular tendon, it contributes in a general way to the reciprocal expansive motion of the brain" (Swedenborg 1882, 250). When the brain is in the expansion phase, the dura mater is stretched, when the brain contracts the dura is "unstrung". From this alternating stretch and recoil results a "reciprocal action" (Swedenborg 1882, 353). This reciprocal stretch and recoil is rhythmic, having a "reactive power" responding to and affecting the alternating cycle of brain motion expansion and contraction (Swedenborg 1882, 286c).

> "Reaction and elasticity are required in order that it [the dura mater] may concur in a general manner with the motion of the brain; for when the latter has reached the extreme bounds of its expansion, then the dura mater urges it to enter upon the reciprocal period of its contraction." (Swedenborg 1882, 261).

Swedenborg goes into more detail of dural motion, including the elevation of the falx cerebri with the phasic motion of the brain (Swedenborg 1882, 353). It is, however, beyond the scope of this paper to describe all of the anatomical detail that Swedenborg uses in describing the dura and its motion.

2.8 The Fountainhead of Dural Motion

The area of the meeting place of the venous sinuses (named at Swedenborg's time as the Torcular Herophili) is along the straight sinus that passes from the occipital bone along the junction of the dural membranes (falx cerebri, falx cerebelli, and tentorium cerebelli) towards the pituitary gland, housed in the sella turcica, located in the center of the sphenoid bone. Swedenborg described this area, along the straight sinus and junction of tent and falx, as the first source of expansile motion of the entire dura mater and its processes (Swedenborg 1882, 333). He recognized this area as the site of the greatest concentration of cerebral forces and motion (Swedenborg 1882, 104i). Swedenborg described strong cords similar to muscular tendons that may be seen along this part of the dura mater. He termed this as the "general fountain-head of motion" of the dura. (Swedenborg 1882, 251)

2.9 Cranial Bone Motion

Swedenborg recognized cranial bone motion as passive and secondary to the primary active motion of the brain. He stated that the structure of the individual bones of the head reflected the motion of the brain (Swedenborg 1882, 196). He described these bones as moving in a cycle of expansion and contraction in harmony with the motion of the brain. Swedenborg emphasized the priority of studying brain motion first and from then moving on to the study of dural membrane motion and lastly cranial bone motion. In his words,

> "It is better, however, to explore these very motions and states from their efficient causes in the brains themselves than to study them from the signatures and traces in the external tables of the cranium" (Swedenborg 1882, 196).

2.10 Cranial Sutures

Swedenborg stated that the cranial bone sutures demonstrate the motion and "sphere of activity" of each individual bone. He wrote that the details of the interdigitations, articulations, protuberances and apophyses display the actual motion of each cranial bone. Various sutures each correspond to different motions of the cranial bones (Swedenborg 1882, 191, 198, Swedenborg 1938, 170, 736, Vol II 9).

2.11 Centers of Cranial Bone Motion

Swedenborg recognized that there are many different individual motions of cranial bones that take place simultaneously with the rhythmic expansion and contraction of the cranium. He described three general centers of cranial bone motion. These are: between the crista frontalis and the crista galli, the middle of the occipital bone, and the center of the sphenoid bone (Swedenborg 1882, 191). He stated that the most general and important center of all motion of the cranial bones was in the sphenoid (Swedenborg 1882, 251). He describes this center as "the complement of all the functions of the cerebrum", for "the individual bones communicate only with the sphenoid" (Swedenborg 1882, 191).

Swedenborg also described an axis of motion that runs from the middle of the occipital bone, from the meeting place of the cerebral sinuses, through the straight sinus to the middle of the sphenoid (Swedenborg 1882, 191; 1887, 572). This sphenoid-occipital axis is a crucial axis determining much of cranial bone motion and function.

2.12 Individual Motion of the Frontal, Parietal, and Occipital Bones

Swedenborg mentions the subtle movement of the bones forming the cranium that accompanies the rhythmic cycle of brain motion. He describes the movements of only three bones: the frontal, the paired parietal and the occipital bones.

Swedenborg described the frontal bone, with its bilateral anterior bosses, expanding anteriorly during the expansion phase of brain motion, in correspondence with the frontal lobe of the brain. He described the paired parietal bones as elevating and moving laterally with the expansion of the parietal areas of the brain. He also described the occipital bone moving with the cerebellum, elevating at the middle (Swedenborg 1882, 198).

Swedenborg does mention that while the movement of this system of interconnected brain, membranes and cranial bones extends throughout the body, it is subtle and not obvious to the senses (Swedenborg 1882, 350).

2.13 Summary of Swedenborg's Description of the Brain, Dural and Cranial Bone Motion

1) The importance of inherent brain motion is a subtle alternating cycle of expansion and contraction, which originates in the cortex and is transmitted throughout the body. This motion is primary to but often synchronous with lung motion.

2) The reciprocal motion of the dural membranes (accompanying the cyclic motion of the brain) is transmitted by dural con-

nections to the cranial bones as well as the rest of the body.

3) The specific motions of individual cranial bones is determined by cranial sutures and the motions of the corresponding dura and brain.

William Garner Sutherland, DO and the Cranial Concept

3.1 Brief Biography of Sutherland

William Garner Sutherland was born in Wisconsin in 1873. (Sutherland 1962, 5) He entered the American School of Osteopathy, the first osteopathic medical school, in 1898. He studied under the early faculty, which included Andrew Taylor Still, the founder of Osteopathy and the president of the school. While a student in 1898, Sutherland had an insight about the bones of the cranium that would later change his life and lead to the development of a new application of osteopathic manipulative medicine. This insight came like a bolt from the blue that the sutures of the cranial bones were, "Beveled like the gills of a fish; indicating articular mobility for a respiratory mechanism" (Sutherland 1998, 146, 214, 228). It was taught at that time that there was no movement between the bones of the cranium. Sutherland let the idea sit until about twenty years later when he picked it up again and began to seriously explore this concept and its ramifications (Sutherland 1962, 18).

During the 1920s, Sutherland developed his initial understanding of the cranial concept. He applied the principles and practice of Dr. Andrew Taylor Still's osteopathy to this emerging cranial concept, experimenting with diagnosis and treatment of cranial dysfunctions on himself and his patients. By 1929, he introduced his concept, with its osteopathic manipulative application, to the osteopathic profession. His initial writings on the topic focused on the movement of the cranial bones and the accompanying motion of the dural membranes. He taught to small groups of osteopathic physicians during the 1930s. In the 1940s, he started teaching organized courses with detailed curriculum to groups of osteopathic physicians that traveled across the country to study with him and his faculty. He continued to teach until his death in 1954 (Sutherland 1998, 41, 46, 51, 74, 142, 147, Sutherland 1962, 76, 77).

3.2 Overview of Sutherland's Cranial Concept

Over his long professional life, Sutherland wrote many articles and gave many lectures that were recorded, transcribed and later published. He described the cranial concept in many ways, but five points are well recognized as fundamental to the cranial concept that he termed the Primary Respiratory Mechanism.

1. Inherent motility of brain and spinal cord
2. Fluctuation of the cerebrospinal fluid
3. Mobility of intracranial and intraspinal membranes
4. Articular mobility of cranial bones
5. Involuntary motion of the sacrum between the iliac bones (Sutherland 1998, 147, 216, 297, 301, Sutherland 1990, 13)

Points one, three and four are the areas of concern for this study.

3.3 Inherent Motility of the Brain

Sutherland described a subtle, powerful rhythmic motion of the brain, as it expands and contracts, which serves as the motor force that drives the motion of the intracranial membranes and cranial bones. He was very specific in his terminology and described brain motion as an intrinsic motility, and intracranial membrane and cranial bone motion as mobility. This motion originates in the cerebrum and cerebellum, but also involves the spinal cord and related structures. In fact, this motion is continuous throughout the body, and is perpetual throughout life. All animate tissues are in constant rhythmic motion, the most primary rhythm being that of the primary respiratory mechanism (Sutherland 1998, 74-75, 97-98, 119, 129, 161, Sutherland 1990, 19).

3.4 Characteristics of Brain Motility

Sutherland described an alternating coiling and uncoiling of the convolutions, or gyri, of the brain. He named the expansion phase the inhalation, or flexion phase of the cycle. He termed the constriction phase the exhalation, or extension phase of this cycling of the Primary Respiratory Mechanism. Sutherland recognized the convolutions and fissures of the brain as being designed to accommodate the intrinsic rhythmical activity of the brain, coiling and uncoiling in a spiral form. This spiral form of the structures of the brain allows motion to take place in a synchronous fashion, fitting into the structures of the dura mater and cranium. This motion is very subtle (Sutherland 1998, 74-75, 119, Sutherland 1990, 63, 64, 172).

3.5 Primary Respiratory Mechanism is Primary to Lung Motion

Sutherland made it clear that the Primary Respiratory Mechanism involves a cyclic movement of the brain that is primary to the motion of the diaphragm and lungs. While the two often move synchronously, brain motion is primary and lung motion is secondary. These are not always synchronous. Sutherland did use the patient's breathing as a respiratory assistance in some osteopathic cranial treatment techniques (Sutherland 1998, 42, 49, 148, 298).

3.6 Reciprocal Tension Membrane

Sutherland described the membranes within the cranium and spine as being moved in a reciprocal fashion following the rhythmic motility of the brain and spinal cord. While he first introduced this as a "balance-reciprocant", he later named the system of membrane motion the Reciprocal Tension Membrane. He emphasized the inner layer of the dura, particularly the falx cerebri, falx cerebelli and tentorium cerebelli, as well as the intraspinal dural membranes. He recognized that these membranes could also function as "propellant tension bands" between the brain and the cranial bones. The dura, in particular, keeps a tension in the system, moving reciprocally with the brain, serving as a check ligament aiding, controlling and limiting brain motion, connecting the brain and the cranial bones. (Sutherland 1998, 74, 97-98, 143, 149, Sutherland 1990, 42, Magoun 1951, 17).

3.7 Sutherland Fulcrum

While the entire Reciprocal Tension Membrane system is important, there is one area of greater significance than the rest, known as the Sutherland Fulcrum. This fulcrum is located at the junction formed by falx cerebri, tentorium cerebelli, and falx cerebelli along the area of the straight sinus. It was named after Dr. Sutherland by Harold I. Magoun, DO, the editor of the first

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edition of the text, *Osteopathy in the Cranial Field*. Sutherland stated that this fulcrum is a key area in the functioning of the Reciprocal Tension Membrane. He wrote that it serves as a "still leverage junction over or through which the three sickles function physiologically in the maintenance of balance in the cranial membranous articular mechanism". This fulcrum can shift with the fluctuation of the cerebrospinal fluid and the motility of the brain. It is an important concept in diagnosing and treating dysfunctions of the intracranial membranes (Sutherland 1998, 305, 306, 337, 342, 346).

3.8 Articular Mobility of Cranial Bones

Sutherland's first inspiration regarding the cranial concept occurred while he was a student at the American School of Osteopathy. As mentioned earlier, he was contemplating the complicated anatomy of the cranial bones and their sutures when the insight came like a bolt from the blue that the sutures of the cranial bones were, "Beveled like the gills of a fish; indicating articular mobility for a respiratory mechanism". This original insight eventually led him down the path to develop his sophisticated cranial concept. He started with the study of the structure and function of the bones of the cranium, and from there explored the intracranial membranes, the concept of brain motility and cerebrospinal fluid fluctuation. He became extremely knowledgeable about the detailed anatomy of the cranial bones and dural membranes. This anatomical detail was a cornerstone of the formal cranial courses that he developed in the mid 1940s and that have continued since that time. It is beyond the scope of this paper to describe his incredibly detailed investigations of each cranial bone. Some key ideas, however, will be summarized (Sutherland 1998, 146, 214, 228).

Sutherland described all cranial bones as moving in a subtle rhythmical fashion with the Primary Respiratory Mechanism. He described the two phases of this mechanism as flexion and extension. In general, the flexion, or inhalation, phase of the head involves an increase in the lateral width of the skull, a shortening of the anterior-posterior dimension of the cranium, with an elevation of the junction between the occiput and the sphenoid. During this flexion phase, the paired bones of the skull go into external rotation. During the extension or exhalation, phase of this cycle, the opposite takes place. The cranium narrows in lateral width, lengthens in an anterior-posterior dimension and is accompanied by a lowering of the sphenoid-occiput junction and paired cranial bones going into internal rotation (Sutherland 1998, 152-156).

3.9 Center of Cranial Bone Motion – The Sphenobasilar Synchondrosis

While Sutherland described the mobility of all bones of the cranium, there is one area of particular importance. This area is the junction of the sphenoid bone with the basilar process of the occiput, which sits centrally within the cranial base. This arch is known as the sphenobasilar junction or symphysis (also known as a synchondrosis). The sphenoid and the occiput can be visualized as two wheels at the cranial base that mesh together with each other and with other important bones of the vault of the cranium, including the temporal, parietal and frontal bones. The sphenobasilar junction can be conceived as a central set of intermeshing gears that drive the other cranial bones in their cyclic movements. This area plays a key role in diagnosis and treatment of cranial dysfunctions of the head (Sutherland 1998, 152-160, 191).

3.10 Individual Motion of the Frontal, Parietal, and Occipital Bones

While Sutherland described the motion of each cranial bone in detail, only three bones Swedenborg discussed will be considered. During the inhalation phase of the Primary Respiratory Mechanism, Sutherland described the frontal bone as moving forward anteriorly as if hinged at the coronal suture that it shares with the parietal bones.

During the inhalation phase the parietals, which are hinged to each other at the shared sagittal suture, move outward laterally. The anterior basilar portion of the occiput moves upward during inhalation. During the exhalation, or extension, phase the frontal moves inward posteriorly, the parietals move inward medially, and the basilar portion of the occiput moves inferiorly. (Sutherland 1998, 152, 193, Sutherland 1990, 73)

3.11 Summary of Sutherland's Description of the Brain, Dural and Cranial Bone Motion

1) The importance of inherent motility of the brain and spinal cord that alternates in a cycle of flexion and extension. This motility is primary to, but often synchronous with, the respiratory movement of the lungs.

2) The mobility of the intracranial and intraspinal membranes moving in a reciprocal fashion following the motility of the brain and spinal cord.

3) The articular mobility of cranial bones moving in a subtle rhythmical fashion with the activity of Primary Respiratory Mechanism.

3.12 Sutherland's References to Swedenborg

Sutherland did make three recorded references to Swedenborg. Two references were published from 1944. The first compared the founder of Osteopathy to Swedenborg. The second reference commented on Swedenborg's descriptions of brain motion.

> "Like Swedenborg who studied anatomy two hundred years ago, in search of the soul, Dr. Andrew Taylor Still studied the handiwork of his Maker – the human body." (Sutherland 1944, 4)

> "If you become a mechanic of the cranial mechanism by correcting a cranial lesion, you become the pharmacist. There is no end to this thought. It is not a new thought. Swedenborg, 200 years ago, said there is movement of the brain. Have we anything totally new? No." (Sutherland 1998, 163)

While Sutherland never wrote any detailed analysis of Swedenborg's ideas, it is interesting that in these brief comments he makes several very important statements. Sutherland compares Andrew Taylor Still, the founder of Osteopathy, (whom he held in the highest regard) to Swedenborg and his search for soul-body unity through the study of the human form and anatomy. Sutherland also mentions that the thought of motion of the brain is not new and credits Swedenborg for his studies 200 years earlier ("The Brain" was written exactly 200 years earlier, in 1744). Sutherland even states that his own ideas are not totally new, implying that Swedenborg did indeed describe important ideas related to Sutherland's cranial concept. In these

statements, it is obvious that Sutherland shows tremendous respect for Swedenborg by tying him in with several of the most important things in his professional life: osteopathy and its founder, and the cranial concept.

Sutherland did make a third reference that involved Swedenborg and one of the translators of Swedenborg's scientific writings, Rev. Alfred Acton, PhD.

> "There was also a [cranial] study group at the Lippincotts' in Moorestown, New Jersey that was visited by Dr. Alfred Acton, the translator of Emanuel Swedenborg's anatomical texts." (Sutherland 1998, 311)

This will be discussed under the section "Acton and the Lippincotts".

Comparison and Contrast of Swedenborg's and Sutherland's Paradigms

4.1 Characteristics of Brain Motion
(see sections 2.3, 3.4 for references)

Both Swedenborg and Sutherland describe a subtle cyclic expansion and constriction of the brain. Both describe a spiral quality of motion of the different gyri of the brain. Swedenborg using the terms "spiral fluxion" in a "harmonious variation" while Sutherland terms this motion a "spiral movement" that coils and uncoils.

In Sutherland's own words:

> "See a sort of spiral movement in connection with the movements of the brain. See the spiral coil moving out one way and then coming together. How many spiral movements can you visualize in that Tide? How many little coils can you see?" (Sutherland 1990, 172)

Compare this to Swedenborg's description in "The Brain"

> "The cerebrum is divided into serpentine and almost vermicular gyres…its periods of expansion and constriction are simultaneous, and not successive.
>
> It is only the spiral fluxion and form, which furnishes an easy power of expansion, and which causes one part not to be in the way of another; it likewise induces a gyre to commence its fluxion anew where it ceases, and it thus perpetuates the same by a certain spontaneous effort." (Swedenborg 1882, 48)

4.2 Brain Motion Primary to Lung Motion (see sections 2.5, 3.5 for references)

Swedenborg and Sutherland both view the inherent motion of the brain and related structures as primary to lung respiratory motion, although the two are often synchronous.

It is interesting to compare several quotes on this topic,

Swedenborg:

> "The times of the animatory motion of the cerebrum, cerebellum, of the medulla oblongata and the spinal marrow, coincide with those of the respiration of the lungs." (Swedenborg 1882, 53)

Sutherland:

> "We might picture the falx cerebri and the tentorium cerebelli as cooperating with the cranial articulations in physiological movement rhythmical with that of the diaphragm." (Sutherland 1998, 42)
>
> "…normally there is movement in cranial articulations coincident with inspiration and expiration." (Sutherland 1998, 320)

4.3 Reciprocal Dural Membrane Motion (see sections 2.7, 3.6 for references)

Swedenborg and Sutherland shared a view of the dural membranes as moving reciprocally in response to the motion, or motility, of the brain.

Sutherland:

> "The falx cerebri and tentorium cerebelli, being tense at all periods, participate in the movement in a reciprocating manner and act as check ligaments." (Sutherland 1998, 143)

Swedenborg:

> "On this account, the universal dura mater is a common tendon, and it is the impulsory cause of the reciprocal motions of the brain and the sinuses; for whenever the brain is expanded, the dura mater, by means of the sinuses is put on a stretch and whenever the brain contracts, the dura mater is unstrung. This results in a reciprocal action." (Swedenborg 1882, 353)

4.4 The Fountainhead of Dural Motion and The Sutherland Fulcrum (see sections 2.8, 3.7 for references)

Swedenborg described the area along the straight sinus, at the junction of the falx cerebri, tentorium cerebelli and falx cerebelli, as the "general fountain-head of motion" of the dura. Sutherland described this same area as also of great importance in the reciprocal tension membrane system (so much so that his students named it the Sutherland Fulcrum).

Sutherland went on to describe this important junction as a fulcrum and incorporated this into treatment of patients. Swedenborg does not describe the concept of a fulcrum in his writings on the brain.

4.5 Cranial Bone Motion (see sections 2.4, 2.9-2.12, 3.8-3.10 for references)

Swedenborg and Sutherland seemed to share the concept of cranial bones moving in a rhythmic fashion, following the motion of the brain and dura, according to the structure of the cranial sutures. Both seemed to place emphasis on the sphenoid and sphenoccipital relationship as playing important roles in this system. Sutherland is more specific in focusing on the sphenobasilar synchondrosis as being a pivotal junction in the cranial mechanism. Swedenborg refers to this as the spheno-occipital axis.

Both men described similar changes in the shape of the head, accompanying the alternate motion of the brain, dura, cranial bones, with the lateral widening and longitudinal shortening associated with the expansion/inhalation phase and the opposite with the constriction/exhalation phase.

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4.6 Emphasis of "Inside Out" verses "Outside In"
(see sections 2.9, 3.8 for references)

Swedenborg emphasized "from the inside out" starting with the motion of brain and working outward to reciprocal dural motion and cranial bone motion. The brain and central nervous system are described as the most active movement, the dural and other intracranial and intraspinal membranes are less active, and the cranial bone movements are passive in nature. Swedenborg focused on the sequence of brain, dural membranes and then cranial bone motion.

Sutherland, on the other hand, seemed historically to approach his paradigm from the "outside in". He initially studied cranial suture and bone structure, function and movement, then developing more sophisticated concepts of dural motion, while all along recognizing the primary activity of brain motion. Over the years he did seem to shift in the importance he placed on the different components of the Primary Respiratory Mechanism.

This difference in emphasis is evident in the detail of study and description of the different parts of the cranial concepts on which Swedenborg and Sutherland each focused. Swedenborg described the anatomy and motion of the brain in more detail than Sutherland, while Sutherland described the anatomy and mobility of the cranial bones in more detail than Swedenborg. While Sutherland's cranial concept contained much more detailed and sophisticated descriptions of individual cranial bone mobility, it is still harmonious with Swedenborg's descriptions of cranial bone motion.

4.7 Therapeutic Application

The most obvious and significant difference between the approaches of Swedenborg and Sutherland is that of therapeutic application.

While Swedenborg studied functional anatomy at length and described the sophisticated model of his paradigm of brain, dural and cranial bone motion, he never developed any therapeutic application of his work.

Sutherland also dedicated himself to developing a similar extensive understanding of human structure and function, arriving at his own cranial concept. He applied this understanding in the context of the osteopathic tradition and philosophy of Andrew Taylor Still. He developed a sophisticated and effective system of diagnosis and treatment of strain patterns and specific dysfunctions of cranial bones, sutures and dura mater. He also taught this paradigm to other osteopathic physicians to diagnose and treat patients.

Historical Connections between Sutherland and Swedenborg

5.1 Rev. Alfred Acton, PhD

The Reverend Alfred Acton, PhD was a minister in the New Church during Sutherland's time. The New Church is also known as the New Christian Church or The General Church of the New Jerusalem. The New Church is founded on Swedenborg's explanation of Christianity. Acton was well versed in Swedenborg's scientific and theological works. He was raised to the degree of bishop in 1936, and was the Dean of the Theological School at the Academy of the New Church headquarters in Bryn Athyn, Pennsylvania. Acton was also one of the world leaders in Swedenborg's scientific works, especially relating to the brain. He reviewed Swedenborg's scientific works and translated Swedenborg's "The Cerebrum" from Latin into English. This was the first (and only) time this work has been translated into English. The Swedenborg Scientific Association published it in 1938 (Swedenborg 1938, title page, Acton 1944).

Acton was widely recognized as a leader in understanding, translating and teaching Swedenborg's scientific works. He actively sought out opinions from scientists and physicians on Swedenborg's ideas, trying to find modern applications and verifications of Swedenborg's scientific ideas, especially in regards to the brain. Acton corresponded with professors at Harvard Medical School, Yale University School of Medicine, Boston University School of Medicine, and University of Cambridge, England among others. The letters to and from the faculty at these institutions ranged from 1931-1957. He also corresponded with at least one osteopathic physician, Isabelle Biddle, DO, who practiced and taught cranial osteopathy. This correspondence took place some time between 1951 and 1956. Acton continued to search for validation and application of Swedenborg's scientific work throughout his life, up until his death in 1956 (Acton Letters, 1931-1957).

Acton had contact with the Lippincotts' study group in Moorestown, New Jersey. Both Acton and Sutherland referenced this contact. Acton mentioned this in autobiographical notes written in November of 1944. In these notes he wrote,

> 1938 – S.S.A. [Swedenborg Scientific Association] published my translation of *The Cerebrum*, 3 volumes.
>
> "In consequence of this publication, I was invited to address a Group of Osteopathic doctors in New Jersey, which I did." (Acton 1944, 12)

Acton visited this New Jersey "Group of Osteopathic doctors" sometime between 1938 and November 1944. This visit was probably the same one mentioned by Sutherland and will be discussed further in the Lippincott section.

5.2 Biddle, Acton and Sutherland

Sutherland and Acton knew of each other and had met and compared ideas. The details were not recorded; so, little is known about their interactions. Each of these scholars was strongly committed to their respective studies on the brain. Their meeting was referenced by an osteopathic physician who was also a practitioner and teacher of cranial osteopathy, Isabelle Biddle, DO from California. She wrote to Acton commenting on the similarities between the ideas of Swedenborg and Sutherland. She mentioned that Acton and Sutherland had met to discuss cranial osteopathy and Swedenborg's ideas about the brain. Biddle studied Swedenborg's "The Cerebrum" and "The Brain", pursuing the application of Swedenborg's ideas to cranial osteopathy. Biddle wrote to Acton:

> "Thank you for sending to me the "New Philosophy" magazine with Dr. Bancroft's article. It is most interesting and I intend writing her. I am making a study of Swedenborg's philosophical and scientific works, as I am especially interested in "The Brain". I have your edition and also Tafel's.
>
> I have studied cranial osteopathy and understand you saw Dr. Sutherland about its relation to Swedenborg's

theory and they seemed to differ: however, I believe they are very similar and that is what I am working out now. The results from treatment indicate that Swedenborg's theory is correct."

(Biddle 1957)

The article to which Biddle referred was, "The Motion of the Brain and Electroencephalography" by Edith D. Bancroft, M.D., published in "The New Philosophy" (the journal of the Swedenborg Scientific Association) in 1951. This article reviewed Swedenborg's concept of brain motion/animation and compared it to emerging findings in electroencephalography (Bancroft 1951, 169-179).

Not much is known about Isabelle Biddle. The archives at the Cranial Academy, in Indianapolis, do have a transcription of a presentation given by Dr. Biddle at the College of Osteopathic Physicians and Surgeons in Los Angeles, California, February 8, 1951, titled, "The Application and Uses of Cranial Technique". While this transcript does not mention Swedenborg, it does demonstrate that Biddle was giving in-depth presentations on cranial osteopathy during the early 1950s. Interestingly, Sutherland moved to California in 1951, where he and his wife lived until his death in 1954. (Biddle 1951, Cranial Academy Archives)

5.3 Acton and the Lippincotts

Sutherland did make reference to Acton in 1953 in a special recording that has been transcribed and printed in *Contributions of Thought, The Collected Writings of William Garner Sutherland, DO*. This reference was made while Sutherland was commenting on early teaching and study groups.

"Dr. Alfred Acton, the translator of Emanuel Swedenborg's anatomical texts, visited the Lippincott cranial study group in Moorestown, New Jersey." (Sutherland 1998, 311)

Acton visited the Lippincott's study group at least once, and was actively exploring connections with osteopathic physicians studying cranial osteopathy. He certainly had contact with Howard and Rebecca Lippincott and other osteopathic physicians through the study group. It is interesting that Acton lived, studied, taught and ministered in Bryn Athyn, a northern suburb of Philadelphia. The Lippincotts' cranial study group was in Moorestown, New Jersey. Another geographically close and interested physician was Beryl Arbuckle, DO, in Philadelphia.

5.4 Howard and Rebecca Lippincott

Howard A. Lippincott, DO and Rebecca Conrow Lippincott, DO were husband and wife osteopathic physicians who became enthusiast students and supporters of Sutherland. They visited Sutherland in 1942 and quickly became immersed in the world of cranial osteopathy. This was the same year that Beryl Arbuckle, of Philadelphia, started studying with Sutherland. In November 1943, the Lippincotts developed the first long standing Cranial Study Group. This group met at the Lippincott's home in Moorestown, New Jersey and was very active. They met regularly with well-structured tutorial and practice sessions for many years. Summary program notes of the meetings from 1947-1964 are preserved at the Cranial Academy Archives. Attendance at the regular meetings was usually around 20 osteopathic physicians. (Sutherland 1962, 77, 81**,** Lippincott Study Group files 1947-1964, Cranial Academy Archives, Still-Sutherland Study Group, 2005, 7)

Since the Lippincotts' Moorestown Cranial Study Group did not start until November 1943 and Acton's reference was written in November 1944, then Acton's visit to the Cranial Study Group (presumably, the one mentioned by Sutherland during reminisces in 1953) must have taken place sometime during the first twelve months of that Group's existence between November 1943 and November 1944. It is interesting that Sutherland's first two recorded references to Swedenborg were made in 1944.

By attending the Lippincott cranial study group, Acton was interacting with leaders and future leaders in Osteopathy, particularly cranial osteopathy.

5.5 Beryl Arbuckle, DO

Beryl Arbuckle, an osteopathic pediatrician in Philadelphia, Pennsylvania, was one of the earliest in the profession to investigate and clinically test Dr. Sutherland's cranial osteopathy.

While born in Natal, South Africa, she studied medicine in the United States, graduating from the Philadelphia College of Osteopathy in 1928. She worked in the Department of Pediatrics at the Philadelphia College of Osteopathy from 1928 until 1944. From 1944 to 1954 she was a staff member of the Department of Osteopathic Therapeutics at the Philadelphia College of Osteopathy. She continued to practice for years after 1954 in suburban Philadelphia. She later received one of the highest awards in the profession, the Andrew Taylor Still Medallion of Honor from the American Academy of Osteopathy. (Arbuckle 1994, iii, iv)

Arbuckle studied with Sutherland in 1942, becoming one of his early prominent pupils. Arbuckle was one of two assistant faculty to assist Sutherland at the first comprehensive postgraduate cranial course. The course was held at the Des Moines Still College of Osteopathy and Surgery in 1944. It was during this course that Sutherland made two references to Swedenborg; one comparing Still to Swedenborg, the other stating that Swedenborg described motion of the brain 200 years earlier (Goodman 2003, xv, Arbuckle 1994, iv, Sutherland 1944, 7, Sutherland 1990, xxii, Sutherland 1998, 163).

Arbuckle was active with later cranial faculty at the Des Moines classes, but went on to teach her own cranial courses in the Philadelphia area. According to one reference, she maintained a cordial and fruitful relationship with Sutherland up until his death in 1954. (Goodman 2003, xvi, xvii)

5.6 Arbuckle's References to Swedenborg

Arbuckle made three references to Swedenborg.

The first reference mentioned Swedenborg's writings concerning brain motion and circulation of cerebrospinal fluid at the American Osteopathic Association Convention in New York, 1946.

"It was two hundred years ago that Swedenborg advanced the thought that the brain moved, and he spoke also of the circulation of the cerebrospinal fluid."

AOA Convention, New York, 1946,
Published in *American Osteopathic Association Journal*,
May 1948 (Arbuckle 1994, 18)

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The second reference was made in 1947. In this remark, she sights Acton's translation of Swedenborg's "The Cerebrum". The reference reads,

> "That the brain moves was told the world by Swedenborg over 200 years ago and the cranial concept provides us with an understanding of the mechanism permitting movement of the brain."
>
> Eastern States Convention, April 1947, Published in *American Osteopathic Association Journal*, February 1948. (Arbuckle 1994, 38)

The third reference also sighted Acton's translation of Swedenborg's "The Cerebrum". It was made at the New Jersey State Convention in 1947.

> Almost a century before the birth of A. T. Still, Swedenborg was teaching that the brain moved with regular expansion and contraction. He describes with amazing clarity how the tensity of one dural reduplication affects the tensity of another. We have been taught by Dr. Sutherland to regard these dural reduplications as reciprocal tension membranes. Swedenborg wrote of the effect of this reciprocal tension upon the change of shape, in cross section and length of the various brain sutures.
>
> These dural membranous reduplications, Swedenborg believed, confined the brain within its limits of activity, and our anatomy books of today ascribe the function of these membranes as holding the contents of the cranium in place, while during development and the early stages of life they protect the developing brain, especially during the stresses and strain of labor and delivery. Bearing in mind these probable functions, are we not able to reason osteopathically that any restriction or alteration in the normal tensity of these membranes will interfere with the vital forces that "vivify all animated nature"?
>
> New Jersey State Convention, May 1947, Published in *The Profession*, October 1947. (Arbuckle 1994, 42)

It is clear that Beryl Arbuckle was one of Sutherland's earliest students and became an important teacher of cranial osteopathy. She was exposed to Swedenborg's ideas while studying with Sutherland. This has been recorded in Sutherland's statements regarding Swedenborg in 1944, while teaching the first Des Moines courses at which Arbuckle was assistant faculty (see section 3.12). Arbuckle went on to study Swedenborg's works, citing Acton's translation of Swedenborg's "The Cerebrum" in professional presentations and publications. She later stopped teaching at the Des Moines courses and the Lippincotts became active faculty with the continued courses.

5.7 Acton, Arbuckle, Lippincotts, Sutherland and Biddle – A Summary

It is evident that Sutherland and Arbuckle were familiar with Swedenborg's scientific writings on the brain by their own references. It is also certain that the Lippincotts had significant exposure to Swedenborg's ideas by interaction with Acton through their study group in Moorestown, New Jersey. Acton and Sutherland met and exchanged ideas, as cited by another osteopathic physician who studied and lectured on cranial osteopathy, Isabelle Biddle. Arbuckle cited Acton's translation of Swedenborg's work, "The Cerebrum" which was published in 1938.

The 1940s and 1950s appear to have been a time of interest in Swedenborg by more than a few osteopathic physicians active within the cranial osteopathy community, including the founder of cranial osteopathy, William G. Sutherland.

5.8 Viola Frymann

Viola Frymann, DO, FAAO (Fellow of the American Academy of Osteopathy), FCA (Fellow of the Cranial Academy) is a living student of Dr. Sutherland who is still in active practice. She was kind enough to respond to inquiries about Sutherland and Swedenborg.

Dr. Frymann graduated from the College of Osteopathic Physicians and Surgeons (COPS) in Los Angeles, California in 1949 (COPS was an osteopathic medical school that was later converted to an allopathic medical school in 1962). She studied with Dr. Sutherland and remains a leader in the osteopathic profession and an important teacher of Osteopathy in the Cranial Field.

Dr. Frymann recalls Sutherland mentioning Swedenborg occasionally, but she does not remember Sutherland going into much detail about him, or writing about him. (V. Frymann, Personal communication, December 8, 2004)

5.9 Herb Miller

Herb Miller, DO, FAAO, FCA is another living student of Dr. Sutherland. He, too, is still in active practice.

Dr. Miller graduated from the College of Osteopathic Medicine and Surgery (COMS) in Des Moines (now known as the Des Moines University Osteopathic Medical Clinics) in 1956, after Dr. Sutherland had died. Dr. Miller, however, did study with Dr. Sutherland while a student at COMS. He also studied closely, at length, with Sutherland's other students. Dr. Miller is an important leader in the osteopathic profession, particularly in Osteopathy in the Cranial Field.

Dr. Miller recognizes and remembers Swedenborg's name coming up in discussions by Sutherland's students in regards to his anatomical works. Similar to Dr. Frymann, he does not recall any detailed discussions about Swedenborg's ideas. In his words, "She probably heard the same things I did". (H. Miller, personal communication, October 25, 2005)

5.10 Summary of Historical Connections

There is no question that Sutherland was familiar with Swedenborg's scientific writings regarding the brain. This is clear from Sutherland's own references to Swedenborg. Of interest ,are the details of the historical connections. Three of Sutherland's students, Arbuckle, Frymann, and Miller, knew of Swedenborg. Arbuckle knew of Swedenborg's ideas in detail, citing Acton's translation of "The Cerebrum". The recollections of Frymann and Miller are only of passing references. The Lippincotts and the early members of their Cranial Study Group in Moorestown, New Jersey were exposed to Swedenborg's ideas concerning the brain through their contact with Alfred Acton.

It is clear that Acton and Sutherland interacted with each other, and that Acton had contact with other osteopathic physicians through the Lippincotts' Cranial Study Group and other avenues. Most of the interest in Swedenborg seemed to be during the 1940s and 1950s.

Conclusion

6.1 Swedenborg's Paradigm of the Brain and Sutherland's Cranial Concept Shared Similar Descriptions of Brain Motion, Dural Motion and Cranial Bone Motion

Swedenborg described brain functional anatomy and motion in a unique paradigm during the 1700s. His paradigm of brain and body interaction was comprehensive and included the concepts of inherent rhythmic brain motion, reciprocal dural motion and motion of the cranial bones. This brilliant anatomical work was a stepping-stone for Swedenborg as he moved on beyond anatomical science, to explore an organic theology that is still influential and meaningful today.

Sutherland had his initial insight into the cranial mechanism in 1898 while he was a student at the first osteopathic school. He had the sudden realization that the structure of the cranial bones indicated mobility as part of a greater mechanism. This was a novel insight, one not recognized by the scholars of his day. Sutherland pursued this idea searching for more insights, eventually developing a comprehensive cranial concept in the early to middle 1900s. This included components of brain motility, reciprocal motion of the dura and mobility of the cranial bones.

Sutherland's genius was not only his original insight into the cranial mechanism, but also the lifelong development of osteopathic applications of the cranial concept. He constantly worked to improve his understanding of the cranial concept, developing ways to utilize this understanding to treat patients from an osteopathic perspective. He developed a comprehensive system of diagnosis and treatment, expanding the osteopathic paradigm, continuing to apply the philosophy of osteopathy's founder, Andrew Taylor Still, in new ways. Swedenborg did not develop a system of treatment, nor did he mention manual medicine.

Swedenborg and Sutherland both studied the anatomy and motion of the brain, dural membranes and cranial bones in great detail. They arrived at models that shared some similar ideas. Swedenborg's paradigm of the brain and Sutherland's cranial concept shared similar descriptions of brain motion, dural motion and cranial bone motion. Sutherland's work followed Swedenborg's work by 200 years. Sutherland did make references to Swedenborg's ideas of the brain.

There is no question that Swedenborg's paradigm of the brain had an influence on the development of Sutherland's cranial concept. The question yet to be answered is, how much?

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An Osteopathic Approach to Visceral Disease: A Case of Recurrent Urinary Tract Infection

Christine Lerma, Michael Mesisca, and Raymond J. Hruby

The Case

Chief Complaint: Burning with urination for three days

History of Present Illness: A 28 year old female, gravida 1 para 0 with 1 spontaneous abortion, presents to the women's health clinic complaining of very painful urination with increasing frequency of twice per hour and mild urgency without incontinence over the past ten days. The pain is graded as 6/10, is described as "burning" and "sharp" during urination; the pain begins at the onset of urination and persists for less than two minutes afterwards. She describes the pain as localized to perineal region, without radiation to the back. Movement does not worsen the pain. Her urine is normal and yellow to clear in color without evidence of gross hematuria. Sexual intercourse is not usually painful, but has been uncomfortable over the past week, which she attributes to anxiety related to the dysuria. She has not taken any medications for this episode. She has, however, been to this same clinic three times over the past ten months with similar complaints and has been treated with oral antibiotics (Bactrim®) on each occasion with resolution of symptoms but has missed appointments for follow-up urinalysis both times.

Her last menstrual period was 27 days ago; her periods are regular (every 27-29 days), without spotting between cycles, lasting five to six days and no recent changes in flow. Her last pap smear was one year ago and she reports as normal, no record or personal knowledge of sexually transmitted disease.

Past Medical History: No history of previous serious illnesses.

Past Trauma History: Patient denies any history of trauma, including sports related injuries, falls, or car accidents.

Family History: There is no family history of bladder cancer and immunodeficiency. Her mother was diagnosed with breast cancer two years ago, at age 46, and was treated with neo-adjuvant chemotherapy and surgery, without evidence of persistent disease. She denies any family history of diabetes mellitus, hypertension hyperlipidemia, or coronary artery disease.

Social History: She works as a kindergarten teacher for a local public school and lives with two roommates. She has had eight sexual partners, three of whom were in the last year. She is not certain whether she has ever had any sexually transmitted disease. She uses condoms, but only intermittently, and is not using oral contraception. She denies smoking or drug abuse, but drinks with friends regularly each weekend, approximately six to seven beers per weekend night.

Medications: She takes a multivitamin, and no other medications.
Allergies: None known.
Physical Examination: Pertinent physical examination findings were:

Vital signs: Height 5'7''; Weight 130 lbs; Temperature 98.9; Blood Pressure 115/78; Pulse 68; Respirations 14.

General Appearance: This patient is a well-developed, well-nourished female who looks her stated age.

Abdomen: Soft, non-distended, suprapubic tenderness noted, no masses appreciated. BS auscultated in all four quadrants. No costo-vertebral angle tenderness. No organomegaly appreciated on exam.

Pelvic Exam: No lesions, ulcers, or varucae noted on the perineum or in the vagina. Speculum exam, performed after Urine B-HCG results, revealed a small amount of pooling in the posterior fornix. No odor detected. Cervix was visualized, no masses, prolapse, or lesions noted. External os is closed without discharge. Bimanual exam revealed a midline uterus without masses noted and no enlargement or tenderness of the ovaries.

Structural Examination:

General: Patient has normal gait, slightly forward leaning posture and decreased thoracic kyphosis and lumbar lordosis. No evidence of scoliosis.

Cervical: OAR_RS_L, AA R_L.

Thoracic: T9-12 NR_LS_R. There is minimal excursion of the thoracic diaphragm on the right.

Ribs: Inhalation dysfunction of rib 1 on the right.

Lumbar: L2 FR_RS_R, L5FR_RS_R. There is mild tenderness to palpation over L4-5 on the right.

Pelvic: Mild tenderness to palpation over the left Sacroiliac joint. Iliac crest heights are level. Positive standing and seated flexion tests were observed on the right (seated > standing). The hamstring muscles were not tight. The right anterior superior iliac spine was inferior to the left and the right pubic was tubercle inferior to the left.

The right posterior superior iliac spine was superior to the left with the right sacral sulcus deeper than the left. The left inferior lateral angle of the sacrum was prominent. Backward bending test reveals greater symmetry in the sacrum. The anterior superior iliac spine compression test was positive on the right. Inhalation somatic dysfunction of the pelvic diaphragm was observed.

Extremities: Leg length revealed a slightly longer right leg, estimated 1/8''.

Laboratory/Imaging Data: Urine Analysis showed 3+ Leukocyte esterase, 1+ Nitrites, - Glucose, - RBCs, - Protein, low osmolarity, yellow-clear Urine Culture pending Urine B-HCG: Negative

Pap and gonococci and Chlamydia cultures pending

Assessment

1. Recurrent urinary tract infection
2. Thoracic, lumbar, and pelvic somatic dysfunction

Plan

1. Ciprofloxacin 500 mg x 14 days
2. Patient Education (Sexual education and sexually transmitted disease prevention, increase fluid intake).
3. Osteopathic manipulative treatment

Outcome

The patient was treated with OMT on this visit and weekly for two more visits. She experienced marked relief of her symptoms within 48 hours of the first visit. The urine culture revealed heavy growth of Escherichia coli. Urine culture and analysis after completion of the course of antibiotics and OMT was negative. She has remained free of any further symptoms or evidence of recurrent urinary infection to date.

Discussion:
The Osteopathic Approach

Defining Urinary Tract Infections: Sporadic, Recurring, And Relapsing

Urinary tract infection is a common disease process that presents to physicians practicing in different fields of health care provision. Urinary tract infection can be limited to the bladder, known as cystitis, or it may spread to the upper urinary tract, known as pyelonephritis. In general, 25-40% of females ages 20-40 experience at least one urinary tract infection at some point in their life.

Patients presenting with a recurrent urinary tract infections are no less common than those presenting with sporadic urinary tract infections. The pathogenesis of a recurrent urinary tract infection is the same as a sporadic. A urinary tract infection becomes "recurrent" when a patient experiences two or more symptomatic urinary tract infections within six months or less, and/or experiences three or more symptomatic urinary tract infections within 12 months or less. Recurrent urinary tract infections are very common, in fact 27% of college females will have their second urinary tract infection within six months of the initial infection and 2.7% of them will experience their third urinary tract infection within that same six-month period. In general, of women ages 17-82, 44% will experience their second urinary tract infection within the year after the first initial infection.

Recurrent urinary tract infections can be classified as either a "reinfection" or a "relapse". A reinfection is considered to have occurred if there is another infection two weeks after the initial infection with a negative urine culture in between, or if there is reinfection with a different organism. A "relapse" is thought to have occurred if an infection occurs less than two weeks from the initial infection, without a negative urine culture in between. The majority of cases are reinfection. As with sporadic urinary tract infection, the rates of infection are much higher in woman than in males.

The Differential Diagnosis:

It is worthwhile to note that before diagnosing a patient with recurrent urinary tract infection that the physician should thoroughly review the differential diagnosis and consider such possibilities as: interstitial cystitis, bladder tumors, kidney stones in the bladder, prostate disease, congenital abnormalities, and incomplete emptying of the bladder.

Risk Factors for Recurring Urinary Tract Infections:

There are a number of risk factors that can increase the susceptibility of patients to be predisposed to recurrent urinary tract infections and can be separated between premenopausal and postmenopausal women. The risk factors for each group are listed in **Table 1**, along with factors that have been shown to have no association. Notice that somatic dysfunction may be a risk factor for patients experiencing recurrent urinary tract infection.

Osteopathic Management of Recurrent Urinary Tract Infections

After the diagnosis of recurrent urinary tract infection has been made, and other possible diagnosis and/or other comorbid disease processes have been excluded, a thorough osteopathic treatment regime would include: patient education on appropriate lifestyle modifications (including personal and sexual hygiene practices), prescribing medications, and osteopathic manipulation.

Counseling and Medical Management:

For recurrent urinary tract infection, the pre-menopausal woman would be advised against using spermacides (especially with diaphragms), to urinate after sexual activity, and to increase fluid intake. For post-menopausal women, the use of topi- →

Table 1. RISK FACTORS FOR RECURRENT URINARY TRACT INFECTION

PRE-MENOPAUSAL WOMEN	POST-MENOPAUSAL WOMEN
1. Genetics	1. Genetics
2. Frequency of Sexual Intercourse	2. Urinary Incontinence
3. Spermacide use esp. with Diaphragm	3. Presence of Cystocele
4. Recent Antibiotic Use	4. Post-void Residual
5. Public Symphysis Somatic Dysfunction	5. Public Symphysis Somatic Dysfunction
6. Sacroiliac Somatic Dysfunction	6. Sacroiliac Somatic Dysfunction
7. Pelvic Floor Somatic Dysfunction	7. Pelvic Floor Somatic Dysfunction
8. Thoracolumbar Somatic Dysfunction Affecting the Sympathetics (T10-L-2)	8. Thoracolumbar Somatic Dysfunction Affecting the Sympathetics (T10-L-2)
NO ASSOCIATION FOUND FOR EITHER GROUP	
1. Pre/postcoital voiding patterns	4. Wiping patterns
2. Frequency of urination	5. BMI
3. Delayed voiding	

cal estrogen cream has been shown to be effective in preventing infection. For both groups, the medical standard of care includes antibiotic prophylaxis, typically with ciprofloxacin, following one of three possible regimens: continuous antibiotic prophylaxis, post-coital prophylaxis, and intermittent self-treatment. Although antibiotic prophylaxis has been shown to be very effective in reducing the number of recurrences, it is also associated with side effects such as vaginal and/or oral candidiasis and gastrointestinal symptoms.

Addressing the Structural Disease:

Osteopathic manipulation has also been shown to be effective in reducing the number of recurrences. The osteopathic approach to the patient assumes an interconnectedness of the body, that dysfunction in one organ system and/or in one structural area of the body, will impact other systems and structures. The treatment approach, therefore, involves using symptoms, disease presentation and palpation to identify the structural problems that will give insight into the source of the patient's underlying functional abnormality that is presumed to facilitate the disease. In a patient with recurrent urinary tract infections, any dysfunction in the pelvis or throughout the body for that matter, may contribute to the disease process. The question to ask prior to treating or diagnosis the structural problem is: what is the underlying factors in this patient that are contributing to her inability to resist infection? One possibility, amongst several, is the presence of an underlying structural problem that is reducing lymphatic flow through the pelvis making the patient more susceptible to infection and then reducing the body's ability to fight the infection.

The Significance of Pelvic Autonomics:

Although dysfunction may be found at any area of the body, and should be addressed, there are several structural abnormalities that osteopathic clinicians have found to be consistently present among patients presenting with recurrent urinary tract infection. They have noted specifically the presence of dysfunction in the thoracolumbar, iliosacral, sacroiliac region and the pelvic diaphragm.

Research evidence and clinical experience support the osteopathic contention that the treatment of somatic dysfunctions in the thoracolumbar and/or the sacroiliac region impacts the urinary tract system through the balancing of the autonomic nervous system. There have been studies, for example, that have shown that sympathetic stimulation increases vasoconstriction of the afferents, which decreases the GFR (glomerular filtration rate) and decreases urine volume and therefore urine output. There have been additional studies that have shown that patients with T11-L1 somatic dysfunction were more vulnerable to acute pyelonephritis and less likely to respond to antibiotic treatment if spinal manipulation was not involved. It is critical, therefore, that the autonomics are addressed when treating a patient with recurrent urinary tract infection.

The thoracolumbar and sacroiliac regions are critical to the success of osteopathic treatment of the pelvic viscera because of the influence of somatic dysfunction to that area on the autonomic nerves of the urinary tract system. The sympathetic nerves that contribute to the regulation of the urinary tract system descend from the spinal cord, exiting at levels T10-L2. The parasympathetic nerves of the urinary tract system are found from S1-S3. The functions of the sympathetics and parasympathetics on the urinary tract system are listed in **Table 2**.

Among the many pelvic visceral structures affected by the autonomics are: the ureters bilaterally, the bladder, and the internal urethral sphincter. The external urethral sphincter is under voluntary control and is innervated by the pudendal nerve (S2-S4).

The Structural Pelvis:

Resolving structural dysfunctions of the iliosacral region and pelvic and thoracic diaphragms has shown to be very significant in the treatment of recurring Urinary Tract Infections. Iliosacral dysfunction can directly affect the bladder, especially pubic shears and/or compressions. These dysfunctions can place excessive tension on the pubovesicular fascia, the pubovesicular ligament and median and medial umbilical ligament. The sustained mechanical tension on ligaments, fascia, neural and skeletal structures, in general, can impair the exchange of fluids and nutrients, and the overstimulation of the nervous system can impair function of the organs. As in recurrent urinary tract infection, iliosacral somatic dysfunction can place excessive tension on fascia and ligaments that causes and/or enhances impairment in the function of the urinary tract system leaving it susceptible to infection.

Although specific areas should be assessed when treating a patient with recurrent urinary tract infection, treatment approaches are likely to be physician dependent. One approach may be to start working from superficial to deep, treating the fascia overlying the posterior pelvis and sacrum with myofascial techniques; then treating the secondary muscles if dysfunctions are present, using muscle energy. The final step then may be to work directly on the bones and joints using articulatory techniques.

The Paradigm Shift of Osteopathy

The osteopathic approach requires a unique patient approach in order to restore health to the patient. Typically, treatment plans are devised to address each "symptom" manifested by a disease. The basic premise of osteopathy, however, directs the physician to assess the anatomy or structure of the patient to determine if there is a structural cause to the patient's problem. The issue of causation is primary, and structure is integral to understanding the triggers for

Table 2. FUNCTIONS OF THE AUTONOMICS
ON THE URINARY TRACT SYSTEM

SYMPATHETICS (T10-L2)	PARASYMPATHETICS (S1-S3)
Decrease ureteral peristalsis	Increase ureteral peristalsis
Relaxation of the bladder	Contraction of the bladder wall
Contraction of the internal urethral sphincter	Relaxation of the internal urethral sphincter
NO URINE OUTPUT	**URINE OUTPUT**

the pathophysiology of disease.

As in this case study, structural dysfunction of the iliosacral and sacroiliac region and the thoracolumbar junction may be the primary reason, or precipitating event, that facilitates this patient's recurrent urinary tract infections. There is not, unfortunately, a one to one correlation between structural dysfunction and medical diagnosis. The human body is much more complicated than that, hence there is not a one to one correlation between disease state and osteopathic treatment paradigm. Patient specific treatment for a single medical diagnosis is an integral and yet sometimes difficult lens with which the osteopathic physician must view disease.

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2008 Component Societies' CME Calendar
and other Osteopathic Affiliated Organizations

June 19-22
Annual Conference: Dynamic Concepts in Facial Development
The Cranial Academy
Directors: Eric J. Dolgin, DO, FCA and Tasha Turzo, DO
Hilton Hotel
Indianapolis, IN
Contact: The Cranial Academy
317/594-0411
www.cranialacademy.org

July 25- 27
Manual Medicine: An Osteopathic Approach: Intro to Osteopathic Medicine and Evaluation & Treatment: Lumbar Spine
UNECOM
Biddeford, ME
CME: 20 Category 1A (anticipated)
Contact: CME Office
207/602-2589
www.une.edu/cme/events.asp

August 8-10
The Face (20-hour intermediate course)
Sutherland Cranial Teaching Foundation
Director: Doug Vick, DO
Indianapolis, IN
CME: 20 Category 1A
Contact: Judy Staser, Exec. Secy.
Phone: 817/926-7705
www.sctf.com

September 12-14
Manual Medicine: An Osteopathic Approach: Intro to Osteopathic Medicine and Evaluation & Treatment: Thoracic & Rib Cage
UNECOM
Biddeford, ME
CME: 20 Category 1A (anticipated)
Contact: CME Office
207/602-2589
www.une.edu/cme/events.asp

October 17-19, 2008
An Osteopathic Approach to Chronic Pain-Endocrine Immune II
Sutherland Cranial Teaching Foundation
Director: Hugh Ettlinger, DO, FAAO
Biddeford, ME
CME: 18 Category 1A
Contact: Judy Staser, Exec. Secy.
Phone: 817/926-7705
www.sctf.com

November 7-9
Biodynamics of Osteopathy: Phase III
Donald Hankinson, DO
UNECOM
Biddeford, ME
CME: 21 Category 1A (anticipated)
Contact: CME Office
207/602-2589
www.une.edu/cme/events.asp

American Osteopathic Association
AOA Annual Convention and Scientific Seminar
October 26-30, 2008
Las Vegas, NV

Registration and housing is now open for the AOA's 113th Annual Convention and Scientific Seminar, which is taking place on October 26-30, 2008 in Las Vegas, NV. Please click on the link below to register for the convention and to reserve your room at the Palazzo Hotel Resort Casino (part of the Venetian Hotel). Advance registration online, mail, or fax, must be completed by September 4, 2008; registrations received after this date will be held for pickup onsite. We look forward to seeing you in Las Vegas.

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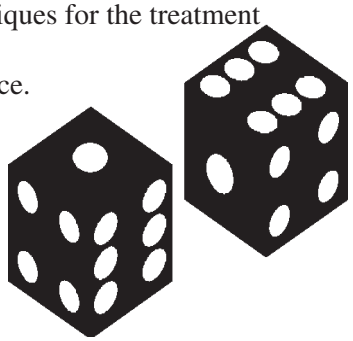
Natalie A. Nevins, DO, MSHPE
2008 Program Chair

Program Goals and Objectives

- Attendees will learn how to educate their patients on choosing and implementing an exercise program.
- Attendees will learn some of the barriers to creating a healthy lifestyle, and how to overcome them.
- Attendees will learn about the special needs of geriatric, pediatric and OB patients in creating a overall fitness plan.
- Attendees will learn appropriate manipulation techniques useful in the treatment of Pediatric, geriatric and OB patients.
- Attendees will learn how to evaluate exercise footwear and how to help patients choose the right ones.
- Attendees will learn methods of identifying key somatic dysfunctions and techniques for the treatment of athletes and weekend warriors.
- Attendees will be exposed to the use of EMR and how to utilize it in their practice.



See you in Las Vegas!

Prolotherapy Weekend:

For all Levels and Experience

October 9-11, 2008

UNECOM, Biddeford, ME

Mark S. Cantieri, DO, FAAO
Program Chair

Additional Faculty: George Pasquarello, DO, FAAO

Courses Outline:

Thursday, Oct 9: This will be required for those physicians who have not taken a prior course in prolotherapy. It will include an introduction to prolotherapy, wound healing, degenerative postural cascade, coding and billing.

Friday and Saturday, Oct 10-11: Participants will be divided into two groups, beginners and advanced. These two groups will alternate between lectures and anatomy and injection technique while the other group will be in the anatomy lab performing injections under supervision and reviewing prosections.

CME:

The program anticipates being approved for 20 hours of AOA Category 1-A CME credit pending approval by the AOA CCME.

Program Time Table:

Thursday, Oct 9 ..... 5:00 pm – 9:00 pm
Friday, Oct 10 ..... 8:00 am – 5:30 pm
Saturday, Oct 11 ..... 8:00 am – 12:30 pm

Course Location:

UNECOM
11 Hills Beach Road, Biddeford, ME 04005
www.une.edu

Hotel Accommodations:

For hotel possibilities, visit:
www.expedia.com; www.travelocity.com;
www.priceline.com; or www.BizRate.com

Search for South Portland, Biddeford or Kennebunkport. A rental car is recommended since the campus is located about 15-20 minutes from most hotels and restaurants.

REGISTRATION FORM
Prolotherapy Weekend
October 9-11, 2008

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AOA # _____ College/Yr Graduated _____

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___ **This is my first Prolotherapy Course**

I require a vegetarian meal ❒
(AAO makes every attempt to provide snacks/meals that will meet participant's needs, but we cannot guarantee to satisfy all requests.)

	REGISTRATION RATES	
	ON OR BEFORE TO 9/9/08	AFTER 9/9/08
Registration fee	$1,500	$1,600
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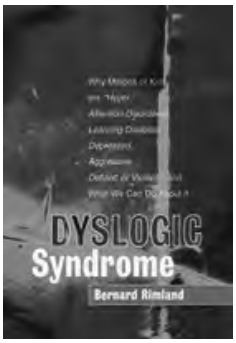
Book Reviews



Dyslogic Syndrome. Bernard Rimland, Ph.D., Jessica Kingsley Publishers, 116 Pentonville Road, London, N1 9JB, UK and 400 Market Street, Suite 400, Philadelphia, PA19106, ISBN 978 1 84310 877 1

Dyslogic behavior is any behavior that is irrational or not logical. It can encompass the spectrum from autism to criminal behavior to violence. Dr. Rimland writes clearly and concisely. In 181 pages, he defines Dyslogic Syndrome and explores its history. He has over 50 years of research and clinic practice in diagnosing and treating autism and was the parent of an autistic child. He explores the dramatic rise in a spectrum of problems that comprise the Dyslogic Syndrome. The book is well referenced. He gives examples of beneficial treatments that have worked in real life as well as treatments that have had recurrent undesirable consequences.

He also exposes the dismal failures of most conventional pharmacological and psychological treatment. "Your dislogical child has a physical problem – a medical problem. It may stem from toxic exposure, a diet lacking in nutrients, a genetic vulnerability, an infectious process, an undetected seizure disorder, a head injury, a medication reaction, an allergy or food sensitivity, or another condition that affects brain function. No matter which of these problems afflicts your son or daughter, you cannot psychoanalyze it away, and you cannot drug it away. Talk therapy doesn't address a biological problem, and drugs merely mask symptoms while adding toxic chemical to an already dysfunctional system."

Dr. Rimland offers solutions that fit with the osteopathic philosophy. He looks at function and what can be done to support and enhance it. His treatment recommendations in the last chapter are fairly easy to follow: quality nutrition, supplements to support the nervous system especially the B vitamin group, eliminate toxins (heavy metals, molds, chemicals) in the diet and the environment, regular physical activity or exercise, more time in the sun and use full spectrum lighting, and avoid simultaneous multiple vaccinations and mercury based vaccine preservatives. He strongly recommends natural approaches and feels drugs are not first line treatment but should be used as a last resort.

Bottom Line's Ultimate Healing; World's Greatest Treasury of Health Secrets Volume II
ISBN 0-88723-453-9
More Ultimate Healing
ISBN 0-88723-457-7
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281 Tresser Blvd, Stamford, CT 06900
www.bottomlinesecrets.com

This pair of books are two of the most recent offerings from Bottom Line Books ® in the area of health care information for the general public. The sections are concise and well written. Topics cover a wide range of interest ranging from pain relief, over the counter and prescription drugs to what to do in a variety of emergencies, as well as food and fitness.

Experts in the field selected by the editors wrote each section. The information covers conventional and alternative medical approaches. The editors show no preference to either. Instead they try to present a balanced view and suggest what they consider the best practices of each approach.

These books are widely advertised in television infomercials. It is worthwhile for physicians to know what their patients are reading and we might learn something!

Instructions to Authors

The American Academy of Osteopathy® (AAO) Journal is a peer-reviewed publication for disseminating information on the science and art of osteopathic manipulative medicine. It is directed toward osteopathic physicians, students, interns and residents, and particularly toward those physicians with a special interest in osteopathic manipulative treatment.

The AAO Journal welcomes contributions in the following categories:

Original Contributions
Clinical or applied research, or basic science research related to clinical practice.

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Unusual clinical presentations, newly recognized situations or rarely reported features.

Clinical Practice
Articles about practical applications for general practitioners or specialists.

Special Communications
Items related to the art of practice, such as poems, essays and stories.

Letters to the Editor
Comments on articles published in *The AAO Journal* or new information on clinical topics. Letters must be signed by the author(s). No letters will be published anonymously or under pseudonyms or pen names.

Book Reviews
Reviews of publications related to osteopathic manipulative medicine and to manipulative medicine in general.

Note
Contributions are accepted from members of the AOA, faculty members in osteopathic medical colleges, osteopathic residents and interns and students of osteopathic colleges. Contributions by others are accepted on an individual basis.

Submission
Submit all papers to Robert Clark, DO, Editor-in-Chief, 3243 Clayton Road, Concord, CA 94519. Email: editoraaoj@yahoo.com in word format or Fax: 925/887-8600.

Editorial Review
Papers submitted to *The AAO Journal* may be submitted for review by the Editorial Board. Notification of acceptance or rejection is given, usually, within three months after receipt of the paper. Publication follows as soon as possible thereafter, depending upon the backlog of papers. Some papers may be rejected because of duplication of subject matter or the need to establish priorities on the use of limited space.

Requirements for manuscript submission:

Manuscript
1. Type all text, references and tabular material using upper and lower case and double-space with one-inch margins. Number all pages consecutively.

2. Submit the original plus two copies. Retain one copy for your files.

3. Check that all references, tables and figures are cited in the text and are in numerical order.

4. Include a cover letter that gives the author's full name and address, the telephone number, the institution from which work initiated and, the academic title or position.

5. Manuscripts must be published with the correct name(s) of the author(s). No manuscripts will be published anonymously or under pseudonyms or pen names.

6. For human or animal experimental investigations, include proof that the project was approved by an appropriate institutional review board, or when no such board is in place, the manner in which informed consent was obtained from human subjects.

7. Describe the basic study design; define all statistical methods used; list the measurement instruments, methods, and tools used for independent and dependent variables.

8. In the "Materials and Methods" section, identify all interventions that are used which do not comply with approved or standard usage.

FLOPPY, CD-ROM or DVD
We encourage and welcome a floppy, CD-ROM or DVD containing the material submitted in hard copy form. Although we prefer receiving materials saved in rich text format on a CD-ROM or via Email, materials submitted in paper format are acceptable.

Abstract
Provide a 150-word abstract that summarizes the main points of the paper and its conclusions.

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2. Photos and illustrations should be submitted as a 5" x 7" glossy black and white print with high contrast. On the back of each photo, clearly indicate the top of the photo. If photos or illustrations are electronically scanned, they must be scanned in 300 or higher dpi and saved in .jpg format.

3. Include a caption for each figure.

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2. For journals, include the names of all authors, complete title of the article, name of the journal, volume number, date and inclusive page numbers. For books, include the name(s) of the editor(s), the name and location of publisher and the year of publication. Give the page numbers for exact quotations.

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AAO Course Calendar

July 11-13
Masters Course:
Comparing FPR, Counterstrain and Still Technique
Ann L. Habenicht, DO, FAAO and
John G. Hohner, DO, FAAO, Co-Chairs
CCOM
Downers Grove, IL
CME: 24 Category 1A (anticipated)

October 9-11
Prolotherapy Weekend: for all Levels and Experience
Mark S. Cantieri, DO, FAAO, Program Chair
UNECOM
Biddeford, ME
CME: 20 Category 1A (anticipated)

October 25
Avoiding Disaster –
Osteopathic Approach to the Flu Pandemic
Dennis J. Dowling, DO, FAAO, Program Chair
Las Vegas, NV
CME: 8 Category 1A (anticipated)

November 7-9
Masters Course: Muscle Energy with
Philip E. Greenman, DO, FAAO, Edward G. Stiles, DO, FAAO, Carl W. Steele, DO, MS
Stephanie Waecker, DO, Program Chair
AZCOM, Glendale, AZ
CME: 24 Category 1A (anticipated)

December 5-7
An Osteopathic Approach
to Treat Cranial Nerve Dysfunction:
ala Barral
Kenneth J. Lossing, DO,
Program Chair
COMP, Pomona, CA
CME: 24 Category 1A (anticipated)

January 9-11
Basic Osteopathic Life Support: Fundamentals of OMM
Ann L. Habenicht, DO, FAAO
NSUCOM
Fort Lauderdale, FL
CME: 24 Category 1A (anticipated)

January 23-25
Basic Osteopathic Life Support: Fundamentals of OMM
Natalie Nevins, DO
AZCOM
Glendale, AZ
CME: 24 Category 1A (anticipated)

February 28 - March 1
Percussion Hammer
Rajiv Yadava, DO
Tucson Osteopathic Foundation's Building
Tucson, AZ
CME: 15 Category 1A (anticipated)

For information regarding these courses:
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Kelli Bowersox, Course Coordinator; kbowersox@academyofosteopathy.org