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Immediate changes to lumbosacral dural regions upon simultaneous bilateral compression to the parieto-occipital (asterion) cranial region:

A dissection study.

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Abstract: *Objective:* The relationship between clinical application to the cranium and sacral region has been questioned. The purpose of this study was to assess whether an anatomical functional relationship could be demonstrated through the application of pressures to the cranium with visualisation of its effect on the dural volume in a dissected sacral region.

Methods: Two cadavers were carefully dissected to expose the lumbosacral dural sac. Lateral to medial pressure was applied by hand simultaneously and bilaterally to cranial contacts just above the asterion. Careful observation of the dural sac pre and post application of pressure was performed.

Results: It appeared that with application of cranial pressure, the sacral dural sac expanded up to twice the resting diameter observed before cranial pressure was applied. It returned to its approximate original volume after the pressure was released.

Conclusion: This study represents the first attempt to assess if a relationship exists between the application of pressure to the cranium and a response in the lumbosacral meningeal region affected by the action of cerebrospinal fluid.

Indexing Terms: Sacro Occipital Technique (SOT); Cranial-sacral connection; dura; dural sac; cranial technique.

Introduction

Relationships between clinical application of manipulative techniques to the cranium and sacral region have been questioned. (1, 2) Some studies suggest that palpation of these regions cannot be adequately reproduced, (3, 4, 5, 6, 7, 8) while others suggest inter- and intra-examiner reliability. (9, 10, 11, 12, 13, 14, 15, 16) An early study by Greenman assessed cranial strain patterns (17) and their relationship to the lumbosacral region via radiograph. (18)

… this dissection study shows an anatomical functional relationship between the cranium and sacrum …

Greenman noted in his preliminary study that '*it appears that it is possible to demonstrate roentgenographically side-bending, torsion, flexion, and extension patterns of the skull.*' (18) He also found an '*excellent*' correlation between '*low occiput on the side of the low sacrum.*' (18) Blum and Curl discussed an anatomical relationship between the cranium and the pelvis, with suggested clinical applications. (19)

Oleski et al (20) also used radiographs to explore cranial bone mobility. They investigated 12 adult patients who had received cranial vault manipulation treatment with pre- and post-treatment x-ray taken with the head in a fixed positioning device. They found that changes in angles formed between various specified cranial landmarks as visualized on x-ray was measurable. '*The mean angle of change measured at the atlas was 2.58°, at the mastoid was 1.66°, at the malar line was 1.25°, at the sphenoid was 2.42°, and at the temporal line was 1.75°. 91.6% of patients exhibited differences in measurement at 3 or more sites.*' They concluded that 'cranial bone mobility can be documented and measured on x-ray.' (20)

Kostopoulos and Keramidas explored possible relationships between forces to the cranial bones and changes in the cranial dura, most specifically the *falx cerebri*. 'The relative elongation of the *falx cerebri* changes as follows: for the frontal lift, 1.44mm; for the parietal lift, 1.08mm; for the sphenobasilar compression, -0.33mm; for the sphenobasilar decompression, 0.28mm; and for the ear pull, inconclusive results.' (21) '*In a nonpublished study Rowe et al. measured the relative elongation of falx cerebri in an unembalmed cadaver using a technique of multiple photography. They recorded a 1 mm displacement of the falx cerebri when they applied 48.2 grams of external force on the frontal bone*.' (21, 22) Kostopoulos and Keramidas in another study measured the relative elongation of the *falx cerebri* during the application of external forces on the frontal bone of an embalmed cadaver and found a positive correlation between the applied force and the degree of relative elongation of *falx cerebri*. (23)

Pick (24) also attempted to investigate the hypothesis that external cranial manipulation can cause change within the structures of the human brain using pre- and post- magnetic resonance imaging. He found that pressure to the hard palate and *bregma* regions, similar to what is used during cranial manipulative interventions, created significant changes in the internal cranial structures. '*Results from the second MRI (administered during the application of external cranial pressure) demonstrated elimination of a 5mm peak along the superior border of the corpus callosum and a 4mm reduction in the width of the fornix column. The exposed anterior/superior wall of the lateral ventricle posterior to the fornix column increased 51 degrees dorsally with manipulative application. The angular surface of the central lobule altered by minus 26°, and the posterior surface of the inferior colliculi varied by minus 7°*.' (24)

The purpose of this present study is not to investigate the clinical applications or inter/intra examiner palpation of the cranium and sacrum but to assess whether an anatomical functional relationship between the cranium and sacrum could be demonstrated through a dissection study.

Material and methods

Two cadaver subjects were studied, a 71-year-old female and an 86-year-old male.The 71-year-old female cadaver was embalmed for anatomical dissection purposes and stored in an immersion tank for over a year, whereas the 86-year-old male was not stored in an immersion tank. The cause of the 71-year-old female's death was attributed to congestive heart failure due to cardiopulmonary arrest. She had a history of late childhood tuberculosis and developed bronchiectasis in the later years of her life. The cause of the 86-year-old male's death was an Intraocular B-Cell Lymphoma with metastasis to the brain. His history revealed a stent in heart, right eye surgery (non specific), and a cholecystectomy. An Institutional Review Board exemption was received from *Cleveland University: Kansas City*, with the following identifier assigned for this study: IRB-10302020A.

Dissection technique

In both cases the dissection was performed with a #22 scalpel blade to create a viewing window over the region of the sacral dural sac. The incision was performed along the lower region of the fifth lumbar, exposing its lower spinous process and L5 S1 facets. The incision continued caudally along the lateral aspect of the sacral laminar region and terminated approximately 1.5cm above the sacral hiatus. The incision viewing frame was completed with a transverse cut connecting the two lower terminal edges of the lateral incisions. Dermal, fascial and muscular tissue (within the framed incision region) was cut and scraped away to expose the bone using the #22 scalpel and the flat edge of a *Huber Mall* stainless steel probe. After the osseous structure was exposed, a bilateral laminectomy was performed utilising the ½ inch stainless steel prybar chisel placed along the lateral borders of the sacral canal and carefully struck with a brass mallet to crack through the osseous shell.

The bone covering the spinal sacral canal was then carefully removed with the aid of a bone forceps to expose the dural sac. As a final step to enhance the dural sac's visibility, excess fluid was siphoned from the area and surrounding adipose was gently removed.

Cranial hand applications

With each cadaver, lateral to medial manual pressure was applied to cranial contacts just above the asterion bilaterally and simultaneously (Figures 1 and 2, 7 and 8). The contacts were with the heel of the hands (the *hypothenar-pisiform* regions) while the fingers interlaced over the parietal-occipital-lambda region (Figures 2 and 7) for positional stability. Approximately 3-4kg of force was applied to the cranial contacts at the female cadaver. Since the male cadaver was not submitted to any form of submersion greater cranial forces were applied (6-9kg of force). For purpose of comparisons, the force generated during routine mastication of food such as carrots or meat is about 7 to 15kg of force with the maximum masticatory force in some people reaching up to 50 to 70kg of force. (25)

Results

During the application of lateral to medial external cranial pressure with the female cadaver (ranging from 3-4kg) and male cadaver (ranging 6-9kg) over the parietal-occipital-lambda region, an obvious ballooning or circumferential expansion of the sacral dura around the region of S1 was observed (Figures 3 and 4, 9 and 10). Upon release of the contact cranial pressure there was a visibly significant decrease in circumferential expansion. (Figures 5 and 6, 11 and 12) Hence, it appears that with the application of cranial pressure, the measurements of the sacral dural sac expanded up to twice (100% increase in size) the diameter that it was before cranial pressure was applied and after that pressure was released.

Discussion

Upon application of the pressures to the cranium an immediate change was visualised in lumbosacral meningeal region. While this was performed on a dissected human it is reasonable to assume this relationship takes place in living subjects. (26, 27, 28) At this early stage of investigation extrapolating clinical relationships (28) with certitude may be premature. Further analysis with other dissected subjects as well as corroborating these findings in vivo human subjects is necessary to determine the generalisation of this current study.

Clinical studies have found relationships between distal ends of the sacral and cranial periosteal/meningeal dura. Ashkenazi et al (29) described a rare case of a paraganglioma of the filum terminale where the patient initially presented with headache and papilledema. Magnetic resonance imaging demonstrated enlarged ventricles of the brain and a well-demarcated intradural spine tumour. Of interest is that after resection of the tumour, the papilledema and headaches resolved, and the ventricles returned to normal size. (29)

Rhee et al. (30) also described a case of a patient with an intraspinal paraganglioma who presented with normal pressure hydrocephalus and six month history of gait disturbance and cognitive dysfunction. Computed tomography of the brain and magnetic resonance imaging of the spine revealed a paraganglioma of the filum terminale. Radioisotope cisternography revealed a severe delay in cerebrospinal fluid circulation; however, symptoms related to communicating hydrocephalus resolved after tumour resection. (30)

Murthy and Deshpande (31) discussed a histological study evaluating the central canal of the excised filum terminale in seven hydrocephalic children and an equal number from control cases. Their observations indicated that the central canal of the filum terminale dilates in communicating hydrocephalus, and the dilatation is proportionate to the lateral ventricular enlargement. (31) Therefore, based on the studies of Askenazi, (29) Rhee, (30) Murthy, (31) and Sankhla, (32) a clinical and anatomical relationship appears to be present between the cranial and sacral meningeal regions related to variants in cerebrospinal fluid pressure or circulation in the subarachnoid and/or the cerebral ventricles/spinal central canal.

Limitations of this study are that it was performed on embalmed humans and it is possible tissue restriction might have contributed to changes in the sacral region with pressure to the cranium. It is possible that these patients had anatomical variants that led to the findings in this study and other subjects might give different findings. Based on the study by Taylor and Twomey (33) it is possible that a direct relationship may be found in forces to the cranium and the sacral dural tissue response in this study could have a similar effect in live human subjects.

Conclusion

This study represents the first attempt to assess if there might be a relationship between pressures applied to the cranium and a response in the lumbosacral dural sac region. While other studies have found pressures to the cranium had a demonstrable change in the shape or length of the dura, most were assessing structures local to the force application.

In this case it appeared that pressures applied on and above the asterion resulted in almost immediate volumetric changes in the lumbosacral region.

Further research is needed to determine if other dissected humans have similar findings and if this can be applicable to live humans.

Disclosure Statement

No conflict of interest, financial interest or benefit has knowingly arisen from the direct applications of this research.

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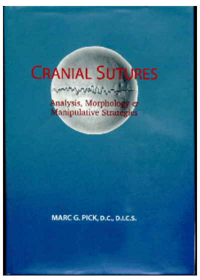

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Also by this author

Pick M. Cranial optokinetic reflex and cervical dystonia [Case Report]. Asia-Pac Chiropr J. 2021;1.3:Online only. URL www.apcj.net/pick-cervical-dystonia-optokinetic-reflex/

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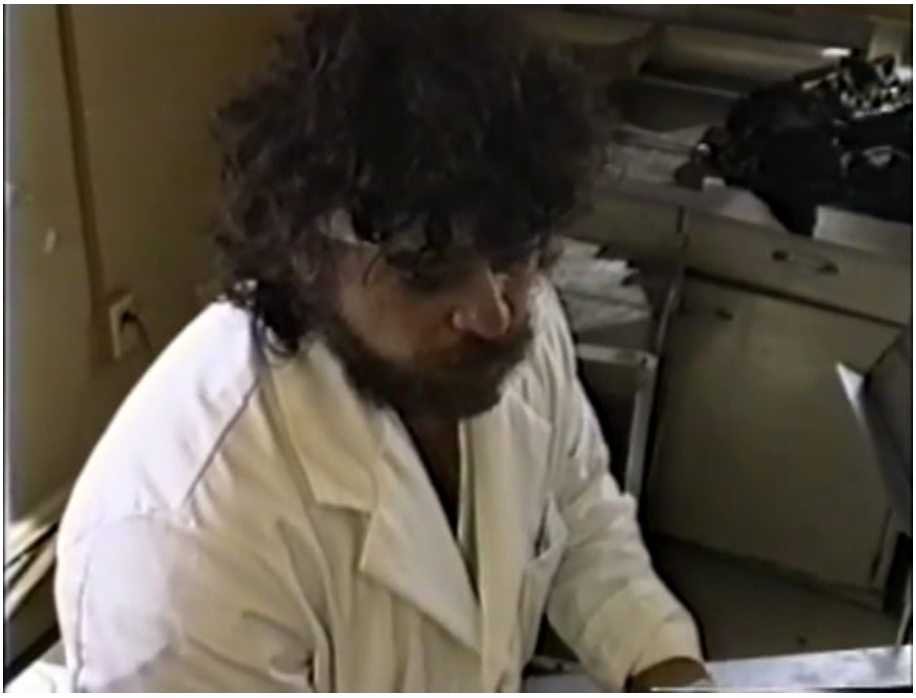
Videos



Video 1: Cadaver 1, showing changes in the dural sac at the level of L5-S1 with manual force applied about the asterion.

Video 2: Cadaver 2, showing changes in the dural sac at the level of L5-S1 with manual force applied about the asterion.

Figures

Figure 1: Demonstrates the hand application posture for bilateral, lateral to medial pressure.

Figure 2: Demonstrates the location of targeted pressure application.

Figure 3: Exposes the sacral dura below L5, around the level of S1 without the application of cranial pressure.

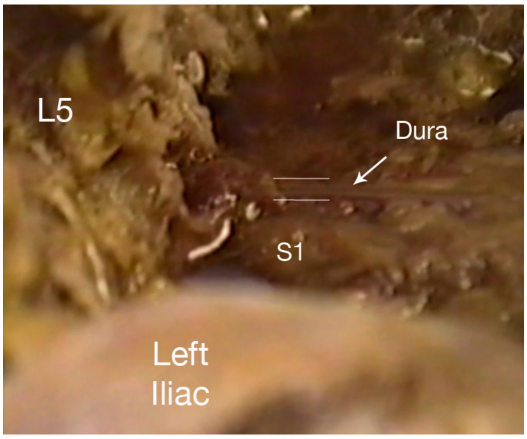


Figure 4: Same image as figure 3, but with landmarks and structures labeled for identification.

These views are visualizing the sacral dural sac (S1 level) from a 5° posterior oblique lateral perspective with the posterior sacral wall removed by a bilateral laminectomy.

Figure 5: Exposes the sacral dura below L5, around the level of S1 with the application of cranial pressure.

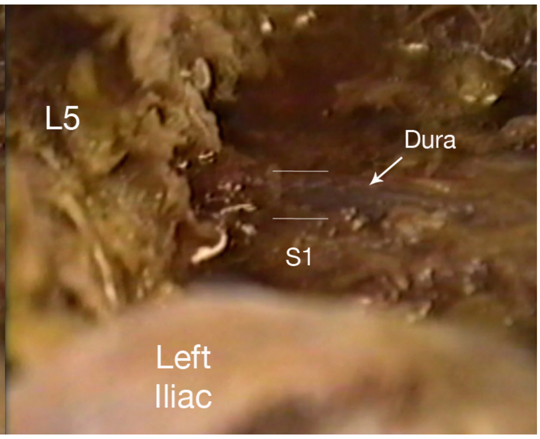


Figure 6: Same image as figure 5, but with landmarks and structures labeled for identification.

Figure 7: Demonstrates the hand application posture for bilateral, lateral to medial pressure.

Figure 8: Demonstrates the location of targeted pressure application.

Figure 9: Exposes the sacral dura below L5, around the level of S1 without the application of cranial pressure.

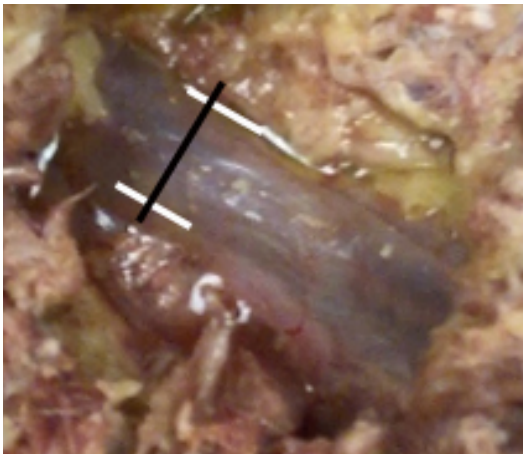


Figure 10: Same image as figure 9, but with markers to set dimensions of dural sac's width.

These views are visualizing the sacral dural sac (S1 level) from a 5° posterior oblique lateral perspective with the posterior sacral wall removed by a bilateral laminectomy.

Figure 11: Exposes the sacral dura below L5, around the level of S1 with the application of cranial pressure.

Figure 12: Same image as figure 11, but with markers to set dimensions of dural sac's width.