CASE REPORT

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Osteopathic Manipulative Treatment for Optic Pathway Glioma

Abstract

Optic gliomas are a known complication of neurofibromatosis type 1 (NF1) and can result in significant impairment. This case report centers around a 3-year-old girl with NF1 and optic glioma diagnosed by MRI, whose optic glioma has not increased in size since commencing treatment with osteopathic manipulative treatment (OMT) at regular intervals. We cover the rationale behind treating these patients with OMT with a thorough review of the relevant anatomy. We suggest a basis of treatment that could benefit patients with a number of intracranial and extracranial pathologies.

Introduction

Optic gliomas are neoplasms of the optic pathway that generally present in childhood, usually within the first 10 years of life. The presentation of optic gliomas varies, from being asymptomatic to diminished vision to proptosis or strabismus.[1] The most common initial symptom is diminished vision. Patients who are asymptomatic or have mild symptoms can undergo close monitoring, but when there are severe symptoms such as visual loss, endocrine disturbance, hydrocephalus, or mass effect, patients may need to undergo invasive treatments including surgery, chemotherapy, or radiation therapy.[1]

Optic gliomas are reported to be present in about 11-30% of patients with neurofibromatosis type 1 (NF1), an inherited genetic disease of the nervous system.[1] While these optic gliomas are usually benign, one-third of patients develop symptoms and 5% of cases experience visual loss, severe proptosis, and/or hydrocephalus.[2] The incidence of NF1 is about 1 in 3500 people.[2] Café-au-lait spots are usually the first symptom of NF1, and in most cases, these are present by age 1 year. While optic gliomas can occur sporadically and not be associated with NF1, when they are associated with NF1 the lesions are more extensive and present with a more variable course.[3] The National Neurofibromatosis Foundation Optic Pathway Task Force currently recommends yearly eye examinations by a pediatric ophthalmologist for children with NF1 to screen for optic gliomas.[2] After diagnosis of optic glioma, patients generally undergo MR imaging every 6 months to monitor for progression, as well as close observation for development of symptoms including vision or balance changes.

When occurring with NF1, these optic gliomas are a result of a tumor suppressor

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associated with chromosome 17q, neurofibromin, being inactivated. This leads to activation of RAS signaling pathways and RAS induced tumors.[4] The gliomas form from astrocytes of the optic nerve and visual pathway. There is variability in where these optic gliomas occur. They are only in the optic nerve 25% of the time, while 75% have involvement of the optic chiasm.[4] Chemotherapy is required for progressive tumors, radiation is used for progressive tumors with patients older than 5-7 years old, and surgery is indicated when there is mass effect or hydrocephalus.[1]

This case report centers on the treatment of optic gliomas in the setting of NF1 through osteopathic manipulative treatment (OMT). No other published examples were found that demonstrated the use of OMT on patients who have optic gliomas.

Case Description

A 3-year-old female with NF1 and optic gliomas presented for osteopathic manipulative treatment (OMT) to prevent progression of the optic gliomas. She was diagnosed with NF1 at age 6 months in September 2016 after a genetic workup due to greater than 6 café-au-lait spots. She had no other comorbid conditions. Per chart review, an MRI in December 2019 showed "enlargement of prechiasmatic optic nerves, optic chiasm, and post chiasmatic optic tracts compatible with optic pathway glioma." She had no visual impairment. She did not undergo any chemotherapy or radiation.

She presented for osteopathic treatment in January 2020. Over the course of January 2020-March 2021, she received 29 sessions of OMT. Since commencing treatment with OMT, subsequent follow up MRIs every 6 months (in June 2020 and December 2020) have shown no enlargement of the optic gliomas. She also has not had any changes in vision or balance.

The patient presented for OMT approximately every 2 weeks. Her treatment involved ongoing diagnostic assessment of the whole body including the head, with cranial osteopathic treatment of the head, as well as the cervical region, thoracic region, lumbar region, sacrum, pelvis, and ribs at most visits. Structural exams were performed at each visit, and findings were varied; structural and functional exam usually revealed a superior vertical strain of the sphenoid and superior displacement of the central fulcrum for membranous and fluid rhythmic motions. Treatment at each visit differed depending on the somatic dysfunction she presented with, but she tended to require repeated treatment most often to the sphenoid region of the head. Treatment to this region was performed via balanced membranous tension to the cranial base, dural membranes, and fluids—meaning the fluid dimension, or fluidity, of physiologic function of those tissues. The most dramatic changes could be observed in the cranial vault and the anterior edges of the parietal bones just posterior to the coronal suture, at the coronal sulcus. Specifically, an abnormally-increased depression or deepening of the coronal sulcus would disappear or nearly correct—presumably as a reflection of the beneficial changes in the tension pattern throughout the neurocranium after OMT. These changes most particularly would occur to the structure and function at the opposite diameter of the neurocranium, in the cranial base where the lesser wings of sphenoid are found within the anterior dural girdle.

Discussion

Thorough understanding of anatomy and osteopathic principles allows us to propose a mechanism for how OMT can help prevent growth of the patient's optic glioma.

A brief summary of the anatomical course of the optic pathway: axons from retinal ganglion cells converge to form the optic nerve. The optic nerve leaves the orbit through the optic canal, a foramen in the sphenoid bone. It then courses into the middle cranial fossa (composed of the sphenoid and the temporal bones), where the right and left optic nerves combine to form the optic chiasm. The nerves from the medial half of each retina then cross over to the contralateral side, while nerves from the lateral half of the retina continue ipsilaterally. After the optic chiasm, the nerves continue as the right and left optic tract. The optic tracts then travel to the lateral geniculate nucleus (LGN) in the thalamus. After the thalamus, axons travel to the visual cortex.

Based on this anatomy, it is clear that at least the sphenoid and temporal bones and their associated meningeal membranes are potential areas of treatment to permit the optimally free course of the optic nerve. There are not many treatments aimed at normalizing the tension range of the dural membranes, and the subtle mobility of the cranial bones. Cranial OMT addresses the primary respiratory mechanism via functional relationships among the cranial bones, sacrum, dural membranes, central

nervous system, and CSF.[5] Changes made to any of these phenomena can potentially influence arterial perfusion, venous drainage, lymphatic drainage, nerve function, and/or any other tissue function. Quantitative biological changes following cranial treatment have been documented, such as changes in blood flow velocity and visual function.[6,7,8]

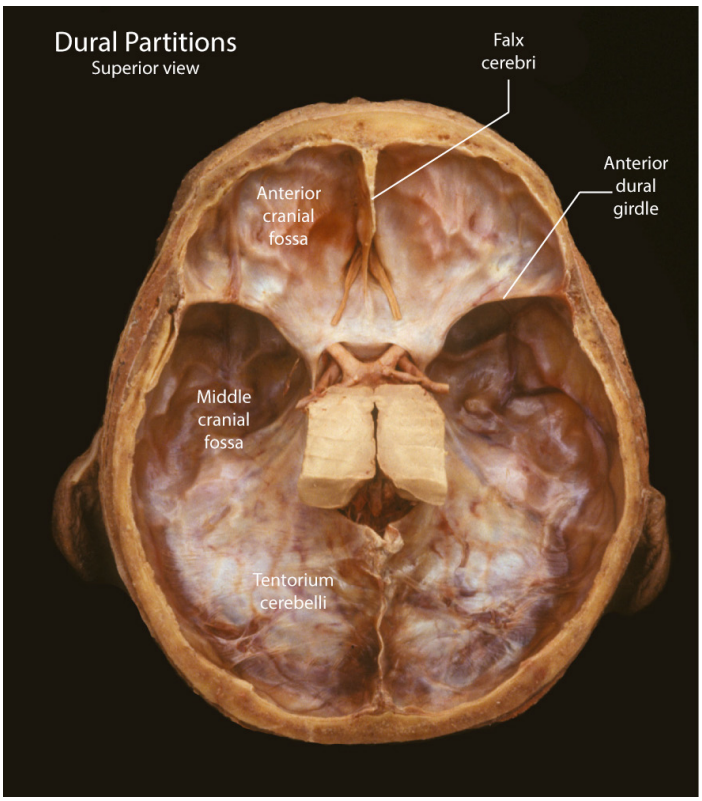
The relation to the sphenoid could also relate to another manifestation of NF1. Sphenoid wing dysplasia is found in about 5% of patients with NF1. On radiography, this is seen by hypoplastic/absent sphenoid wing, widening of the superior orbital fissure, elevation of the lesser sphenoid wing, and ipsilateral orbital enlargement.[9,10] This is usually unilateral, and can lead to proptosis. One-half of patients with sphenoid wing dysplasia develop ipsilateral temporal orbital plexiform neurofibroma.[2] Clearly, the sphenoid has a close relationship with the disease process of NF1.

Study of the dural attachments suggests additional potential areas of treatment. Understanding the organization and function of the dura helps us understand the potential value of treating the dura. The inner (or meningeal) layer of dura forms 5 partitions between different areas of the brain. First, the falx cerebri separates the cerebral hemispheres. Second, the tentorium cerebelli separates the cerebellum and cerebrum. Third, the falx cerebelli separates the cerebellar hemispheres. Fourth, the diaphragma sella partially covers the sella turcica, separating the pituitary from the base of the brain. Finally, the anterior dural girdle separates the temporal lobes from the frontal lobes of the cerebral hemispheres, and continues supero-laterally in a hoop-like shape which is oriented in an approximately coronal plane intersecting both the sagittal plane of the falx and the horizontal plane of the tentorium at approximately 90 degrees to each. The anterior dural girdle arises developmentally from the embryonic transverse septum of mesenchyme and later envelopes the posterior margin of the lesser wing of the sphenoid. It also has relationships to the optic chiasm and optic nerves as it courses across the anterior clinoid processes. Further, this structure has broad connections to the rest of the dura which extends throughout the cranium. Normalizing the tension and action through the anterior dural girdle could improve the forces which shape the sphenoid and allow its motions. Balancing that membranous tension could also improve arterial and venous circulation, lymphatic drainage, and CSF fluctuant activity in that region to a degree that benefits the optic nerve tracts and their meningeal sleeves and associated fluids even more directly. This helps contribute a rationale to the widespread as well as specific effects of treating the dura mater successfully.

Regarding the function of the dura, the meningeal (inner-most) layer of dura mater surrounds portions of the dural venous sinuses which drain blood from the brain. That same meningeal layer of dura mater also forms the reciprocal tension membrane (RTM). Synchronizing with the movement of the cranial bones, the RTM has been described as both guiding and limiting the subtle motions of the bones through rhythmic tension/pressure changes.[11]

Addressing and freeing dural strains could allow improved drainage and fluid exchange within and around the brain, discouraging pathology and allowing improved functioning of intracranial structures. Alterations in dural tension could contribute to strains in the cranial bones themselves, and/or interference with cranial nerve blood supply and function. Freeing dural restrictions could help the cranial bones move better overall.[12] Craniosacral inherent motion is managed in part through the tension of the dura. Strains or dysfunction of the dura can result in abnormal or diminished craniosacral motion, which leads to overall dysfunction. Cranial

Figure 1. *Dural Partitions, Superior View. Credit: F. H. Willard at University of New England. Reproduced with permission.*



osteopathic diagnosis and treatment aimed at improving the RTM and the entire primary respiratory mechanism improves structure and function within and outside of the cranium, which could explain the improved health and the lack of progression of disease in this patient.

Further, the rationale for initiating treatment early in childhood is partially based upon an understanding of the developmental formation of the bones of the cranium. At birth, many of the bones of the cranium are still in different parts, and they later ossify intra-osseously and form sutures inter-osseously over time. For example, the occipital bone is in 4 parts at birth, and fusion of all parts does not occur until age 6 or 7 years. Some portions of the bones of the skull are not completely ossified until age 25.[13] Initiating treatment at an early age can relieve strains and allow the skeleton to grow and develop with less stress, achieving more functional forms, because the shapes of bones are conferred by the forces imparted to them. The earlier treatment is initiated, the greater the growth forces which are present to drive the treatment, and the more flexible the bone is, and the easier it is to effect change via OMT. For example, the proportion of water to mineral salts in developing bone is found to be greater than in mature bone, allowing both flexibility and tensile strength.[13]

Conclusions

We use this case as an example that regular intervals of OMT can influence the development of intracranial structures and prevent the progression of disease. Through treating the patient's cranium, stress and congestion that could be affecting the nerves involved in her disease process could be relieved. The patient in this case was found to frequently have dysfunction of the anterior dural girdle as well as the sphenoid bone, 2 related structures which are closely related to the nerves involved in her optic glioma growth process. It is clear here that correcting the dysfunction in and around these structures could allow for improved function.

Understanding the anatomy involved is integral in treating the disease process. The cranial bones, dura, brain, and fluids all could potentially contribute to dysfunction of the cranial nerves, and these structures can be influenced by OMT. Reducing the associated strains allows for proper structure and function, contributing to overall healing. Treatment should be initiated as early as possible to confer the most effective changes for the patient, and to potentially change the course of the disease process as early as possible.

One possible limitation of this case is that not all optic gliomas progress, and this optic glioma may have stayed the same size without OMT. However, OMT when properly applied is a safe treatment without likelihood of adverse events. This pathology should not be treated by OMT alone, and patients should continue to receive routine multidisciplinary care with Oncology, Ophthalmology, and Neurology. Further research could include study of a larger number of patients with NF1 and optic gliomas being treated with routine care with adjuvant OMT, compared to control patients who are receiving routine care without OMT. Additionally, these principles not only apply to patients with optic gliomas but could apply to a large number of patients suffering from dysfunction in the region of the second cranial nerves or other pathology inside and outside of the cranium.

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