Conductive Hearing Loss: A Case Report

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Abstract

In this case report, osteopathic manipulative treatment restored hearing to an 8-year-old female suffering from conductive hearing loss. Numerous factors can result in hearing loss. In children and adolescents, mild or greater hearing loss occurs with a prevalence of 3.1%.[1] Current osteopathic literature focuses on conductive hearing loss due to middle ear effusion (MEE). This case report examines an 8-year-old female presumed to have permanent conductive hearing loss without MEE after a traumatic ATV accident. The use of osteopathic manipulative treatment (OMT) resulted in complete resolution of the patient's conductive hearing loss. To the authors' knowledge, this is the first case report documenting the successful use of OMT to treat conductive hearing loss without MEE. Being able to recognize and understand the connection between the primary respiratory mechanism (PRM), which includes the cranial bones and nerves, allows an osteopathic physician to provide a unique approach to patient care and the use of OMT as a treatment modality for conductive hearing loss should be considered.

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Introduction

The prevalence of mild to severe hearing loss in children and adolescents, including conductive hearing loss, is 3.1%.[1] Delays in diagnosis, a wide range of causative factors, and psychosocial implications are challenges encountered with hearing loss in children. Common etiologies of hearing loss include viral complications, meningitis, head trauma, prenatal or perinatal disorders, and genetic disorders.[2] Current osteopathic literature focuses on conductive hearing loss associated with acute otitis media with middle ear effusion (MEE), a common and prevalent illness affecting children. While antibiotics are the mainstay of treatment, osteopathic manipulative treatment (OMT) has proven effective in aiding and accelerating the resolution of MEE.[3] OMT for ear dysfunction, including MEE, target the eustachian tube to break adhesions, restore eustachian tube opening, normalize middle ear pressure, and encourage fluid drainage.[4] The Muncie technique, developed by Curtis H. Muncie, DO, and its subsequent modified Muncie technique are manipulative treatment options used by osteopathic physicians to relieve eustachian tube dysfunction.[4] Use of this technique dates back to the early 1900's when Muncie performed his technique on William Rockefeller and others, restoring hearing previously thought to be permanently damaged.[5,6]

Likewise, chiropractic studies have described improved hearing with spinal manipulation. Wagner and Fend[7] reported resolution of conductive hearing loss with chiropractic spinal manipulation after a 36-year-old soccer player headed a soccer ball and experienced sudden hearing loss and tinnitus. Additional chiropractic studies have noted similar results of improved hearing with post chiropractic spinal manipulation.[8,9]

Case Report

History of Chief Complaint

An 8-year-old female presented to the Osteopathic Care Center with her mother in May 2017 complaining of hearing loss of 7 months duration. Acting as the main historian, her mother stated symptoms started after the patient sustained a traumatic ATV accident where the patient was thrown from the ATV and hit her head on the ground hard enough that her helmet broke, however, she did not lose consciousness. Additionally, she complained of associated headaches every day lasting all day, tinnitus, neck pain, and difficulty hearing others speak. The patient and her mother deny dizziness, nausea, vomiting, shooting pain, chest pain, or shortness of breath. Her mother stated the patient was typically a happy child who made straight A's in school, but since the accident, her grades dropped and her mood became erratic and irritable.

Prior to presenting at the Osteopathic Care Center, the patient was examined and treated by many other providers. Per her mother, the patient was initially evaluated by her pediatrician in October 2016 one week after her ATV accident. The patient first failed a general hearing test at the pediatrician's office. At follow-up 1 month later, she again failed the hearing screening. Therefore, she was referred to an otolaryngologist (ENT) where ear examination was negative for middle ear effusion bilaterally. The patient was prescribed Amoxicillin for 1 month and scheduled for follow up in 2 months. At her 2-month follow-up with ENT in January 2017, the patient's middle ear was anatomically normal in appearance on otoscopic exam and again was negative for middle ear effusion. Despite a normal exam, the ENT physician prescribed 2 Azithromycin antibiotic packs in addition to ordering a CT scan of the head and allergy testing for the patient. The CT scan and allergy testing results were negative. Between the 2 ENT office visits, the patient was evaluated and treated by a local chiropractor every 2 weeks for a total of 5 visits. She received spinal manipulation, visceral adjustment, and infrared light therapy. In late January 2017, the patient was evaluated by an audiologist and diagnosed with permanent bilateral conductive hearing loss through formal audiometry testing. The patient's mother sought a second opinion with a pediatric ENT in early February 2017 who evaluated the patients' hearing with a handheld audiometry device and tympanometry. The pediatric ENT agreed with Audiology regarding the diagnosis of permanent bilateral conductive hearing loss (Fig.1). In April 2017, the patient again followed up with the chiropractor and was treated with the aforementioned treatment modalities. The patient continued to have conductive hearing loss with no resolution or improvement.

Medical and Surgical History

The patient is a healthy child with one prior traumatic episode in November 2014 where she hit her head on a windowsill. She has history of 1 surgery in 2012 for surgical excision of a Spitz nevus from her arm. The patient does not take any medications routinely; however, she does use Flonase for sinus congestion and a naturopathic salve for a rash on her medial thigh as needed.

Social History

Patient denies any tobacco, alcohol, and illicit drug use. She follows a healthy diet and enjoys playing outside.

Physical Exam

The patient was well appearing, in no distress, and had no obvious physical trauma. She was alert and oriented to person, place, and time. Physical exam for the head was normocephalic and atraumatic. Her pupils were round, reactive to light and accommodation. Patient's neck was supple with midline trachea. Gross examination of the ears revealed normal appearing pinna and otoscopic exam revealed intact tympanic membranes bilaterally with good cones of light and normal appearing middle ear architecture, no retraction or bulging of the tympanic membranes, and no visible fluid. Her respirations were regular and unlabored. Deep tendon reflexes were +2 out of 4 bilaterally in all extremities, and muscle strength was 5 out of 5 bilaterally in all extremities with full active range of motion in all extremities. Compression and Spurling's special tests were performed and negative. Osteopathic structural examination revealed a bilateral respiratory diaphragm restriction; hypertonic scalene, levator scapulae, trapezius, rhomboid, and pectoralis minor muscles bilaterally; myofascial restriction of the thoracic outlet was flexed, rotated and sidebent right; OA was extended, rotated left, sidebent right; C2-C3 spinal levels were flexed, rotated and sidebent left, and C5-C6 spinal levels were extended, rotated and sidebent right. Cranial dysfunctions found included SBS compression, internal rotation of the left temporal bone, external rotation of the right temporal bone, right frontal bone externally rotated, left frontal bone internally rotated, right nasofrontal suture restricted, bilateral occipitomastoid suture restrictions, right parietal bone externally rotated, left parietal bone internally rotated, temporozygomatic suture restricted on the left, temporosphenoid suture restricted on the left. T2 and T6 were flexed, rotated and sidebent left, and T8-10 were neutral, rotated right and sidebent left. L2 was flexed, rotated and sidebent right, and L5 was neutral, rotated right and sidebent left with a left on left sacral torsion.

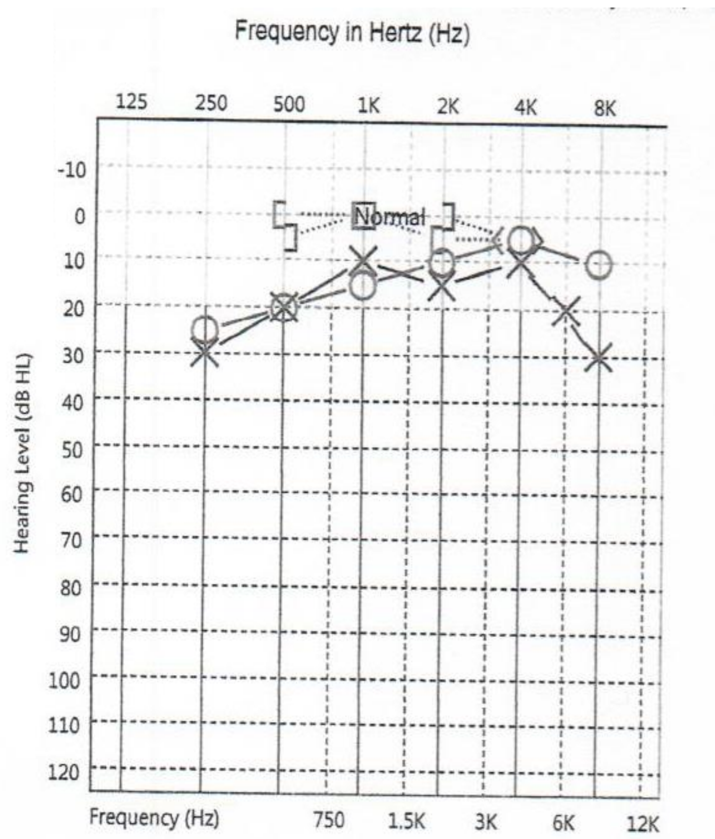
Assessment

1. Mild conductive hearing loss
2. Cervicalgia
3. Somatic dysfunction of head, cervical, thoracic, rib, lumbar, pelvis, and sacral regions

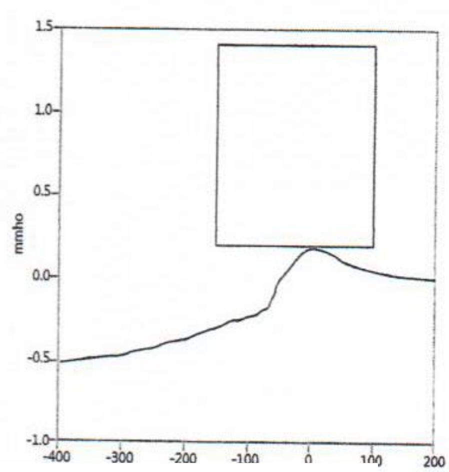
Treatment Approach

Based on the patient's physical exam, OMT was preformed to the aforementioned somatic dysfunctions using percussion hammer to the thoracic, lumbar, and sacral regions. Soft tissue was used to treat the cervical, thoracic, and lumbar regions. Myofascial release was used to treat the head, thoracic, and rib regions. Muscle energy was used to treat the cervical, thoracic, rib, lumbar, and pelvis regions. Counterstrain was used to treat the cervical and rib regions. High-velocity low-amplitude was used on the thoracic region. Ligamentous articular strain and balanced ligamentous tension was used in the cervical region. Articulatory technique and Still technique were used in the cervical and rib regions. Osteopathic cranial techniques was used in the head region. The patient tolerated the procedure well with no apparent complications. She was given instruction on how to stretch the trapezius and scalene muscles, and advised to stretch once a day. The patient was recommended to follow-up in four weeks.

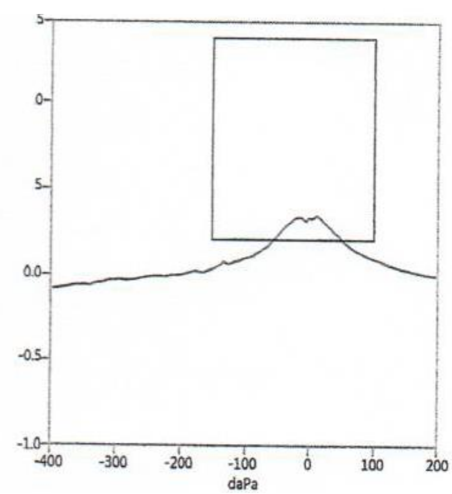
At her 4-week follow-up, the patient stated that when she woke up the day following her OMT, her hearing was normal and she no longer experienced tinnitus or headaches. Because of this change,



1a. Audiometry.



1b. Tympanometry, left ear.



1c. Tympanometry, right ear.

Figure 1. Audiometry and Tympanometry from ENT prior to OMT treatment.

the patient returned to the pediatric ENT 7 days after OMT. Repeat audiometry and tympanometry were performed and her audiometry results were within normal limits with normal tympanometry, and her hearing loss reported as resolved. (Fig. 2) Her mother reported the patient's mood had returned to her original baseline before the accident since the last OMT visit.

Discussion

To date, there have been no case reports or studies looking at the use of OMT in patients with hearing loss caused by factors other than MEE. Current osteopathic case reports and studies have focused on OMT to help drain the middle ear and hasten recovery of acute otitis media and MEE.[3,4]

There are 2 main types of hearing loss: conductive and sensorineural. Conductive hearing loss is caused by decreased sound transmission from the external ear to the middle ear, including cerumen impaction, MEE, and trauma. Sensorineural hearing loss results from a problem with the cochlea or vestibulocochlear nerve.[10] Hearing loss is evaluated using audiometry and tympanometry. Pure tone audiometry, the most common test for evaluating auditory sensitivity, tests the ability to hear sounds via air and bone conduction.[11] Air-conduction thresholds measure the function of the external, middle, and inner ear as a system. Bone-conduction thresholds evaluate the auditory threshold of the cochlea of the inner ear. By evaluating discrepancies between air-conduction thresholds with bone-conduction thresholds, type of hearing loss and severity can be assessed. Hearing loss occurs when an individual's thresholds fall outside the range of 0-25 dB, which is considered normal.[11] As in this case, when air-conduction thresholds are elevated relative to the bone-conduction threshold, a conductive hearing loss occurs. However, when both air-conduction and bone-conduction thresholds are elevated to a similar degree, the hearing loss is classified as sensorineural.[11] For school-age children, it is important to identify minimal hearing impairments and ASHA guidelines recommend a maximum screening level of 20 dB to catch any impairment early.[12] Tympanometry tests the compliance of the middle ear by measuring air pressure changes on either side of the tympanic membrane.[11,13] Decreased compliance, or increased stiffness, of the tympanic membrane opposes sound transmission through the middle ear. Tympanograms show the compliance of the tympanic membrane in graphical form where the peak of the tympanogram signifies the resting pressure of the middle ear.[13] The outlined box within the tympanogram indicates where the normal arch and peak pressure should fall for normal tympanic membrane compliance. There are 4 basic patterns associated with this diagnostic. "Type A" pattern tympanograms indicate normal middle-ear pressures. Within the type A pattern, there are 2 subtypes: type A_s and type A_d. Type A_s shows a peak with decreased amplitude and type A_d shows an uncharacteristically high-pressure peak.[11] Type B pattern is flat indicating no maximal point of compliance and is often found in association with middle ear effusion and space occupying lesions. Type C pattern is indicative of negative pressure in the middle ear and is commonly found in conjunction with eustachian tube dysfunction. Lastly, Type D pattern is often seen with otosclerosis or with normal hypermobile tympanic membranes.[11] Middle ear pathology is easily discerned with tympanometry.

The patient's initial audiometry and tympanometry results support her diagnosis of bilateral conductive hearing loss. According to the ASHA guidelines, since the patient in this case is school aged, the threshold for abnormal hearing was lowered to 20 dB. The initial audiometry report (Fig. 1a), which occurred prior to OMT, indicated an air conduction threshold at or above 20 dB for frequencies of 250, 500, 6000, and 8000 Hertz in the left ear, and at 250 and 500 Hz in the right ear with a normal bone conduction threshold. These findings are consistent with conductive hearing loss, more so in the left ear. Tympanometry performed prior to OMT (Fig. 1b, 1c) indicated an A_s tympanogram with reduced compliance in the left ear and a type A tympanogram in the right ear. As observed, the tympanogram of the left ear (Fig 1b) does not peak within the normal range, and the tympanogram of the right ear (Fib 1c) peaks just within the normal range. Based on these 2 diagnostic exams, the patient's conductive hearing loss was mild in nature. One week after OMT, the patient followed up with the pediatric ENT and had repeat audiometry and tympanometry testing completed (Fig. 2). Her audiometry results indicated normal hearing limits, with hearing below 20 dB for all frequencies in both ears (Fig. 2a). Additionally, tympanometry indicated bilateral type A tympanograms with normal peak pressures describing normal compliance of the tympanic membrane (Fig 2b, 2c).

Osteopathic cranial manipulative medicine, developed by William G. Sutherland, DO, examines the inherent motion of the cranial bones with the primary respiratory mechanism (PRM) of the body.[14] Cranial motion is described from the relationship and movement of the sphenobasilar symphysis and occiput. Various motions of the bones are felt through light palpation. Disruption of the normal cranial bone movement results in strain patterns of the sphenobasilar synchondrosis (SBS).[15] An SBS compression strain occurs when the sphenoid and occiput are forced together such that the physiologic flexion-extension motion of the SBS is impaired.[15] Internal or external rotation of the temporal bones can result in asynchrony of temporal bone movement and can impair hearing.[16] Without normal motion, somatic dysfunction manifests. The intimate relationship between the cranial bones and cranial nerves is also affected by cranial strains. Cranial somatic dysfunction will influence cranial motion, the PRM, and impact the nerves and blood vessels which travel throughout the cranium. Somatic dysfunction involving the temporal, sphenoid, and occipital bones can impact the auditory nerve as it passes through the internal acoustic meatus.[15] The vestibulocochlear nerve is responsible for hearing and balance and enters the temporal bone through the internal acoustic meatus.[17] Compression of this nerve can result in hearing changes and disequilibrium.[14] Nerve impingement, by vestibular schwannoma or vascular compression, has been reported to cause hearing loss, imbalance, tinnitus, and vertigo.[14]

Trauma is a major cause of disruption to the PRM and head trauma often causes SBS strains.[15] Patients with head trauma may trigger migraine headaches due to vasoconstriction in cerebral blood flow, causing anoxia and acidosis. Reflexively, non-innervated arterial systems dilate to increase cerebral blood flow, resulting in migraine pain.[16] Internally rotated temporal bones, from head trauma or other factors, can result in increased sympathetic tone to the head, causing tight upper back and neck muscles.[16] As a result, patients with head trauma may have cervical muscle hypertonicity and somatic dysfunction.

Chiropractic studies and case reports describe hearing improvement with cervical spinal manipulation.[7-9] Wagner[7] and Ferranti[9] experienced improvement in conductive hearing loss with cervical spinal manipulation. The understanding of cranial OMT and how strains can affect the cervical spine explains why hearing improved in these patients. Spinal manipulation provided by chiropractors relaxed the cervical musculature. Relaxation of cervical musculature with attachments to the cranium would thereby allow for restoration of normal mobility and positioning of all the cranial bones, resulting in improved hearing.

In this case, we theorize that the compliance and stiffness of the tympanic membrane was altered due to head trauma, resulting in conductive hearing loss. The traumatic ATV accident caused an SBS compression and significant internal rotation of the left temporal bone. Such internal rotation caused increased tension of the tympanic membrane, which increased its stiffness. Increased stiffness, or decreased compliance, opposes the passage of low frequencies, resulting in hearing loss.[11,13] Additionally, the internal rotation and SBS compression may have caused impingement of the vestibulocochlear (auditory) nerve as it traveled through the internal acoustic meatus within the temporal bone, contributing to the hearing loss. The SBS is responsible for initiating physiologic flexion and extension of the midline cranial structures, thereby allowing internal and external rotation of the paired bones that they articulate with. With compression of the SBS, flexion and extension is limited, further restricting the temporal bone in internal rotation, causing the associated symptoms in this patient. Relieving the SBS compression restored physiologic motion to the cranial bones. With physiologic motion to the temporal bone restored, the tympanic membrane was able to relax, allowing for normal compliance, and the vestibulocochlear nerve entrapments resolved, allowing the hearing system to normalize. As a result of OMT, the patient's hearing returned to normal with no additional problems.

Conclusion

To the authors' knowledge, this is the first case report documenting the successful use of OMT to treat conductive hearing loss with no MEE. This case demonstrates the interrelationship between cranial structure and nerve pathways, and how osteopathic medicine can restore function when standard treatment modalities have failed. Being able to recognize and understand the connection between the PRM, cranial bones, and nerves allows an osteopathic physician to provide a unique approach to patient care.

While further study and research is necessary, the use of OMT as a treatment modality for patients with conductive hearing loss is encouraging and should be considered, especially when standard treatment modalities fail and no other pathology is found. Further investigations addressing underlying structural problems related to hearing should be conducted.

References:

1. Haddad Jr. J, Keesecker S. Hearing loss. In: Kliegman R. ed *Nelson Textbook of Pediatrics*. 20th ed. Elsevier; 2016:3071-3080.
2. Tharpe A, Sladen D. Causation of permanent unilateral and mild bilateral hearing loss in children. *Trends in Amplification*. 2008;12(1):17-25. doi:10.1177/1084713807313085.
3. Steele K, Cameron J, Viola J, Conte J, Ridpath L. Effect of osteopathic manipulative treatment on middle ear effusion following acute otitis media in young children: a pilot study. *J Am Osteopath Assoc*. 2014;114(6):436-447.
4. Channell M. Modified Muncie Technique: osteopathic manipulation for eustachian tube dysfunction and illustrative report of case. *The JAOA*. 2008;108(5):260-263.
5. Mr. William Rockefeller's hearing restored through operation by C.H. Muncie. *The Osteopathic Physician*. 1921;4(1):4.
6. Osteopath cures deaf mute by constructive finger surgery. *The Osteopathic Physician*. 1921;4(2):18.
7. Wagner U, Fend J. Treatment of sudden deafness by manipulation of the cervical spine. *Manuelle Medizin*. 1998;36(5):269-271. doi:10.1007/s003370050086.
8. Di Duro J. Improvement in hearing after chiropractic care: a case series. *Chiropractic & Osteopathy*. 2006;14(2):1-7. doi:10.1186/1746-1340-14-2.
9. Ferranti M, Keene K, Prothero C. Resolution of hearing loss after chiropractic manipulation. *Topics in Integrative Health Care*. 2014;5(3).
10. Medscape. Hearing Impairment: Background, Anatomy, Pathophysiology 2017. https://emedicine.medscape.com/article/994159-overview#showall. Accessed November 10, 2017.
11. Kileny P, Zwolan T. Diagnostic audiology. In: Flint P. ed *Cummings Otolaryngology*. 6th ed. Elsevier; 2015:2051-2410.
12. American Speech-Language-Hearing Association. Guidelines for Audiologic Screening. 1997;41-45. http://www.asha.org/policy
13. Venema T. Continuing education: tympanometry. *The Hearing Professional*. 2012;2:22-30.
14. Wuertenberger C, Rosahl S. Vertigo and tinnitus caused by vascular compression of the vestibulocochlear nerve, not intracanalicular vestibular schwannoma: review and case presentation. *Skull Base*. 2009;19(06):417-424. doi:10.1055/s-0029-1220209.
15. King, H. Osteopathy in the cranial field. In: Chila A. ed. *Foundations of Osteopathic Medicine*. 3rd ed. Lippincott Williams & Wilkins; 2011;728-748.
16. Heinking K, Kappler R, Ramey K. Head and occipital region. In: Chila A. ed. *Foundations of Osteopathic Medicine*. 3rd ed. Lippincott Williams & Wilkins; 2011;484-512.
17. Mancall E, Brock D. Cranial nerves. In: Elliott L, ed. *Gray's Clinical Neuroanatomy*. Elsevier Saunders; 2011:185-208. ■