CASE STUDY

Resolution of Sensorineural Hearing Loss in a 9-Year-Old Child Following Chiropractic Care to Reduce Vertebral Subluxation: A Case Report & Review of the Literature

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Abstract

Objective: To present a case report describing the chiropractic treatment of a patient diagnosed with sensorineural hearing loss.

Clinical Features: A 9-year-old female was brought in seeking chiropractic care for bronchitis, upper back pain, headaches, and hearing loss in her left ear.

Intervention and Outcomes: The patient received chiropractic adjustments in her upper cervical and thoracic spinal regions. The next day she reported being able to hear without the use of her hearing aid.

Conclusion: This case report detailed the chiropractic treatment of a 9-year-old female patient diagnosed with sensorineural hearing loss, which resolved after a single chiropractic adjustment. A possible mechanism for these results is presented, as well as a review of the literature dealing with hearing loss and chiropractic care. This may suggest a role for chiropractic care in the co-management of patients with sensorineural hearing loss.

Keywords: *Sensorineural hearing loss, children, subluxation, chiropractic, adjustment*

Introduction

Hearing is the sense by which sounds are perceived, or the capacity to perceive sound.[1] The organ of hearing is the ear. There are three main components to the ear: the outer ear, the middle ear, and the inner ear.

The outer ear includes the pinna, the external auditory meatus, and the tympanic membrane. The pinna is the visible part of the ear, which acts to focus sound waves into the external auditory meatus. The external auditory meatus, or ear canal, is a tube that serves to transmit the sound waves from the pinna to the tympanic membrane. The tympanic membrane, or eardrum, is an airtight membrane that vibrates when hit by sound waves.[2]

The middle ear consists of a small air-filled chamber that is located between the tympanic membrane and the oval window. This chamber houses three small bones, the malleus, incus, and stapes, also known collectively as the ossicles. The ossicles transmit vibrations from the tympanic membrane to the oval window. The oval window is a flexible membrane separating the air-filled middle ear from the fluid filled inner ear.[2-4]

The inner ear consists of the oval window, perilymph, and the cochlea. The oval window, the beginning of the inner ear, has vibrations transmitted to it through the ossicles. Perilymph is the liquid of the inner ear that moves in waves caused from the

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vibrations of the oval window. The cochlea is a spiral-shaped, fluid-filled tube that converts the wave like movement of the perilymph into nerve impulses.[2,4]

The nerve impulses, called action potentials, are transmitted to the brain along the cochlear nerve. The cochlear nerve, also called the auditory nerve, is one of two parts of the vestibulocochlear nerve, the eighth cranial nerve.

Action potentials from the cochlear nerve arrive in the brain at the brainstem. From there, the signals are projected to the midbrain, which integrates auditory input with input from other parts of the brain. The signal then moves to the thalamus and is then relayed to the primary auditory cortex, where sound first become consciously experienced. The signal is then relayed to Wernicke's area, which is involved in the understanding of written and spoken language.[5]

Hearing loss is defined as partial or complete loss of the sense of hearing and is also called deafness. Sensorineural hearing loss is hearing loss associated with some pathological change in structures within the inner ear, the cochlear nerve, or the auditory processing centers of the brain.[6]

The average annual prevalence of moderate to profound hearing loss, among 8-year-old children, from 1991 through 2010 was 1.4 per 1000, or 1 in 714 children. Sensorineural hearing loss was the predominant type, affecting 81% of children with hearing loss.[7]

Hearing loss is one of the most prevalent disabilities, affecting 1 in 1000 newborns and up to 11% of school-aged children. Unilateral hearing loss affects 3% of school children.[8]

There is a significant association between mild hearing loss and academic school performance.[6] School-age children with unilateral hearing loss have an increased rate of grade failures, with a 22-35% rate of repeating at least one grade.[9] There is also a need for additional educational assistance in 12-41% of children with unilateral hearing loss.[10]

Diagnosis

Sensorineural hearing loss is diagnosed by demonstrating a reduced ability to hear sounds. Audiometry is a relatively simple procedure that tests the ability to hear sounds. Audiometers allow the tester to increase and decrease the intensity or loudness of the sound, measured in decibels (dB); and the frequency or pitch of the sound, measured in Hertz (Hz). The threshold of 0 dB is defined as the intensity at which a normal young adult perceives a tone of a given frequency 50% of the time.[11] Pure-tone testing determines if the patient's hearing levels fall within normal limits at selected frequencies across the speech spectrum, 500 to 4,000 Hz.[12] Audiometers have a sensitivity of 92 percent and a specificity of 94 percent in detecting sensorineural hearing loss.[12]

Severity of hearing loss is graded as normal if it is within 20 dB of the defined threshold, mild (20–40 dB), moderate (41–55 dB), moderately severe (56–70 dB), severe (71–90 dB), or profound (>90 dB).[11]

Sensorineural hearing loss is typically treated with amplification devices such as hearing aids.[2,13] A hearing aid is a small electronic device that fits into the ear, which consists of a tiny microphone to pick up the sounds, an amplifier that increases the volume and a tiny speaker that transmits sound to the ear.[14]

Case Report

History

The patient is a 9-year-old female presented by her mother for chiropractic care. Her primary complaints were bronchitis, upper back pain, headaches, and hearing loss in her left ear. She complained of sharp upper back pain beginning three days earlier. She saw her medical doctor when it began and was diagnosed with bronchitis. An ear, nose, throat, and allergy specialist had also seen her approximately eight months earlier for evaluation and treatment. An audiogram had been performed which showed sensorineural hearing loss (SNHL) on the left. (Figure 1) The finding was sensorineural hearing loss probably congenital, as diagnosed by the specialist. Brain and Internal Auditory Canal MRI's were normal. The patient received a hearing aid in her left ear and was given preferential seats in school.

Examination

Upon examination it was revealed that her paraspinal muscles were taut and tender. She had moderate tenderness in the suboccipital and thoracolumbar areas, and slight tenderness in all other areas. Cervical x-rays revealed misalignment in the first cervical vertebra (atlas) relative to the occiput. It was determined that the anterior arch of atlas was positioned superiorly, the lateral misalignment was to the left of occiput, and atlas rotated in an anterior direction. This translates to an atlas listing of ASLA.

Intervention & Outcomes

On her first visit she received a posterior thoracic adjustment, as determined by static and motion palpation. She was placed face down on the table, and the spinal level of involvement was contacted on the transverse process on the side of vertebral body rotation. The doctor used a pisiform contact. A high-velocity, low- amplitude (HVLA) thrust was then given to the specific level, depending on palpation findings. Torque was to close the wedge.

She also received a toggle adjustment to her atlas, as determined by x-ray findings. The patient was placed in side-lying posture, with her left side up. The height of the cervical piece was adjusted so that the patient's cervical spine remained in a neutral position. The doctor used a pisiform contact on the lateral tip of the transverse process of the patient's atlas, and the stabilization hand was in the anatomical snuff box of the contact hand. The thrust was given in a lateral to medial, superior to inferior, and anterior to posterior direction, with a counter-clockwise torque. The thrust was followed immediately by recoil of the doctor's contact, so that the contact was no longer on the atlas when the headpiece dropped.

The next day at school, the patient noticed she was able to

hear without the use of her hearing aid. Her mother confirmed this later that evening, as the patient was able to hear words whispered into her ear. Although the patient is still being seen on a regular basis, the resolution of her hearing loss occurred after a single adjustment.

Discussion

Chiropractic has long been associated with hearing. The first chiropractic adjustment given in 1895 was reported to have cured deafness.[15] Several case studies have been published with accounts of resolution of hearing loss following adjustments. There are no randomized controlled trials present in the scientific literature.[16]

Review of literature

A search for "Hearing Loss" was performed on the index to chiropractic literature data base, which yielded 17 results. Of this 17, 11 case reports and 1 case series are reviewed in this paper. We did not include 2 audio lectures on prevention of hearing loss and 1 letter to the editor. Also not included were 2 case reports where hearing loss was an incidental finding and resolution of the hearing loss was not reported on.

Ferranti et al presented a case report of a 46-year-old female with chronic neck pain and associated left-sided tinnitus and hearing loss (HL). An audiogram had been performed which showed conductive HL on the left at 500 Hz. The patient received medications from an ear, nose, and throat specialist, which she reported provided no help. Her care included full spine adjustments, electrical muscle stimulation in the upper thoracic region, and home cervical exercises. She was seen for 12 total visits with a frequency of 1 time per week for a period of 4 months. A post audiogram shows hearing at all frequencies restored to within normal limits.[16]

One case series, presented by DiDuro, used audiometry before and immediately after the first chiropractic adjustment to examine the effects on the central nervous system. The study included a series of 15 hearing-impaired patients ranging in age from 34 to 71 years. Out of the 15 patients, 6 had hearing restored, 7 improved, and 2 had no change.[17]

Another study, by Leboeuf-Yde et al, examined non-musculoskeletal responses to chiropractic adjustments. The study included 245 patients who listed "hearing" as one of their complaints. After 2 weeks of treatment, 13% of these patients listed their hearing as "definitely better."[18]

A case report by Kessinger and Boneva involved a 75-year-old female who demonstrated improvement in audiologic function. An audiometric study performed after 13 weeks of upper cervical chiropractic care demonstrated improvement in all frequencies.[5]

Emary reported on a case study of a 40-year-old woman who presented with a diagnosis of Ménière disease, including a history of vertigo, tinnitus, low- frequency hearing loss, and aural fullness. Treatment included adjustments to the upper cervical and thoracic spine, along with soft-tissue trigger-point therapy, and stretching exercises. The patient's tinnitus and vertigo were fully resolved, and she only experienced episodes of mild aural fullness. No mention is made of whether or not the hearing loss was resolved.[19]

Feeley and Kemp also reported on a case of Ménière disease, this time in a 56-year-old male. His presenting complaints included pain and fullness in the left ear, accompanied by dizziness and progressive hearing loss over the past twenty years. His auditory exam four months from the start of care showed improvements, especially with lower frequencies.

These improvements continued into his second year of care, and then were maintained over the course of treatment.[20] A third case of Ménière disease was reported by Bryner and Cowin. This was a case report describing symptoms, chiropractic assessments, and adjustments over 7 years with a 43-year-old female patient. Audiograms showed improvements after initial care with thresholds that had improved and were normal. Thresholds remained normal for the next 4 years, but 2 years later started to show deterioration in hearing.[21]

Brown reported the case of a three-year-old girl who was previously diagnosed by her pediatrician with bilateral otitis media with effusion. She had associated bilateral hearing loss. Treatment included chiropractic adjustments applied to the sites of vertebral subluxation. Cervical distraction exercises were also performed. The patient reported an increase in hearing, and the child's mother reported the child had less ear pain and was less irritable after the initiation of chiropractic care. Medical audiology reports documented speech and hearing improvements after the implementation of chiropractic care.[22] Dwyer and Boysen,[23] Pilsner and Richardson,[24] and O'Connor[25] also reported cases of children with otitis media and conductive hearing loss, which were resolved through chiropractic care.

Rowswell-Kulikowski presented a case of a 1-year-old child who was diagnosed with auditory neuropathy. She presented to the office with developmental delays. After 20 treatments over the course of one year, she started reaching developmental milestones.[26]

Pathophysiology

All known systemic autoimmune diseases have a very high incidence of inner ear disease, generally running 30–50%.[27] This leads to the theory that systemic inflammatory factors may cause hearing loss by disrupting vascular endothelial cell integrity in the stria vascularis of cochlear duct, causing breakdown of the blood-labyrinth barrier and endolymph ion homeostasis.[27]

Autoimmune sensorineural hearing loss was first described by McCabe. His study presented 16 patients with sensorineural hearing loss (SNHL) which improved after treatment with corticosteroids, suggesting an autoimmune pathogenesis.[28] Trune and Nguyen-Huynh presented a review discussing how vascular pathophysiology may cause hearing loss. Their findings showed that elevated levels of inflammatory cytokines, including tumor necrosis factor α (TNFα) and interleukin 1β (IL-1β), were found in various types of hearing loss, suggesting that the inner ear is sensitive to these circulating immune factors.[27]

The normal vascular reaction to inflammatory factors would be harmless in most organs, but because the cochlear vasculature is very sensitive to circulating inflammatory factors, hearing and vestibular functions can become damaged with small vascular changes.[27] Thus, the inner ear is often the first organ affected in systemic autoimmune diseases.[27] In studies of autoimmune mice, the primary defects in the inner ear include breakdown of the stria vascularis blood vessels, loss of blood-labyrinth barrier integrity, and hearing loss.[27]

Since the lateral wall can repair itself, hearing loss due to autoimmune etiology can be restored as long as there are no permanent changes in the organ of Corti.[27]

In a study by Teodorczyk-Injeyan et al, asymptomatic subjects who received a single high velocity low amplitude adjustment in the thoracic spine demonstrated suppression of the *in vitro* production of two pro-inflammatory cytokines, tumor necrosis factor α (TNFα) and interleukin 1β (IL-1β).[29] Two hours after intervention, the production of both cytokines increased significantly in both the sham adjustment and no adjustment control groups. In contrast, a significant reduction of the pro-inflammatory cytokine secretion was observed in cultures from the adjusted group.[28] These are the same inflammatory cytokines which Trune and Nguyen-Huynh found were elevated in patients with hearing loss.

As stated above, hearing loss due to autoimmune etiology can be restored, since the lateral wall can repair itself. It is proposed that the lateral wall repair can take place once the pro-inflammatory cytokine levels have been reduced after the adjustment.

One proposed mechanism for this to occur is through the spinovisceral reflex effect on the immune system, which may be mediated by vagus nerve activation. The vagus nerve provides innervation to the principal body organs as well as the reticuloendothelial system.[29] Recent investigations have shown that the vagus nerve may control central inflammatory responses.[30] Investigations in vitro have shown that human macrophage production of TNF-a, IL-1b, and IL-6 was inhibited after the exposure of these cells to the principal neurotransmitter of parasympathetic nervous system, acetylcholine (Ach).[31]

The Ach-mediated reactions, described now as the cholinergic anti-inflammatory pathway, occur after vagus nerve stimulation and the subsequent interaction of Ach with the nicotinic receptor a7 subunit expressed by many cells of the immune system.[32] The study by Teodorczyk-Injeyan et al also supports the hypothesis that the spinovisceral reflex effect can encompass functional activity of the immune system.[29]

Limitations

Possible limitations of this study include limited patient history and limited documentation of examination findings.

Conclusion

This case report details the chiropractic management of a 9-year-old female patient diagnosed with sensorineural hearing loss, which resolved after a single chiropractic adjustment. A possible mechanism for these results is also presented. This may suggest a role for chiropractic care in the co-management of patients with sensorineural hearing loss. Further research is necessary to examine this in more detail.

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Appendix

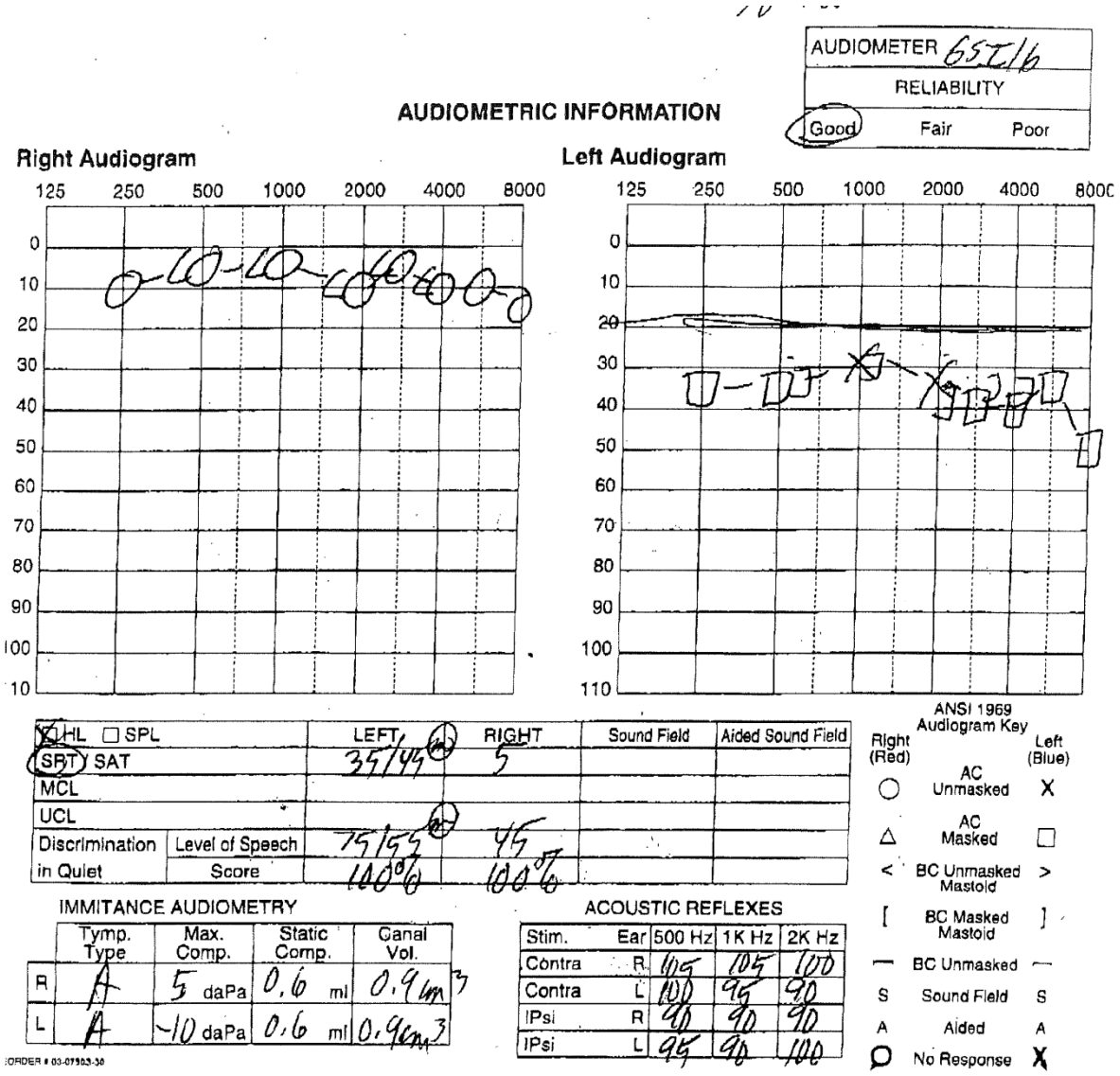

Figure 1. Audiogram prior to the chiropractic adjustment.