# CASE STUDY

# Resolution of Otitis Media, Improvement in Hearing & Avoidance of Tympanostomy Tubes Following Chiropractic Management in a Child: A Case Report & Selective Review of the Literature

*Kimberly O'Connor, D.C., C.A.C.C.P.[1] Joel Alcantara, D.C.[2] Grant Schneider[3]*

## Abstract

**Objective:** To describe a detailed case report entailing chiropractic management of a 9 and a half-year-old girl experiencing chronic ear infections as well as to discuss relationships between etiology, chiropractic theory and current literature on the topic.

**Clinical Features:** A 9 and a half-year-old female presented to a chiropractic clinic with her mother for consultation and possible care. According to the girl's mother, her daughter suffered from chronic ear infections, neck pain and headaches and was diagnosed with chronic otitis media by her medical doctor whom subsequently scheduled her for tympanostomy tube surgery. Examination of the cervical region revealed hypolordosis, hypertonicity of paraspinal musculature, lymphadenopathy, decreased ROM, positive orthopedic tests and chiropractic subluxations.

**Intervention and Outcomes:** The subject was managed with Diversified adjustments of $C_1$, $C_4$ and $L_4$ three times per week for three weeks. Over the course of care, the patient experienced zero episodes of headache and neck pain and her otolaryngologist reported a 95% improvement in previous hearing loss. Accordingly, the tympanostomy procedure was cancelled.

**Conclusions:** Numerous studies have identified possible efficacy in treating otitis media with chiropractic care, but the majority of these have been criticized for their lack of sound methodological constructs. The subject in this case demonstrated significant improvement from chronic otitis media after the inception of chiropractic care. Small sample size, lack of randomization and lack of a control group limit extrapolative application of this study.

**Key words**: *Subluxation, Diversified, otitis media, tympanostomy, myringotomy, hearing, Eustachian tube, adjustment, spinal manipulative therapy.*

**Introduction**

*Epidemiology*:

Today, otitis media (OM) is broadly defined as inflammation of the middle ear without reference to etiology.[1] Data shows OM is currently the most common reason for children under the age of 15 to visit a physician.[2] It's treatment demands nearly half of all pediatric prescriptions and is the reason for $2-5.3 billion in annual expenditures. It has a peak incidence in children between six and fifteen months of age.[3,4] In the

United States, approximately two thirds of all children will be affected by the age of two.[5] Recent literature has linked OM to certain risk factors including sibling history of OM, male gender, formula fed infants, exposure to second hand smoke, prior antibiotic use, immunocompromised state, seasonal allergies and presence of congenital anomalies such as craniofacial defects.[1,6] OM is a secondary disease commonly resulting from a primary infection of the sinuses and/or other constituents of the respiratory system. OM is subdivided into categories including OM with (OME) or without effusion, chronic OM (COM), serous OM, bacterial OM, and acute OM (AOM).[4] Although demarcations described by various sources appear to be inconsistent, accurate sub-category diagnosis remains crucial in order to render appropriate treatment.[4,7] This case study will mainly address the OME, AOM and COM subtypes.

*Pathogenesis:*

As previously mentioned, AOM is the result of a primary infection's migration to the middle ear.[4] Infection of the upper respiratory tract can result in congestion extending into the Eustachian tube (ET). This creates an ideal environment for bacterial proliferation. The most common infectious agents precipitating OM onset are Haemophilus influenza, Streptococcus pneumonia and Moraxella catarrhalis.[8] The process of infection leads to inflammation, blockage and eventual OM.[1,8] Several studies have described facilitation of this mechanism by means of generalized ET dysfunction secondary to mechanical and/or neurophysiologic insult. Proper ET function is dependent upon the function of the tensor veli palatini muscle, which is the only active opener of the ET. This muscle receives neurological stimulation from the mandibular branch of the trigeminal nerve. Trigeminal nerve fibers unite with sympathetic fibers of the $C_1$-$C_4$ nerve roots via the superior cervical ganglion. Thus, mechanical dysfunction of the cervical vertebrae can affect neurological input to the tensor veli palatini muscle and consequently, ET function. ET function can also be mechanically impaired by hypertrophy of the cervical lymphatic tissue, which causes pressure on and blockage of the ET. Infantile anatomy is especially susceptible to this process due to horizontal orientation of the ET which effectively diminishes gravitational advantage on middle ear drainage.[4] This is congruent with the decreased frequency of middle ear infections observed as children grow in age.[9] Regardless of the precipitating factors, most literature acknowledges an infectious, as well as a mechanical component to OM pathogenesis.[4]

*Signs, Symptoms and Sequelae:*

As previously stated, clinicians do not unanimously agree on diagnostic criteria but common signs and symptoms of general OM include ear pain, fever, middle ear inflammation, redness or bulging of the tympanic membrane, hearing impairment, vertigo, tinnitus, feelings of "fullness" or "popping", possible GI distress and swollen lymph nodes. Parents may note irritability, sleep disturbances, decreased attentiveness, and behavioral changes in their child.[2,4] OME will demonstrate fluid accumulation in the middle ear without infection or acute inflammation and typically follows episodes of AOM.[2,8,10] COM presents with signs and symptoms similar to AOM, including tympanic membrane dysfunction and systemic infection, but over the course of at least several months.[11] OM becomes significantly concerning when considering the possibility of sequelae such as behavioral changes, irritability, sleep disturbances and decreased attentiveness. As a result, OM is a common cause for significant absences in children attending elementary school. One sequela of AOM and COM is hearing loss, which can interfere with proper development of a child's language comprehension, speech development and social interaction and may be responsible for some learning disabilities in children with COM.[2,4]

*Diagnosis:*

Diagnosis is rendered by evaluation of previously mentioned signs and symptoms as well as diagnostic testing. Use of pneumatic otoscopy to assess middle ear status is recommended because it combines visualization of the tympanic membrane combined with a test of membrane mobility. Parameters of this exam include evaluation of light reflex, exudates, position of landmarks, and degree of translucency and color of the tympanic membrane. When performed by an experienced examiner, the accuracy for diagnosis of OME may be between 70% and 90%. Tympanometry is another effective tool in diagnosis of OME because it quantifies tympanic membrane mobility. The positive predictive value of an abnormal tympanogram is between 49% and 99%, but is much more effective when used in conjunction with pneumatic otoscopy.

Finally, hearing evaluation via air and bone conduction can be used since hearing loss is a possible indicator of OM. These tools are generally considered to be the most definitive means to differentiate between OME, AOM and COM.[12] Signs and symptoms are also considered when diagnosing OM. OME is differentiated by identifying persistent effusion lasting longer than three months with no signs of infection.[13] Diagnosis of AOM should be made by identifying fluid in the middle ear that is accompanied by signs or symptoms of systemic involvement and ear infection such as pain, redness and a bulging tympanic membrane. Similarly, COM is diagnosed when there is evidence of AOM but over the course of several months to a year.[11] Additional differential diagnoses which require ruling out in patients presenting with signs and symptoms of OM include otitis externa, TMJ dysfunction, trauma, foreign body, labyrinthitis, and cervical spine dysfunction.[5] Accurate diagnosis is crucial in order to limit the quantity of inappropriately prescribed treatments, especially antibiotics.[12,14]

*Treatment:*

Conventional medical treatment for OM remains under much controversy and typically begins with prescription of antibiotics. According to the Academy of Pediatrics/American Academy of Family Practice and Centers for Disease Control and Prevention, the "wait and see" approach is recommended based on evidence that 70-80% of AOM cases resolve without intervention. Regardless, antibiotics continue to be used despite the lack of compelling evidence for efficacy in improving long term outcomes, preventing reoccurrence or reducing symptom duration in OM.[2,4] Antibiotics are prescribed with the goal of eliminating the inciting bacterial

growth. However, at least half of OM cases are not caused by bacteria. This has resulted in misdiagnosis and inappropriate prescription of antibiotics that pose a serious public health concern.[4] Additional concerns regarding continued use of antibiotics to treat OM include side effects, costs and the potential for antimicrobial drug resistance.[2] For a child presenting with effusion and hearing deficits for a total of four to six months, the next protocol is myringotomy and insertion of tympanostomy tubes with the goal of preventing recurrence, mastoiditis and hearing loss.[4] Tube insertion is theorized to help by restoring hearing to the pre-effusion state as well as reducing middle ear pressure by allowing fluid to drain.[12] These claims appear dubious when considering that even with tubal insertion, 98% of children have a reoccurrence of effusion within two months and 25% have total hearing loss within 7-10 years.[4] Other risks with this procedure include cholesteatoma, persistent tympanic membrane perforation, tympanosclerosis as well as several risks associated with general anesthesia.[8]

**Case Report**

*Patient History:*

A 9 and a half-year-old female presented with her mother to the Platinum Chiropractic Clinic for consultation and possible care. According to her mother, the subject had been suffering from chronic ear infections and headaches, and medical care didn't seem to be helping. At the time of chiropractic presentation, the patient was scheduled to have tympanostomy tubes placed in her ears in three weeks time due to approximately 60% hearing loss in her left ear and 30% hearing loss in her right ear. In the 4 months prior to presenting to the clinic, she had been treated for 4 or 5 double ear infections with antibiotics during each episode, although she was not experiencing an active ear infection at the inception of her chiropractic care. During three of her previous ear infections, the patient's tympanic membranes had burst and she was prescribed different antibiotics each time this occurred. The patient also presented with neck pain and headaches. She characterized her headaches as "extremely bad" with respect to pain intensity and "occasional" in frequency, typically developing a few days prior to an emerging ear infection. Her headaches were identified as dull and throbbing in the temporal region bilaterally.

She had previously visited a neurologist who reported no known cause for her headaches. The neurologist also claimed that there was no correlation between her headaches and the ear infections that always occurred two to three days after. Her neck pain was typically experienced following her bouts of ear infections. Her neck pain was located specifically at the atlas fossa area unilaterally and the sub-occipital region bilaterally, without radiation. At the time of clinical presentation, the patient was experiencing an episode of headache as well as neck pain. She related the headache was causing serious hindrance in her ability to carry out daily activities. Specifically, she was struggling with caring for her personal hygiene and other basic needs due to the pain. Her ability to hear and engage in conversation was described as "extremely limited" during and a couple of days after an ear infection. The ear pain, neck pain and headaches also affected her ability to concentrate on academics.

*General Examination:*

Cervical soft tissue palpation revealed bilateral lymphadenopathy of the superficial and deep cervical lymph node chains. Results of the active cervical range of motion (ROM) exam are provided below (Table 1). Forward flexion was interpreted as moderately restricted, extension as severely restricted and left and right lateral flexion as well as left and right rotation as mildly restricted. Orthopedic examination of the cervical spine revealed bilaterally positive Jackson compression and maximum compression tests. Soto-Hall test was positive with the localized pain at $T_1$-$T_4$. Neurological examination utilizing muscle grading, deep tendon reflexes, pathological reflexes and dermatomal sensations was unremarkable.

*Chiropractic Examination:*

Inspection revealed hypolordosis of the cervical spine compared to patients of similar gender and age. Upon digital palpation, cervical paraspinal musculature was hypertonic and tender to the touch, especially on the right side. Superficial and deep palpation of the sternocleidomastoid muscles revealed exquisite tenderness. Inter-segmental digital examination including static and motion palpation, an exam procedure highly utilized by chiropractors to identify subluxations, revealed subluxations at $C_1$ (ASRP), $C_2$ (body left), $C_4$ (body right), $C_7$ (body right) and $L_4$ (body right).

*Diagnostic Impressions:*

Diagnosis was succinctly stated as cervical and lumbar subluxations. These diagnoses were supported by findings from the patient history and exam with emphasis on chiropractic palpation and ROM. Additionally, the patient's medical doctor had previously rendered a diagnosis of COM and was pushing for tympanostomy surgery, but was not treating the patient at the time chiropractic care was initiated.

*Intervention:*

Based on the report of findings, the patient's mother consented to the doctor's recommendation of a trial of chiropractic care. This would consist of Diversified technique, specific, high velocity, low amplitude (HVLA) manual forces applied to particular vertebrae in order to correct bony misalignments, termed subluxations. This intervention is hereafter referred to as spinal adjusting. In order to concisely describe the adjusting applied in this case, an understanding of the Cartesian coordinate system is necessary. The Cartesian coordinate system, which is used to describe directional misalignments as well as vectors of force, is rooted in mathematics and generally accepted across the scientific community. This system defines any directional movement or static spatial position as either a negative (-) or positive (+) direction and a translational (T) or rotational (R) motion about the x, y and/or z geometric axes. For example, if one was to turn their head ($_H$) to the left, this is described as positive rotation about the y-axis and is noted as $+R_HY$ (H denotes 'head' position relative to the thorax).[15] On the first visit, the $L_4$ subluxation was addressed with the patient in a side-lying position whereupon a +TZ +TY vector was applied with an additional rotational component opposite the particular (unknown) rotational

misalignment of the vertebrae while contacting either the spinous or mammillary processes. The thoracic vertebrae were addressed utilizing a similar vector while contacting either the spinous or transverse processes on the prone-positioned patient. $C_1$ was addressed with the patient in a supine position while contacting the posterior, lateral aspect of the right transverse process and placing the head in $+R_HZ$ and $+R_HY$ position before applying a force in a +TZ, -TY +TX vector. $C_4$ was addressed in a similar fashion with the exception of applying a +TY and a rotational component (unknown) opposite the rotational misalignment. $C_7$ was addressed in the same manner as $C_4$. All adjustments were delivered in a manner accounting for the specific orientation of spinal curvatures, intervertebral disk plane lines and facet morphologies of each spinal level. The patient was cared for in a similar fashion during subsequent visits. Chiropractic adjustments remained the exclusive form of care during the entire case management.

*Outcomes:*

Over the course of the next three weeks, the patient did not experience another headache or episode of neck pain. At the first reassessment she reported increasing ease with activities of daily living, especially with respect to blow-drying her hair. She reported that she could hear much more clearly during conversation. Following three weeks of chiropractic care at three visits per week, consultation with the subject's otolaryngologist was sought whereupon another hearing test was conducted. The results of the test showed a 95% restoration of the hearing that was initially lost. Accordingly, tympanostomy tubes were declared unnecessary. The patient's care was eventually decreased to wellness care, and she has not had another ear infection. She has experienced headaches on three occasions over the last 5 years. Adjustments were applied each time she experienced a headache whereupon she would immediately experience total relief. The headaches were never followed by an ear infection, as they had been in the past.

**Discussion**

*Current Literature:*

As chiropractic has recently strived to embrace scientific justification of its interventions, several papers have been published. When searching the terms "chiropractic" AND "otitis media" and "chiropractic" AND "ear infection" in search engines including Pubmed, Galileo, Mantis and Index to Chiropractic Literature while screening for relevant, peer-reviewed, full-text articles written in English, 9 case studies, 5 literature reviews, one non-randomized cohort study, one feasibility study, and one case series were obtained.

The 9 case studies generally reported symptom relief from OM as well as improvement in objective findings. Conclusions were described as limited due to small sample size and lack of control groups. Fysh was able to demonstrate no recurrence of OM after two chiropractic visits.[16] Saunders was able to demonstrate the same after four visits.[10] Erickson published evidence of improvement in an OM case utilizing a combination of chiropractic, homeopathic and medical treatment.[9] Marino, Lanjopoulos and Thomas described successful treatments of OM with chiropractic.[1,10,17] Stone-McCoy published two studies, each of which depicted successful avoidance of tympanostomy procedures utilizing chiropractic.[4,8] Fedorchuck noted improvement in subjective and objective measures through chiropractic.[18] Systematic reviews generally concluded that the literature did not demonstrate compelling evidence for or against the use of SMT in treating OM.[3,7,13,19,20] In one of the largest known case series on this subject, Fallon examined 332 children with diagnosed OM for effectiveness of chiropractic care. Children who had AOM (n=127) received an average of 4 (+/-1.03) SMT treatments and attained normal otoscopic exams and tympanograms after 6.67 (+/-1.9) and 8.35 (+/-2.88) days, respectively.[6] Fallon's study too, was criticized for failure to eliminate biases and confounders.[20] In Froehle's 2013 non-randomized cohort study of 46 children with OM, 93% of cases improved under chiropractic care. Unfortunately, this study had had no control group which equivocates the conclusions.[21] Sawyer's feasibility study concluded that recruitment for large randomized controlled trails is feasible.[2]

Despite many studies demonstrating improvement in OM symptoms under chiropractic care, the scientific community continues to demand further evidence.[10,17,18,20,22] Although it is true that many studies are lacking in methodological rigor including confounding variables and lack of control groups, there is a small amount of literature supporting the utilization of chiropractic care in treating OM and further investigation is certainly warranted.[10,18,20]

*The Chiropractic Subluxation:*

The chiropractic discipline has developed a healthcare delivery system based on removal of nerve interference, termed subluxation. Subluxation has been a part of healthcare debate since Randall Holme first used the term in 1688 to describe "dislocation of a joint". Since then, there has been much debate on the definition, existence of and best way to manage subluxation. Even within the chiropractic profession, which has historically centered its focus on subluxation, there is hardly a cohesive definition. Although it has been described through many different philosophical and scientific standpoints, when simplified, all theories generally describe a subluxation as a loss of normal bony juxtaposition resulting in some form of abnormal nerve impulse activity. The nervous system is vastly complex and the current reservoir of scientific knowledge is unable to completely grasp the intricacies at play. As such, the manifestation of subluxation, which affects the nervous system, is described by several different theoretical mechanisms. These mechanisms include kinetic and biomechanical processes and can potentially affect muscle, nervous and/or connective tissues.[23] Henceforth, specific subluxation models will be defined and discussed as they may apply to the etiology of OM. Other non-subluxation based models will be heeded and discussed as well. Furthermore, after each etiology presented, a detailed neurophysiologic pathway regarding possible efficacy of chiropractic in OM will follow and is also summarized below (Table 2).

*Dysafferentation and Neurodystrophy:*

A healthy ET performs the function of draining

nasopharyngeal fluid from the middle ear. Since bacteria proliferate more effectively in moist, static environments, this function effectively protects the middle ear from infection. ET function also protects the tympanic membrane from pressure fluctuations by providing equalization to the external environment through its opening to the nasopharynx.[8] As previously stated, these mechanisms are regulated by a dilation mechanism which is dependent upon contraction of the tensor veli palatini muscle. This muscle receives direct innervation from the medial pterygoid nerve which diverges from the mandibular branch of the trigeminal nerve. Sympathetic fibers synapsing at the level of the $C_{1-4}$ vertebrae also converge with the trigeminal nerve via the superior cervical ganglia.[4] Furthermore, the nucleus of the spinal trigeminal tract has been shown to extend down to the level of the upper cervical segments.[21]

These anatomical facts demonstrate a clear neurological link between the cervical spine and the middle ear.[4] Being that the cervical zygapophyseal joints and intervertebral disks are richly endowed with proprioceptive and mechanoreceptive fibers, proper mechanical function of this area is crucial to maintaining integrity of normal afferent input into the central nervous system.[23] Unfortunately, due to a number of factors including gravity, poor posture and trauma, it is possible to develop segmental biomechanical dysfunction of the cervical vertebrae. This dysfunction results in abnormal movement patterns and distribution of force across bony and soft tissues which can cause a perpetual amplification of said dysfunction.[15] This injurious combination of segmental dysfunction and copious innervation will create distorted afferent messages regarding spatial orientation and movement, termed dysafferentation, to be relayed to the central nervous system.

According to Kent, this neurological distortion is stressful to bodily tissues and can result in alteration of nerve trophic function by means of facilitation, termed neurodystrophy.[23] Therefore, when cervical segmental dysfunction causes dysafferentation and neurodystrophy of $C_{1-4}$ sympathetic fibers which eventually converge with the trigeminal nerve, sub-optimal function of the tensor veli palatini may result and thus contribute towards susceptibility to OM by affecting proper patency and drainage of the ET.[4,18] Chiropractic is applied to correct segmental dysfunction and abnormal bony juxtaposition. This correction leads to restoration of normal afferent and subsequent efferent signal. Restoration of the previous allows for proper axonal propagation and tone of the nervous system.

Appropriate nerve system function ensures correct CNS perception of the body and its environment, and in this case, would specifically affect the tensor veli palatini muscle and by extension, function of the ET.[4,23] An identical etiological pathway can also affect the facial nerve, which due to its course will affect ET mucus production, further contributing to ET congestion.[6] In summary, adjustments to the cervical spine are applied by way of a specific vector in order to improve inter-segmental motion, re-establish normal bony juxtaposition, stimulate proprioceptive and mechanoreceptive fibers, and most importantly, to procure normal neurological tone.[23]

*Lymphatic dysfunction:*

The middle ear relies on lymphatic flow to aid in drainage as well as regulation of phagocytic activity.[6] Since cervical subluxations may be accompanied by muscular spasticity and dysfunction, especially of the sternocleidomastoid (SCM) muscle, and since lymphatic flow is directly dependent upon the adequate muscular contractions for flow, a connection between subluxation and decreased lymphatic flow can therefore be discerned.[6,16,21] Several studies have identified significant evidence of reduced lymph drainage from the ET in OM patients.[16] The consequential alteration of phagocytic activity in a child may cause increased susceptibility to infections leading to OM.[16]

Interestingly, the ET is not the only structure responsible for regulation of middle ear pressure. Mastoid air cells are a physiologic space contiguous with the middle ear which contain tissues responsible for performing gas exchange in order to help regulate long-term middle ear pressure. Once this function fails, OM is much more likely to occur. This is substantiated when observing the positive correlation between patients with poor mastoid air cell development and occurrence of chronic OM.[24] Connections between the mastoid antrum and the middle ear threaten to spread infection to the mastoid air cells. This further emphasizes the implication of the lymphatic component of OM. Proliferation of bacterial cultures in the middle ear must be checked by phagocytic activity regulated by lymphatic flow.

Chiropractic subluxation removal can help by restoring normal muscular tone as well as reestablishing proper lymphatic flow, and thereby improving health of the immune system.[9,17] A study by Brennan et al demonstrated that HVLA thrusts primed polymorphonuclear neutrophils for an enhanced respiratory burst.[17] Gentle massage, although not chiropractic per se, has also been shown to relax musculature, improve lymphatic flow and restore function.[9] Such treatment has been used by chiropractors in conjunction with adjusting as a non-invasive strategy to facilitate lymphatic flow and deserves attention.

*Inflammation:*

As has thus far been discussed, OM typically develops through presence of many different etiological factors. Secondary to many of these is an inflammatory process. Many scientific works have demonstrated examples of chronic inflammation altering the structure and function of tissue. In the case of OM this inflammatory process is likely due to infection and/or mechanical irritation. Inflammatory changes can preclude the drainage of the middle ear and the ET. Inflammation has also been shown to alter normal nerve transmission by inducing hyperactivity. In the case of inflammation related to subluxation, it is the contention of the chiropractic profession that adjustments to reestablish biomechanical function may reduce inflammation secondary to tissue stress.[6]

**Conclusion**

This case study demonstrated a total remission of chronic ear infections in a girl under chiropractic care. Limitations of this

particular study include a small sample size, lack of a control group and lack of randomization. Spontaneous remission is also a possibility that must be considered; however, this progression is more typical of AOM rather than COM. Also, the subject's lengthy history of recurrent OM episodes which abated during the time of care suggests an association. Beyond this case, OM continues to pose a significant health concern to the children in the United States. Standard medical interventions for OM have been demonstrated ineffective by many studies. Furthermore, application of antibiotics and tympanostomy tubes are rendered regularly despite significant risk of serious side effects and sequelae. Complementary and alternative medicine, including chiropractic, has yet to produce compelling evidence capable of stimulating reform in OM standard of care protocols. Numerous studies have identified possible efficacy in treating OM with chiropractic SMT, but the majority of these have been criticized for their lack of sound methodological constructs. Chiropractic posits several reasonable models linking the correction of subluxations to health of the middle ear. The need for cessation of ineffective and dangerous medical treatments is matched by the demand for empirically indubitable evidence supporting chiropractic treatment of OM. Equivocal findings in the current chiropractic literature require larger studies of the randomized-controlled nature. The financial burden of such feats is upon the chiropractic profession. Inspiration of collective interest and financial support to chiropractic research organizations is an obligation, and an absolute necessity.

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| ROM | 1st Attempt | 2nd Attempt | 3rd Attempt |
|---|---|---|---|
| Forward Flexion | 20° | 20° | 20° |
| Extension | 10° | 10° | 10° |
| Left Lateral Flexion | 20° | 25° | 25° |
| Right Lateral Flexion | 30° | 30° | 30° |
| Left Rotation | 65° | 65° | 65° |
| Right Rotation | 65° | 65° | 65° |

**Table 1. Active ROM findings in the cervical spine**

| Etiology | Function of related structures in healthy state | Relationship to pathogenesis of OM | Physiological response to chiropractic |
|---|---|---|---|
| Dysafferentation/neurodystrophy | Neurological afferent and efferent signals allow for normal levator veli palatini function and appropriate ET patency resulting in regular drainage and neutral middle ear pressure.[8] | Segmental dysfunction and subsequent to neurological derangement causes dysfunction of the levator veli palatini. Dysfunction disrupts ET drainage and creates pressure buildup as well as an environment supportive of bacterial growth.[4,19,20,21] | Restoration of segmental dysfunction reestablishes the brain's perception and control of involved tissues. Newly appropriate neurological signals allow for timely patency of the ET, reducing probability of OM manifestation.[6] |
| Lymphatic dysfunction | Normal lymphatic flow provides adequate phagocytic activity and prevention of infection in the middle ear.[6] | Disruption of lymphatic flow secondary to abnormal muscular tone can predispose the middle ear to infection.[6,17,23] | Chiropractic may normalize muscular tone by reestablishing normal biomechanics and subsequently remove interference of lymphatic flow.[9,18] |
| Inflammation | Inflammation is a protective mechanism initiated under tissue stress, trauma and infection. Inflammation can be detrimental and is normally not present in healthy tissues.[6] | Dysfunctional and biomechanically stressed tissues stimulate inflammatory processes which can impede on biological processes such as nerve flow.[6] | Removal of biomechanical stress will effectively mitigate inflammatory processes. In turn, non-inflamed tissues including nervous tissue function more effectively.[6] |

**Table 2. Subluxation models as they relate to OM etiology**