ORIGINAL RESEARCH

The Role of the Chiropractic Adjustment in the Care and Treatment of 332 Children with Otitis Media

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ABSTRACT

Objective: To conduct a pilot study of chiropractic adjustive care on children with otitis media using tympanography as an objectifying measure, and to propose possible mechanisms whereby subluxation is implicated in the pathophysiology of otitis media.

Design: Case series

Setting: Subjects presented in a private clinical practice in New Rochelle, New York. The subjects were referred by various sources including pediatricians, other MDs, chiropractors and parents.

Participants: 332 children who presented consecutively with previously diagnosed otitis media, ages 27 days to 5 years.

Main Outcome Measures: A survey of the parent/guardian was used to determine historical data with respect to previous otitis media bouts, age of onset of initial otitis media, feeding history, history of antimicrobial therapy, referral patterns, and birth history. Otoscopic and tympanographic data was collected as well as data concerning the number of adjustments administered to produce resolution of the otitis media. Data with respect to recurrence rates over six months was also collected.

Results: The average number of adjustments administered by types of otitis media were as follows: acute otitis media (n=127) 4.0±1.03, chronic/serous otitis media (n=104) 5.0±1.53, for the mixed type of bilateral otitis media (n=10) 5.3±1.35 and where no otitis was initially detected on otoscopic and tympanographic exam (but with history of multiple bouts) (n=74) 5.88±1.87. The number of days it took to normalize the otoscopic examination was for acute 6.67±1.9, chronic/serous 8.57±1.96, and mixed 8.3±1.00. The number of days it took to normalize the tympanographic examination: acute 8.35±2.88, chronic/serous 10.18±3.39, and mixed 10.9±2.02. The overall recurrence rate over a six month period from initial presentation in the office was for acute 11.02%, chronic/serous 16.34%, for mixed 30% and for none present 17.56%.

Conclusion: To our knowledge this is the first time that tympanography has been used as an objectifying tool with respect to the efficacy of the chiropractic adjustment in the treatment of children with otitis media. As tympanography has been used extensively in the medical assessment of children with otitis media, it also serves as a bridge from which the chiropractic field and the medical field can begin to communicate with respect to otitis media. The results indicate that there is a strong correlation between the chiropractic adjustment and the resolution of otitis media for the children in this study. This pilot study can now serve as a starting point from which the chiropractic profession can begin to examine its role in the treatment of children with otitis media. Large scale clinical trials need to be undertaken in the field using tympanography as an objectifying measure. In addition, the role of the occipital adjustment needs to be examined. This study begins the process of examining the role of the vertebral cranial subluxation complex in the pathogenesis of otitis media, and the efficacy of the chiropractic adjustment in its resolution.

Key Indexing Terms: otitis media, chiropractic, otoscope, tympanogram, adjustment, manipulation, chiropractic adjustive therapy

INTRODUCTION

Otitis media accounts for over 35% of all pediatrician visits in the United States.[1] In 1990, over 25 million office visits in the United States were a direct result of otitis media (OM).[2] Traditional allopathic treatment including the use of antibiotic therapy, myringotomy and tympanostomy have had only limited success in stopping the recurrence of the problem which has resulted in significant morbidity in the pediatric population.[3,4]

Anecdotally, the chiropractic profession has claimed favorable clinical responses for otitis media and other upper respiratory infections for nearly 100 years. With little research to support these claims, the author attempted to produce two pieces of information which could serve as a guide to the profession with respect to the treatment of otitis media with the chiropractic adjustment. The primary goal was

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to conduct a pilot study of children with otitis media, and see if the chiropractic adjustment is efficacious in the treatment of children with otitis media. The second was to produce a model which explains the pathophysiology of otitis media with respect to subluxation theory.

This paper will report and analyze the data collected with respect to otitis media, and propose possible mechanisms whereby subluxation is implicated in the pathophysiology of otitis media, a concept which heretofore has been rarely reported.[5]

BACKGROUND

The classification and terminology surrounding otitis media has only in recent years become standardized.[6,7] The most current definition of otitis media is: inflammation of the middle ear without reference to causation or etiology.[8] Subdefinitions include: otitis media with and without effusion, chronic otitis media, serous otitis media, acute otitis media and bacterial otitis media.[7,8] The majority of these diagnostic names are given based on subjective criteria of inspection of the tympanum, a true definitive name cannot be given with certainty.[6,7,8] For the purpose of this paper we will use the general definition of otitis media and specific references to the subdefinitions will be made as applicable.

The pathogenesis of otitis media has been thought to be multifactorial.[9,10] Table 1 lists the various epidemiological factors traditionally thought to be associated with otitis media. One can see from Table 1 that the etiologies are vast and cover a wide range of childhood events.[11] The classic allopathic model used to describe the pathogenesis of otitis media is as follows: an event (usually a viral upper respiratory infection) results in congestion throughout the respiratory tract including the middle ear. The congestion of the eustachian tube (ET) results in the obstruction of the narrow isthmus separating the bony ET from the cartilaginous ET. The obstruction can be furthered by immaturity of the ET or by other unknown means. The obstruction permits continued effusion and without egress, the secretions build up in the middle ear producing a viral/ serous otitis media.[11,12] The fluid that builds up as a result of this mechanism has a potential for the growth of bacteria which can subsequently produce an acute or bacterial OM.[10,11,12]

TABLE 1
EPIDEMIOLOGICAL FACTORS ASSOCIATED WITH INCREASED RISK OF OTITIS MEDIA

- Sibling history of OM
- Male
- Non-breastfed
- Exposure to second-hand smoke
- Group day care
- Early onset of OM
- Seasonal effect
- Allergy
- Prior antibiotic use
- Immuno compromise

Once an acute bacterial OM has occurred, the sequelae, which can include ruptured tympanic membrane, tympanosclerosis, cholesteatoma, and rarely encephalitis are considered too great a threat to the child, that prevention of these sequelae are of the utmost importance to the allopathic physician.[14,15] Table 2 lists the most common allopathic interventions for OM. These interventions often can prevent the most severe of the sequelae. These interventions do not however, prevent the OM from occurring or recurring. Often times there is a need for multiple or repeat interventions to accomplish their task.[14,15,16]

Intervention with respect to otitis media is usually accomplished based on a host of subjective criteria, including but not limited to inspection of the tympanum which may reveal redness, loss of the light reflex, full or partial obliteration of the typmpanic landmarks, as well as fever, ear pain, head tilt and history of upper respiratory tract infection (URTI).[8,1] Further evaluation of the tympanic membrane using tympanic pneumoscopy which demonstrates to the eye of the examiner the movement of the tympanic membrane, is used only in a small percentage of examinations performed by pediatricians.[17,18] More detailed examination employing the use of the tympanometer, which measures acoustic impedence is employed in an even smaller percentage of examination by pediatricians and is often considered to be the domain of the ENT physician.[18,19,20,21]

TABLE 2
COMMON INTERVENTION FOR OM

- Antimicrobial agents (antibiotics)
- Series of antibiotics
- Prophylaxis with antibiotics
- Myringotomy
- Typanostomy
- Surgical removal of tonsils and/or adenoids

Since tympanometry is an important tool used to document the necessity for further intervention with surgery with tympanostomy tubes (t tubes), it is therefore employed quite consistently by the ENT physician.[18,19,20,21]

In addition to the factors outlined in Table 1 with

TABLE 3
OTHER FACTORS ASSOCIATED WITH OM

Craniofacial defects	cleft palet (soft/hard) submucous cleft
Race	Native American Eskimo Tibetan
Genetic syndrome	Turners Syndrome Alperts Down

respect to the pathogenesis of OM, there are numerous other issues which can account for significant occurrences of OM.[9,10,21] These other factors are shown in Table 3. These occurrences are without clear understanding and cannot be accounted for through the usual epidemiological events, such as those outlined above in the allopathic model. For example, as listed in Table 3 children with cleft palates have a greater incidence of OM as do Native American children, Tibetan children, children with Downs syndrome, with submucous clefts, with Turners syndrome or Alperts syndrome as well as those with other genetic or dysplactic syndromes.[21,22] In addition, children with nasogastric tubes or with trauma to the tensor veli palatini muscle, ptyergoids, and trigeminal nerves have been shown to have a greater incidence of OM.[22] It follows from these occurrences and from the basic pathogenic model that other models of the occurrence of OM have merit and are necessary.

This study serves a multipurpose: First it examines background data on the children who presented with otitis media in the author's office. This background data may be helpful in examining further the epidemiological implications and origins of OM. Secondly, the use of the tympanogram as an objectifying measure is employed, yielding data of import. Thirdly, the efficacy of the chiropractic adjustment is tested with respect to its importance in the care of the children with otitis media. Fourthly, a model for subluxation is proposed which will aid in future studies of OM, children and chiropractic.

MATERIALS AND METHODS

The study was funded in part through the Foundation for Chiropractic Education and Research (FCER). Parts of the original intake forms were devised by Northwestern College of Chiropractic. All subjects/parents were provided with informed consent forms. 332 subjects who presented consecutively from June 1993-January 1996 with a previously diagnosed otitis media (within 5 days of presentation) were considered for the study. Their ages ranged from 27 days to 5 years of age. Each parent was asked to fill out a standard case history form in addition to specific questions which included the following information: age of initial onset of OM (if not the first bout), number of previous otitis media occurrences, who referred the patient, number of siblings and their OM histories, birth history including type of delivery, birth position if known, length of labor, pre/post term date of delivery, prenatal testing history including ultrasound, and amniocentesis, feeding history including breastfeeding history, smoking in the household, previous treatment modalities per episode of OM.

Four children who presented were immediately referred out for allopathic intervention due to the apparent imminent rupture of the TM, and did not become part of the study.

General Examination

Each child was given the standard pediatric examination including ENT, cardiovascular, respiratory, musculoskeletal, and vital signs. Each child was assessed in particular for structural abnormalities such as those which are known to give rise to OM.[21,22]

Otoscopic examination

An extensive ear examination was performed including inspection of the external canal and TM using a Welsh Allen otoscope. Inspection parameters included position of the TM including the presence of degree of absence of the light reflex, color of the TM, the degree of translucency (including the presence or absence of landmarks) light reflex by % and landmark visibility.[23] Table 4 lists the inspection parameters. Each child was examined with the child in the sitting position either on the examination table or on the lap of the parent. The pinna of the ear was pulled in an outward and upward direction so as to straighten the ear canal and allow full view of the TM. The opposite hand of the doctor which contained the otoscope was placed against the head of the child with the speculum placed initially into the external auditory meatus, and subsequently into the external canal. In the case of the

TABLE 4
OTOSCOPY INSPECTION PARAMETERS

Position of tympanic membrane
Presence of light reflex - degree
Absence of light reflex
Color of TM
Degree of translucency
Presence/absence of exudate in external canal
Presence/absence of landmarks

small or very young infant the pinna is moved in a more downward fashion as to allow full visualization of the TM. TM positions are listed in Table 5 and are depicted in Figure 1.

Chiropractic Examination

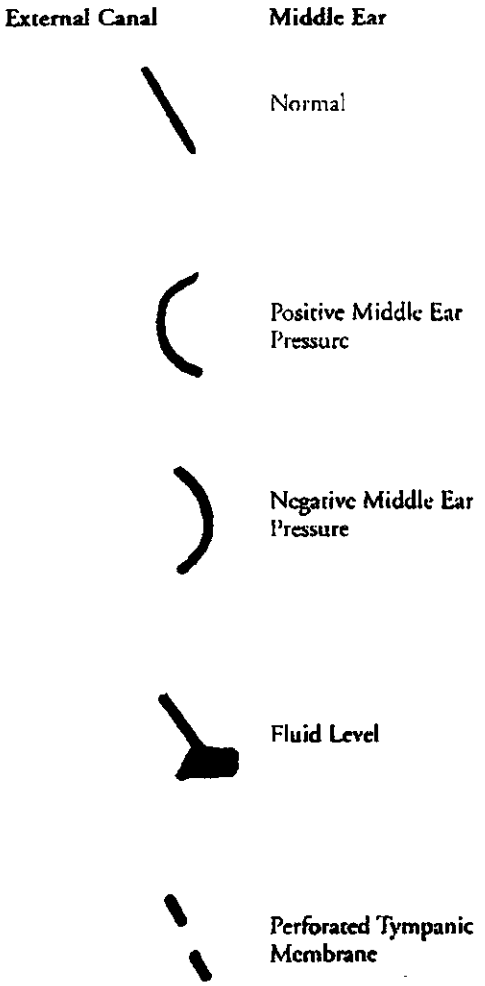
Chiropractic examination of each child was performed using static and motion palpation for the determination of subluxation. In children under the age of 4 months, the McMullen reverse fencer reflex was employed in determining subluxation.[24] In addition, examination of the cranium was performed. The following criteria were used with respect to the examination:

1) Static palpation of the Co-C1-C2 areas bilaterally to assess the tissue texture changes and the sensation of fullness over the joint spaces.
2) Motion palpation of the Co-C1-C2 areas to determine restriction in vertebral range of motion as evaluated with lateral translation of Co on C1 as well as rotation of C1 on C2 and lateral translation of C2 on C3 .
3) The McMullen reverse fencer reflex is employed in children under 4 months of age to examine reflexive head turning, as well as femur head/acetabulum joint texture upon joint motion.[24]
4) Cranial examination including suture examination was performed running the examiner's fingers along each suture line in children under the age of one year to determine if there is overlap of the sutures. In addition, children under the age of one year were examined with respect to the hard and soft palate, again looking for overlap of the bony structures.
5) Static and motion palpation of the remainder of the spine and pelvis with special attention to ROM and tissue texture change.

TABLE 5
TM POSITION

Normal
Mild retraction
Severe retraction (Atelectasis)
Full
Fully Bulging

Figure 1. Tympanic Membrane Positions



Tympanographic Studies

Each child over the age of 3 months received a minimum of 2 tympanometric measurements, each of which occurred during the first and the last visit. The WelshAllyn MicroTymp 2 machine was used. Measurements for acoustic immittance (in the form of acoustic impedence) was recorded in addition to ear canal volume. For each tympanogram a typanometric pattern was obtained. Figures 2 through 8 give the major tympanogram patterns and their interpretation. Manual pneumatic otoscopy is an

Figure 2. Tympanogram Associated with a Normal Middle Ear

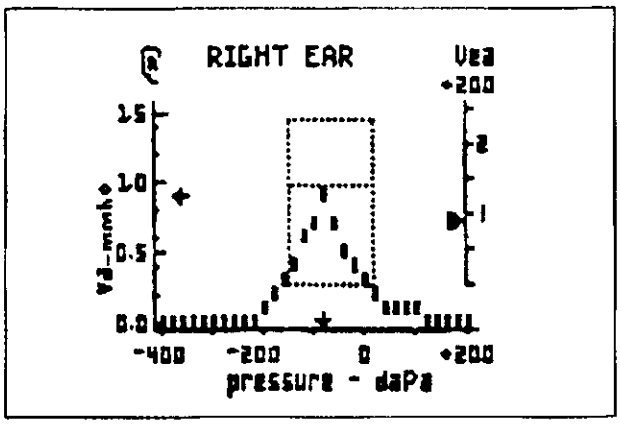


Figure 3. Tympanogram with Decreased Peak Height (Associated with Otitis Media with Effusion/ Cholesteatoma/Tympanosclerosis)

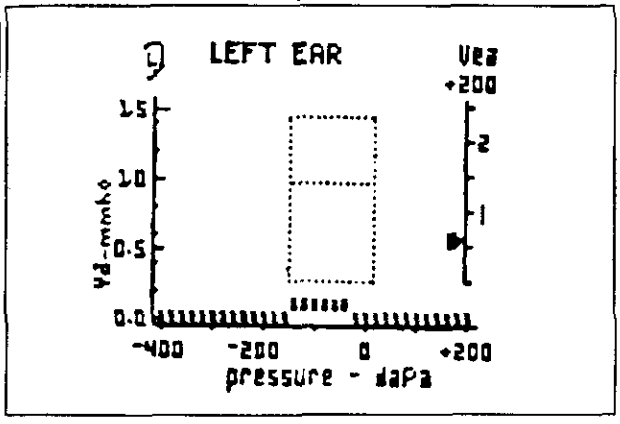


Figure 4. Wide Tympanogram (Associated with a Resolving or Oncoming Otitis Media)

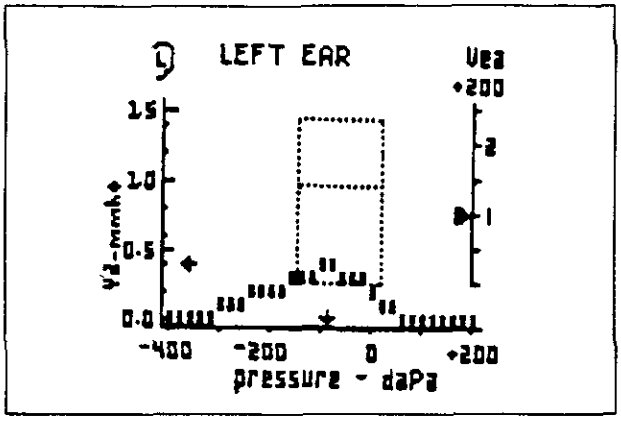


Figure 5. Tympanogram with Positive Middle Ear Pressure (Associated with acute Otitis Media)

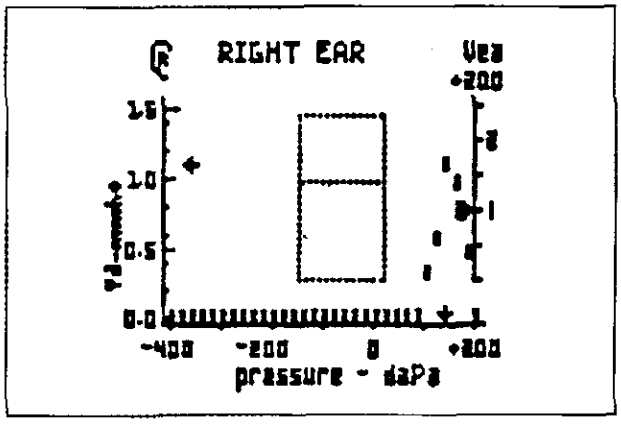


Figure 6. Tympanogram with Negative Peak Pressure (Associated with Serous/Chronic Otitis Media of Allergy, Cold, or Eustachian Tube Dysfunction)

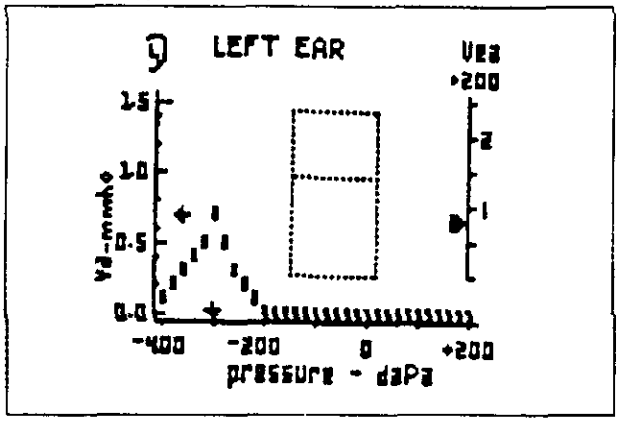


Figure 7. Flat Tympanogram (Large Ear Volume) (Associated with Tympanic Membrane Perforation)

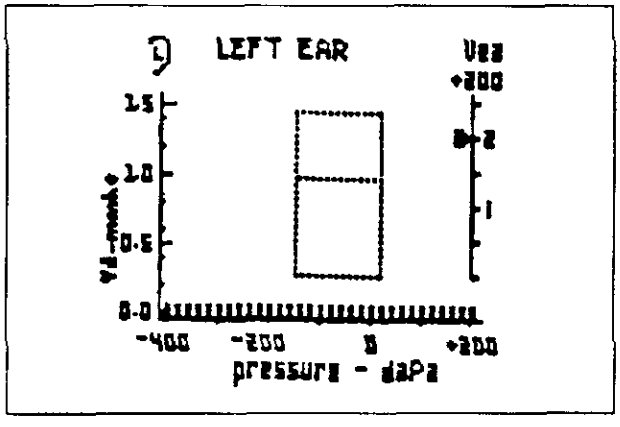
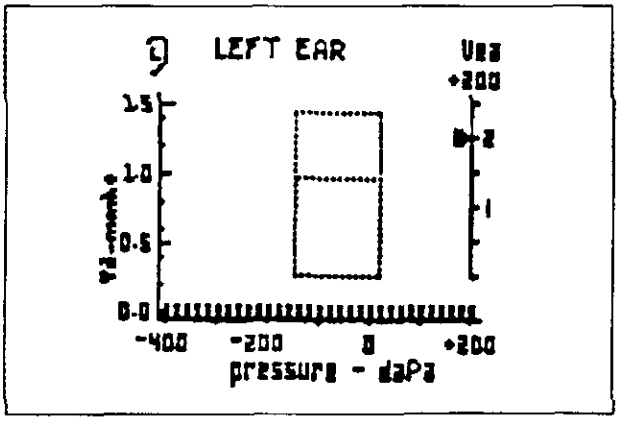


Figure 8. Flat Tympanogram (Small Ear Volume) (Associated with Ear Canal Occlusion)



invaluable tool with respect to the visualization of the movement of the TM but was excluded in this study due to its variability. Tympanography was used in place of the pneumatic otoscopy.[3]

Treatment

Each child was given a series of chiropractic adjustments in accordance to the clinical findings with respect to the parameters defined on previous page. Each child was delivered the initial treatment session in addition to the manipulation of other spinal segments as indicated. In addition a short course of soft tissue effleurage involving the sternocleidomastoid muscles bilaterally was employed. The occipital adjustment which is considered a specific short lever adjustment was delivered in the following fashion: With the child supine the doctor stands at the head of the patient. The head of the child is rotated to the side of the occipital subluxation (for example PSRSRP). In this case with the child's head rotated slightly to the right, the left index finger of the doctor is placed under the inferior portion of the occiput on the left side for stabilization. The head of the child is then rotated back into the neutral position. The doctor then places the lateral side of the index finger on the mastoid process on the right side of the patient. The child's head is then placed into 5 degrees of lateral flexion and 3 degrees of rotation thrust is delivered superior to inferior, posterior to anterior and right to left. For an occipital adjustment on the left side of the patient, the mirror image motions are employed. With respect to other segments that required adjusting, Diversified or Gonstead techniques were employed.

Soft tissue effleurage, stroking of the SCM's bilaterally was performed from superior to anterior for 2-3 strokes each side.[35]

Follow-up

All parents of children who were not active patients 6 months following the commencement of care for OM were contacted as to the child's OM status in the intervening 6 months. In addition all children who remained under care had their charts examined for any recurrence of OM.

RESULTS

Of 332 children who began the study, 4 were referred out immediately for intervention without any chiropractic care (not assigned case numbers). 2 discontinued treatment after the initial consultation for unknown reasons, 6 could not be contacted with respect to the 6 month follow-up, and 5 were below the age of 6 months, and the typanogram could not be validated. Each of these children were excluded from the study (n=315).

History

With respect to the history of each child the following were reported. The ages of the children who presented in the study 5 were under the age of six months (1.51%)(excluded due to lack of tympanographic data), 78 were between the ages of 6 and 12 months (23.49%), 152 were between the ages of 1 to 3 years (45.78%) and 97 were between the ages of 3-5 years (30.79%).

With respect to smoking 297 were reportedly not subjected to smoking in the household and 18 were exposed to second hand smoke. Of the initial bout of otitis media (n=315)16.2% (51) were under the age of 6 months, 53.7% (169) were between 6 and 12 months, 24.4% (77) were between 1-2 years, and 5.7% (18) were between 3 and 5 years of age (Table 6).

TABLE 6
AGE OF ONSET OF THE INITIAL OM

AGE	NUMBER OF CHILDREN N=315	%
< 6 months	51	16.2%
6–12 months	169	53.7%
1-2 years	77	24.4%
3–5 years	18	5.7%

TABLE 7
NUMBER OF PRIOR OM

BOUTS	NUMBER OF CASES	%
No prior OM	12	3.8%
1–2	72	22.9%
3–5	142	45.1%
>5	89	28.3%

Table 7 shows the number of reported bouts of otitis media each child experienced prior to presenting for treatment in the author's office (n=315) 12(3.8%) presented with no prior history of OM, 72 (22.9%) had a history of 1-2 prior bouts, 142 (45.1%) had 3-5 prior bouts and 89 (28.3%) had more than 5 prior bouts of OM. Of those who reported having 3 or more prior bouts (n=231), 28 (12.1%) reported having spent at least 3 months on continuous antibiotic therapy.

When prior treatment modalities were examined of the 315 children, all but 4 had prior histories of antibiotic use. 26 children presently had t-tubes, and 9 had a prior history of t-tubes which had either been removed or which had fallen out. Of the 311 children who had a history of prior antibiotic use, 150 (48.2%) had a history of taking 6-8 series of antibiotic therapies for otitis media, 64 (20.6%) had a history of taking more than 8 series of antibiotics, 71 (22.8%) had a history of taking 3-5 series of

TABLE 8
ANTIMICROBIAL HISTORY

# OF ANTIBIOTICS	NUMBER OF CASES	%
0	4	1.27
1–2	26	8.25
3–5	71	22.54
6–8	150	47.62
>8	64	20.32

N=315

TABLE 9
REFERRAL PATTERN

REFERRAL SOURCE	NUMBER	%
Pediatrician	68	21.5%
Other MD	27	8.6%
DC (non-related)	82	26.0%
DC (related)	84	26.7%
Other health professionals	17	5.4%
Parents	26	8.3%
Other	11	3.5%

antibiotics, and 26 (8.4%) had a history of taking 1-2 series of antibiotics for otitis media.(Table 8)

Referral patterns are reported in Table 9. Of 315 children 21.5% (68) came from their pediatrician, 8.6% (27) came from other treating MD's, 26.0% (82) came from a doctor of chiropractic who was non-related to the patient, 26.7% (84) came from a DC who was related to the child, 5.4% (17) came from other health professionals, 8.3% (26) came from parents of other children who had been treated for otitis media, and 3.5% (11) came from other various sources.

TABLE 10
BIRTH HISTORY

BIRTH	NUMBER	%
Vaginal	196	62.2
C-Section	119	37.8

Birth history results were as follows: of 315 children, 119 were C-section deliveries (37.8%) and 62.2% (196) were vaginal deliveries.(Table 10) Of those who had a vaginal delivery (n=196), 109 could recall the position of the child with 43 stating that the baby was "upside-down" / posterior, 6 stating the baby was breech, 4 that the forehead of the baby was first (brow presentation), 1 stating that the child's arm came out first (nuchal arm), and 1 stating that they had to break the child's clavicle in order to be born (shoulder dystocia) (Table 11). Of the 315 children who presented, 286 stated that they had at least one ultrasound (90.8%) and 108 (34.3%) stated that they had more than 2 ultrasounds during their pregnancy. Of the 315 in the study, 124 (39.4%) had amniocentesis, and 2 (0.63%) had chorionic villi sampling. (Table 11)

TABLE 11
VAGINAL BIRTH POSITION

SUBJECT INDEX	NUMBER	%
Occiput anterior	54	49.54
Occiput posterior	43	39.45
Breech	6	5.50
Brow	4	3.67
Nuchal arm	1	0.92
Shoulder dystocia	1	0.92

N=109

Of the 315 in the study length of labor time was examined. Length of labor was determined by the onset of rhythmic timeable contractions through the birth of the baby. Not including the C-sectioned children which brings the total to 196 total vaginal deliveries (n=196) 92 (46.9%) had labor times between 1 and 4 hours, 39 (19.9%) had labor times between 5 and 8 hours, 37 (18.9%) had labor times between 9 and 12 hours, and 28 (14.3%) labored longer than 12 hours.

Feeding histories revealed that 170 (54.0%) breast fed their babies for at least one day.(Table 12) Of the breast fed, 145 (46.1%) were breast fed for at least one month, 122 (38.7%) for at least three months, 113 (35.9%) for 6 months, and 68 (21.5%) for between 6 and 12 months, and 36 (11.4%) for greater than one year.(Table 13) 145 (46.0%) reported no history of breast feeding at all. Of

TABLE 12
FEEDING HISTORY

BIRTH	NUMBER	%
Breastfed	170	54.0
Non-breastfed	145	46.0

TABLE 13
BREASTFEEDING DURATION

SUBJECT INDEX	NUMBER	%
At least one day	170	54.0
At least one month	145	46.0
3 months	122	39.0
6 months	113	36.0
6–12 months	68	22.0
> 1 year	36	11.0

N=170

those who reported no breastfeeding at all, (n=145) 79 (54.5%) used a soy based formula, and 44 (30.3%) used a milk based formula, and 10 (6.9%) used a rice based formula (Tables 12,13).

TABLE 14
TYPES OF OM FOUND USING OTOSCOPIC EXAM

TYPE OF OM	NUMBER	%
Acute	127	40.3
Serous	104	33.0
None	74	23.4
Mixed bilateral OM	10	3.7

N=315

Otoscopic Examination

Of the 315 children who presented Table 14 lists the types of otitis media found. 127 (40.3%) presented with otoscopic criteria for an acute otitis media, 104 (33.0%) presented with evidence of serous OM, 74 (23.4%) presented with no apparent evidence of otoscopically diagnosable OM and 10 (3.17%) with mixed bilateral criteria. Of those children who presented diagnostic criteria for acute OM, 72 were right-sided, 58 were left sided, and 8 were bilateral. Of those who presented with diagnostic criteria for chronic serous OM, 40 were right-sided, 38 were left sided and 26 presented bilaterally. Of those children with mixed types, 6 presented with acute OM in the right ear and serous OM in the left, and 4 presented with the reverse.

Tympanographic Examination

Tympanographic results were obtained for all but 91 of the children. Figures 1-6 demonstrated the ranges of typmpanographic patterns possible and their significance.

Treatment outcomes

Treatment outcomes were measured with respect to three parameters: number of adjustments, normalization of otoscopic examination and normalization of tympanographic examination. Overall the average number of adjustments given per child was 4.9. The number of days that it took for the otoscopic examination to return to normal was 7.65. The number of days it took for the tympanographic examination to return to normal was 9.26. In the case of the otoscopic examination and tympanographic examination n=241 due to the lack of necessity for each as 74 children presented with prior histories of OM but with no otoscopic or tympanographic evidence upon initial presentation in the author's office. The total number of children who had recurrence of OM within 6 months was 49 (n=314). The overall percentage of children having recurrences of OM within 6 months of initial presentation in the author's office was 15.56%. When the total of 314 cases used in this case series were broken down into 4 categories, the following results emerged: in the case of acute OM presentations n=127 the average number of adjustments administered was 4.09, with a standard deviation of ± 1.03, the total numbers of days to normalization of the otoscopic examination 6.67 with a standard deviation of ± 1.99, and the number of days to normalization of the tympanographic examination was 8.35 with a standard deviation of ± 2.88. The overall recurrence rate within six months of initial presentation was 16 (n=127) with a percentage of 11.02% (Tables 15,16). In the cases of chronic serous OM (n=104)

TABLE 15
AVERAGE NUMBER OF ADJUSTMENTS GIVEN FOR ALL TYPES OF OM

TYPE OF OM	NUMBER OF CASES	NUMBER OF ADJUSTMENT
Acute	127	4.09 ± 1.03
Chronic/Serous	104	5.0 ± 1.53
Mixed	10	5.3 ± 1.35
None	74	5.88 ± 1.87

TABLE 16
RECURRENCE RATES FOR ALL TYPES OF OM WITHIN A SIX MONTH PERIOD

TYPE OF OM	NUMBER OF CASES	NUMBER OF RECURRENT CASES	%
Acute	127	16	11.02
Chronic/Serous	104	17	16.34
Mixed	10	3	30.00
None	74	13	17.56

the average number of adjustments was 5.0 with a standard deviation of ± 1.53. The number of days it took to normalize the otoscopic examination was 8.57 with a standard deviation of ± 1.96, and the number of days it took to normalize the tympanographic examination was 10.18 with a standard deviation of ± 3.39. The overall recurrence rate was 17 (n=104) with a percentage rate of 16.34% (Tables 15,16). In the case of mixed OM (n=10), where the child presented with evidence of both serous and an acute OM in opposite ears, the average number of adjustments given were 5.3 with a standard deviation of ±1.35. The total number of days it took to normalize the otoscopic examination was 8.3 with a standard deviation of ± 1.00. The total number of days it took to normalize the

tympanographic examination was 10.9 with a standard deviation of ± 2.02. The overall recurrence rate in this category was 3 (n=10) with a percentage recurrence of 30% (Table 15,16). In the cases where the child presented with no evidence of either an acute/purulent or chronic/serous OM but have had long histories of such (n=74) the average total number of adjustments given was 5.88, with a standard deviation of ± 1.87. Since the child did not present with either otoscopic or tympanographic evidence of a present OM, generalized otoscopic or tympanographic information was not used with respect to the normalization of the condition. The recurrence rate within this category was 13 (n=74) with a percentage rate of 17.56 %. Tables 15 & 16 demonstrate the typical tympanographic changes that occurred with each of the above categories, acute OM, chronic OM, and mixed OM.

DISCUSSION

The discussion of these findings will be done in three sections, history, treatment outcomes and subluxation model

History

With respect to the history, many interesting facts have emerged in the data. The initial age of onset of the otitis media of the subjects in this study demonstrated that 53.79% of the children had their first bout of otitis media between the ages of 6 months and 1 year, and a total of 69.9% of the subjects in the study had their first bout of OM under a year of age (Table 6). Hoekelman 1977 in his survey of children in Rochester in their first year of life (n=246) found that otitis media was second only in frequency to the common cold during the first year of life.[26] These findings are also consistent with the findings of Teele et al 1989 in the Boston study of children with otitis media. This study was conducted between the years 1975-1982. In this study Teele found that 62.4% of children in the study had an initial bout of otitis media during the first year of life. He found that the highest incidence of age specific incidences of otitis occurred between the six and 13th month of life.[27] Wright et al 1985 found that the peak incidence of otitis media occurs in children 7 to 9 months of age.[28] It has long been postulated by the author that the age of 6-7 months is a critical time in an infant's life and that the epidemiology of the 6th month old contributes to the occurrence of otitis media at this time. The child loses the maternal antibodies at the age of approximately 6 months including iron stores.[29] This may make the child more susceptible to infection at that time. In addition the child's environment changes during the 6th month or thereabouts due to the fact that the child begins to crawl. This places the child at some increased risk of infection due to the environment of the floor when the child begins to crawl. In addition, children at the age of 6 months begin to teeth and/or get their first tooth. This has always been associated with an increase in mucosity and possibly an increase in infection.[30,31] It is therefore important to examine the epidemiology of the child when recurrent ear infections begin to occur. In addition, it has been well documented that day care plays an important role is the pathogenesis of otitis media (Daley et al, 1988).[30] Pukander et al 1984 demonstrated in his study of Finnish children that those who lived in urban areas were more likely to be in day care and had higher incidences of otitis media than those living in the Finnish countryside who were more likely to receive their care at home.[31] Alho, also identified children in day care being at risk for increase incidences of otitis media.[32]

Schappert 1992, identified a 150 percent increase in otitis media diagnoses during the years ranging from 1975-1990 in a CDC survey, the results of which he authored.[33] Alho also identified children as being "otitis prone", and that these otitis prone children often had multiple bouts of otitis prior to their 2nd birthday.[32] In our study 22.9% of the subjects reported having 1-2 prior bouts, 45.1% reported having 3-5 prior bouts and 28.3% reported having more than 5 bouts (Table 7). This data can be compared to that compiled from the Boston study which demonstrated that 46 percent of the children in that study had three or more episodes, and 16% had six or more episodes.[27]

Exposure to second hand smoke has been linked to increased incidence of otitis media in children. Etzel et al 1992, demonstrated that high incidences of cotinine.[34] Strachan et al 1989 demonstrated that cotinine concentrations in the urine were directly related to the number and amount of smoking that takes place in the environment.[35] Wanner 1977 demonstrated that passive smoking and environmental pollutants can alter ciliostasis and decreased mucociliary transport, possibly altering the immune function of the child.[36] In our study 18 children (5.71%) were exposed to second hand smoke.

Nelson et al 1987 showed that in 1986 44.5 million courses of antibiotics were prescribed for children under the age of 10 and that 42% of those prescriptions were for otitis media.[37] Fosarelli et al 1987 in a study conducted at John's Hopkins University Hospitals amoxicillin was the most frequently prescribed medicine (31.7%) and that otitis media accounted for 33% of all prescription medications.[38] Schappert 1992 estimates that 20.6 million antibiotic prescriptions for the treatment of otitis media in children were written in 1990.[33] Teele et al 1981 described

his study of Boston children that in those children who failed with a course of antimicrobial therapy, 19% had organisms resistant to initial therapy, and 57% had no bacteria isolated from their middle ear fluids.[37] In our study, 311 children had a history of prior antibiotic use. Of those 26 (8.4%) had a history of taking 1-2 series of antibiotics in the past, 71 (22.8%) had a history of taking 3-5 series of antibiotics, 150 (48.2%) had a history of taking 5-8 series of antibiotics in the past, and 64 (20.6%) had a history of taking more than 8 series of antibiotics (Table 8).

Referral patterns for the children represented (n=315) demonstrated that 30.16% came from MD sources, and 52.7% came from DC sources with the remaining 17.4% coming from parents and other allied health professionals (Table 9). These patterns may not be reflective of MD and DC referral patterns in general but may be reflective of the author's specialization in this particular field. DC referral to the MD has always been part of the education of the chiropractor. MD to DC referrals have always been a source of difficulty for the DC. Some of these barriers have begun to change with respect to some of the managed care companies incorporating alternative care and especially chiropractic into their covered benefits.

Birth histories (n=315) demonstrated that 119 children (n= 315) (37.8%) were C-section deliveries (Table 10). This number exceeds both the national and local averages for this type of birth. Of those who had vaginal births (n=196) 55 (28.06%) had a malposition (Table 11). This number also exceeds previously reported averages for birth malposition.[20] In previous work, the author has reported that birth malposition and C-section babies have a higher incidence of otitis media.[20] This is in keeping with the notion that cranial molding is an essential part of the birth process.[20] Overlapping of the cranial bones during the birth process permits their proper juxtaposition. It is the author's theory that the lack of this proper molding or absence as with the C-section, alters the proper juxtaposition of the cranial bones and potentially alters the pressure gradients within the ear mechanism. This will be more thoroughly discussed in the section on the subluxation model.

Breastfeeding has previously been identified as an otitis media modulator.[40] It has also been known to aid in the prevention of respiratory and gastrointestinal problems.[39,40] Cunnigham 1977 examined cases from a hospital in Cooperstown N.Y.[41] He found that a significantly lower incidence of lower respiratory tract infection in children who were breastfed for a minimum of 4.5 months.[41] Saarinen followed 256 healthy infants during their first three years of life and categorized their breastfeeding habits into long (only breastfed for 6 months), intermediate (breastfed 2-6 months) and short (little < 2 months or none). He found that the incidence of otitis media was inversely proportional to breast feeding duration. These differences persisted up to 3 years of age.[42] In our study a greater number (170) (n=315) 54.0% of children were breast fed for at least some portion of time. However only 122 (n=315) were breastfed for at least three months. Teele et al 1989 in his study of Boston children found that 31.2% of the children were breastfed at some time. This number compared to our findings of 54.0% may be indicative to location and socioeconomic factors which come into play with breastfeeding. It has been demonstrated that women in higher socioeconomic status are more likely to breastfeed their children.[37] Our study was conducted in Westchester County N.Y., which has a relatively high per capita income level. This may account for the possible discrepancy in the outcomes. In addition, with increased awareness of the potential benefits of breastfeeding increasing numbers of women are choosing breastfeeding as an option for their children.[37,39] This may be reflective in the 8 year difference in the dates of publications of the two studies.

Hanson et al 1985 wrote a paper suggesting that a significant number of non-immunological components of breast milk may play a role in the protection against otitis media.[42] He suggests that antiviral factors such as interferon, and antibacterial factors such as lactoferin and lysozomes may play a key factor. In addition, he found that breast milk has an antiadhering property for pneumoncocci, and Haemophilus influenza.[42] Bluestone et al in their 1992 study of 2807 effusions from children with acute otitis media, and 4589 children with OM with effusion found that 35% of the children with acute OM carried S.pneumonia, and that 23% carried H. influenza in the effusions. In the children with OM with effusion (serous otitis media) 7% carried S pneumonia and 15% with H. influenza.[43]

Otoscopic examination

Otoscopy is a subjective examination which relies on the skill of the examiner. This method of assessment is the one most often applied by the pediatrician, and is completely dependent upon the skill of the examiner, as well as the skill of the mentor who taught the pediatrician. While the pediatrician will most often correlate the otoscopy findings with the symptomotology, it is further necessary to correlate the otoscopy with the tympanometric results.[44]

In our study (n=315) 40.3% presented with Otoscopic criteria for acute OM, 33.0% presented with evidence of serous OM, 23.4% with no otoscopically diagnosable OM, and 3.1% with a mixture of bilateral serous/acute OM. Table 14 demonstrates the various TM

appearances by the use of otoscopy and their relative meaning with respect to the type of OM present.

Tympanography

As said earlier in this section, the use of otoscopy alone whether that be either by direct visualization in a monocular fashion or by pneumatic otoscopy is not sufficient for making a diagnosis of OM. Otoscopic finding coupled with the use of the tympanometer is essential in making a proper diagnosis of OM.[43] The theory behind the use of the tympanogram is that the flow of acoustic energy is maximized by a healthy TM/middle ear mechanism. It is measured by the ease of energy flow which is termed acoustic admittance or in earlier times by acoustic impedence which measures the opposition to energy flow.[45,46,47] A TM with its juxtaposed middle ear which has significant impedence stiffness, mass, or friction, will not transfer sound efficiently to the chochlear mechanism.[45,46,47] Therefore when acoustic impedance is increased, acoustic admittance is decreased.

The MicroTymp 2 (Welsh Allen) uses the measure of acoustic admittance. The ordinate of the tympanogram records admittance Y of a volume of air in units known as milimhos (mmhos). The abscissa of the tympanogram records air pressure in decapascals (daPa). (1 daPa=1.02 mm H_2O). Figure 2 depicts a normal tympanogram.

With respect to interpretation, it is important to see that the basis for the tympanographic patterns is tympanic membrane compliance. When TM compliance is maximized the pressure on both sides of the drum is equal. The peak of the normal immittance tympanogram will be at approximately 0 mm H_2O. In the admittance instrument the peak is located at approximately -15 daPa. . The peak heights vary with respect to the ages of the children.[47] In children 3-5 years of age, the values range from 0.22-0.8 with a mean of 0.5.[47] These value ranges vary slightly from one instrument to another.

Tympanic patterns reflect many variations. In conditions which increase the impedance of the middle ear such as an effusion, ossicular fixation or otosclerosis, a reduced peak height is found.[44-47] (Figure 3) In some cases where the admittance (peak height) is normal the typanogram is abnormally wide.This may be indicative of an oncoming or resolving otitis media, as well as the presence of tympanosclerosis.[45-48] (Figure 4). Those patterns which demonstrate positive peak pressure are often items indicative of an acute otitis especially when it is extremely positive. (Figure 5). Those that demonstrate a negative peak pressure are indicative of an OM without effusion or a chronic serous otitis as well as a possible associated eustachian tube dysfunction, which could be associated with a cold, or allergy.[44-47] (Figure 6). A flat tympanogram with a low ear canal volume, is indicative of a blocked canal, or one with a high volume may be indicative of a perforation of the TM[45-48] (Figures 7 and 8). As stated previously, there is no validation for tympanography performed in children under the age of 6 months. In this study 5 children were excluded due to this fact. In the following section on treatment outcomes we will examine the changes in the tympanographic patterns for each child.

Treatment Outcomes

One of the main focuses of this paper is to determine if chiropractic adjustments are efficacious in the treatment of otitis media. Examining the referral patterns which include 95 children who were sent by an MD gives preliminary indications that a course of chiropractic care for the treatment of otitis media is being tried by a specific number of medical doctors in the area where the author practices. With respect to the various treatment modalities employed it is of importance at this time to discuss the occipital adjustment which was given at least once to each child. This form of standardization was employed by the author based upon her experience and study with respect to the pneumaticization of the eustachian tube and middle ear mastoid airflow system. It has been the author's clinical experience that occipital subluxation exists almost always on the side of the ear infection. Whether this is a primary subluxation or a compensatory one, needs to be further determined with respect to the necessity for a specific adjustment at a specific level for a specific condition. While the chiropractic profession has moved away from such thinking, it has been the author's clinical experience that this is so, and thus the specific technique became one of the bases for her hypothesis. The efficacy of the occipital adjustment will be discussed more in the section on subluxation hypothesis, but it is necessary at this time to examine the physiology of the eustachian tube with respect to the possible interaction of occipital subluxation.

The middle ear is continuous with the mastoid air cell system.[9,11,17] This allows for a continuous system connecting the mastoid air system, the middle ear and the ET.[9,11,12,17] It is well stated in the literature that positional duskiness of the vertebrae can significantly affect neuropathology.[49,50,51] As we will see later in the section on subluxation theory, mechanical changes, myologic changes and other changes not limited to but including vascular, lymphatic, and biochemical changes can produce a significant environment for the vertebral subluxation complex (VSC). With respect to the occipital adjustment and the subluxation complex, it is important to break down the various components which directly apply to the pathophysiology of otitis media.

The myologic component of the dilatation mechanism of the eustachian tube plays an important role in the pathogenesis of otitis media.[48,52,53] As stated earlier in the paper, a most important function of the eustachian tube is to drain fluids from the middle ear.[48,49] The tensor veli palittini (TVP) muscle appears to be the major muscular component of the dilatation mechanism of the eustachian tube.[48,52,54,55]

Present allopathic theory holds that the closure of the ET is to a great degree a function of the increased pressure of the prygoid muscle in the prygoid fossa.[54,55] The increased size of the pterygoid muscle increases the medial pressure on the TVP muscle . This medial pressure will in turn aid in the closure of the ET. The TVP muscle is composed of two distinct muscle bundles, one of which is considered to be the TVP proper and the other which is known as the dilator tubae. These muscles assist in the opening and the closure of the TVP.[54,55]

In children with craniofacial defects, birth trauma, or inflammatory conditions surrounding the mastoid air cell system, and or subluxation of the occipital bone, will directly alter and compromise this muscular mechanism with respect to the opening and closing of the ET. The functional motor units as well as the largely cartilaginous occipital bone can become unstable, and fixation can result which impairs the proper functioning of this ET mechanism.[49,51] These events can be cyclic in nature and can lead to an unending cycle whereby muscle spasm leads to joint contracture which in turn leads to more increased muscle spasm and even greater joint contracture.[51]

The neurological component of this mechanism involves quite directly the trigeminal nerve as well as the facial nerve.[55] With respect to the myologic component of the VSC an immobilized muscle due for example to an occipital or atlas fixation, increases spindle activity which in turn can feed central reflex activities resulting in altered efferent responses. When the trigeminal nerve and facial nerve are affected in this way, the mucosa of the ET is directly affected.[53,54] The mucosity of the ET which may increase due to increased neurological input due to aberrant efferent responses, can cause ET congestion and the resultant formation of otitis media.[52,53,54,55]

With respect to the use of effleurage of the sternocleidomastoid muscle and the cervical lymph nodes in general that was applied in the study, Fysh 1997 states that vertebral misalignment of the cervical spine may cause nerve irritation which causes muscle hypertonicity with subsequent restriction of lymph drainage of the head and cervical lymph nodes.[12] These lymphatic effects may also alter the course of the phagocytic activity in the child precluding the continued impact of the child's immune system. In addition one of the major allopathic remedies for chronic recurrent otitis media is the removal of lymphoid tissue (adenoids and tonsils) which may be obstructive to the drainage of the ET.[1,2,15] The author therefore concluded that this may be an essential component of the treatment.

Treatment outcomes reflected the number of adjustments given, and the length of time in days necessary for the child's otoscopic examination as well the tympanographic data to return to normal. Each child was treated on an outpatient basis which meant that their presence in the office where the outcome measures could be obtained, was dependent upon a scheduling process which involved both the doctor and the parents/guardian of the child. It is possible therefore, that for example if a child required four adjustments over seven days to return to a normal otoscopic exam, and nine days to return to a normal typmpanographic exam, the scheduling may have been such that if the child was seen on day eight the tympanographic exam could have been normal at that time, but the child was not seen until day nine where the normal exam was then recorded. In future clinical trials, this factor must be more closely controlled.

The results demonstrated a somewhat more expedient return to normal examination of both parameters with respect to the acute OM (6.67 ± 1.99, and 8.35 ± 2.88) as compared to the chronic OM (8.57 ± 1.96 and 10.18 ± 3.39) (Table 15.) This difference may account for the pathophysiologies of the two types of OM. Chronic serous OM may well be the result of such conditions as allergy, seasonal effects, genetic factors, and smoking.[56,57,58]

TABLE 17
NORMALIZATION OF OTOSCOPIC EXAM
(IN NUMBER OF DAYS)

TYPE OF OM	NUMBER OF CASES	NUMBER OF DAYS TO NORMALIZATION
Acute	127	6.67 ± 1.99
Chronic/Serous	104	8.57 ± 1.96
Mixed	10	8.3 ± 1.00

TABLE 18
NORMALIZATION OF TYPMPANOGRAPHIC EXAM

TYPE OF OM	NUMBER OF CASES	NUMBER OF DAYS TO NORMALIZATION
Acute	127	8.35 ± 2.88
Chronic/Serous	104	10.18 ± 3.39
Mixed	10	10.9 ± 2.02

Allergy plays an enormous role in the pathophysiology of chronic serous otitis media as does major craniofa-

cial defects.[56,57,58] Paradise et al 1969 and Randall 1967 found that children with unrepaired cleft palates had a universal finding of otitis media with effusion.[59] In addition children with chronic sinusitis, and chronic respiratory tract infections may have a defect in their mucociliary transport system.[57,58,59] In addition multiple bouts of antimicrobial therapies for previous infections may leave the child with a drug-induced compromise of the immune system.[58,59] It is therefore reasonable to assume that the number of factors that contribute to chronic serous otitis media may indeed impair the rate at which chiropractic intervention may be of help.

Those children with mixed OM where the sample size in this study was small and not necessarily significant, the rate of normalization for the return of the otoscopic examination was 8.3 ± 1.00, and the rate of normalization of the typmpanographic exam was 10.9 ± 2.02. Some of the same epidemiological factors that apply to the chronic otitis may also apply to these children. In addition those children who presented with no apparent evidence of OM but were being medically treated at the time of presentation had no objectification with respect to testing due to their normal presentations.

With respect to the OM return, the mixed OM group had the highest level of OM return with 30%. This sample size however is small, and further studies on this specific group need to be undertaken. The chronic OM had a reoccurrence rate of 16.3 %, the acute OM a rate 11.02% and those with no evidence of OM had a rate of 17.56%.

These statistics are in keeping with other studies that outline the fact that chronic serous otitis media may be linked to allergy.[56,57,58] Many children with recurrent serous otitis media with effusion have concurrent respiratory disease.[58,60] Mast cells as well as eosinophils are often found in the nasal mucous of children with chronic serous OM. It would then follow that if OM in this group was solely due to mechanical drainage or immunological issues, their OM would have a shorter duration. In addition earlier in this paper we showed that many of the OM treated with antimicrobial agents did not respond due to the fact that it is caused by an agent other than a bacteria.[50]

With respect to the numbers of adjustment needed to treat the OM, in acute OM the average number of adjustments was 4.09 ± 1.03, in chronic OM the number was 5.00 ± 1.53, in the case of no evidence of OM it was 5.88 ± 1.87, and in the mixed OM the number was 5.3 ± 1.35. The results demonstrate a trend whereby those children most likely to have had more OM bouts took a greater number of adjustments to get well with a greater standard deviation, and those who may have had multiple isolated bouts took fewer adjustments.

Subluxation Model

Subluxation models have long been proposed by the chiropractic profession.[61,62,63] Lantz in his 1989 paper entitled *The Vertebral Subluxation Model* proposes a model for subluxation which has long been cited by the profession as the basis for explanation of subluxation.[64] Gatterman has further defined the subluxation complex as: a theoretical model of motion segment dysfunction (subluxation) that incorporates the complex interaction of pathologic changes in nerve, ligaments, muscle, vascular and connective tissues.[65]

At this time I would like to propose a model for subluxation at it relates to the pathogenesis of otitis media, using the various components cited by all of my predecessors, and add to it the involvement of the cranial bones. I will call it the Vertebral-Cranial Subluxation Complex (VCSC) model. It is important to include the cranium when speaking about subluxation in the child due to the fact that the cranium takes the largest portion of the external forces applied to the child's body which may contribute to the formation of the subluxation. From birth, through their milestones the cranium and cervical spine have the most involvement with external forces.[66]

I will briefly discuss five parameters of subluxation as they relate to the pathogenesis of otitis media. While other parameter are a specific part of the VSC and the VCSC, these five play the most central role in the pathogenesis of OM. The parameters are: mechanical, myologic, lymphatic, inflammatory, and neurologic.

Mechanical

Some of the mechanical manifestations of the VCSC have been previously discussed. With respect to the VCSC, it is important to examine such occurrences as birth trauma, and birth malposition. Children born in malposition such as breech presentation, brow, and occiput posterior, often have disruption of the normal vertebral motion segments of the cervical spine as well as those of the cranium.[67] Normal cranial molding which is essential for the proper juxtaposition of the cranial bones, often does not occur in the case of a birth malposition, as well as in the case of the child born with the aid of a C- section.[67] In addition children born with the aid of forceps and or vacuum extraction often times experience contusions on the scalp and facial bones, and alteration of the normal cranial juxtaposition may be involved[67] (Figure 11).

In children with craniofacial defects it is well documented that they have an increase incidence of OM.[59]

Lewit in his work describing cranio-cervical joint restriction in his study of 76 children with chronic tonsillitis spoke about the most consistent finding among the children was a joint restriction at the C0-C1 junction 92%.[68]

Another aspect of mechanical change is represented in trauma to the cranium and spine. The child's spine and cranium is significantly cartilaginous and therefore maintains a great ability to approximate its normal range of motion even with fixation and postural dyskinesia.[69] This would reduce the child's exposure to the pain often associated with dyskinesia and it may also reduce the visualization of positional dyskinesia on X-ray examination. Any child who sustains repeated trauma to an area either from the birthing process or by some other means may likely have a hypermobile articulation.[69]

Myologic

As stated in an earlier section, the myologic component of the VCSC plays a significant role in the pathogenesis of OM with respect to the dilatation mechanism of the cartilaginous ET.[48,53,54] When one adds to this the presence of muscle spasticity and altered reflex pathways due to increases in muscle spindle activity, the myologic effect is quite significant.

Lymphatic

The lymphatic component of the VCSC as it pertains to the pathogenesis of OM is generally assumed to be a secondary or tertiary component. While alterations in lymphatic flow are generally not thought to be a primary component of the VCSC, it can be a direct result of the formation of the VCSC. Since lymphatic flows are directly dependent upon the movement of the organism, restriction of muscle movement may result in lymphatic congestion. As stated earlier, when the VCSC occurs at the C0-C1 articulation, postauricular, preauricular and suboccipital lymph swelling may be present. In addition lymphatic flow in the anterior and posterior cervical chain lymph nodes my be slowed. This lymph congestion may play a significant role in the ET inability to drain middle ear fluids completely.[12]

Some allopathic remedies for recurrent otitis media have revolved around the removal of lymph tissue, specifically the tonsils and adenoids.[15] As stated earlier, Fysh outlined the fact that lymphatic effects may alter the course of phagocytic activity in the child precluding the continued impact on the immune system of the child.[12] A proposed mechanism for the lymphatic effect from the VCSC is noted in Figure 12.

Inflammation

As we have seen, OM may be the culmination of various etiologies including the VCSC, and central to many of these etiologies is an inflammatory process. The literature is replete with examples of chronic inflammation altering the structure and composition of connective tissue.[70] Chronic inflammatory changes also may lead to fibrotic changes, which in the case of OM may preclude the drainage of the middle ear and ET.[70]

In the case of neurologic inflammation it has been noted that changes in nerve transmission may occur.[71,72,73,74] The nerve may become hyperexcitable and thereby produce aberrant transmission.[71,72,73,74] Inflammed ganglia cease to fire long after mechanical stimulation has ceased.[71,72,73,74] This may account for the findings in this study that normal movement of the TM as measured through the use of the typmpanogram fails to return to normal until after the ear appears to be healthy upon inspection. It has been shown that inflammed ganglia are more susceptible to blood-borne agents which may contribute to the continuation of the inflammatory cycle.[71-75]

The VCSC may result from localized trauma applied to a spinal or cranial area or from a visceromotor reflex set up by a condition elsewhere.[71-75] As in the case of OM, the inflammation set up by the VCSC can be a reactive phase of an acute inflammatory process due to such etiologies as an allergic response.[71-75] This allergic response may promote continuation of the OM, as that experienced in multiple succeeding bouts of OM, or in chronic serous OM.

Neurologic

In the Faye model of VSC, he speaks of multiple biomechanical insults to nerve tissue.[75,76] It is from this model that we examine the VCSC as it applies to the pathogenesis of OM. Irritation of the nerve receptor, a decrease in axoplasmic transport along the nerve fiber and compression to the neural tissue.[75,76] If we examine these possible effects on the neurological tissue as they relate to OM we will see some possible places where the VCSC may play a role in the pathogenesis of OM.

Proctor 1967 describes in great detail the innervation of the ET.[77] The pharyngeal orifice of the ET is innervated by a branch from the otic ganglion, the sphenopalitine nerve and the pharyngeal plexus. The remainder of the tube receives its sensory innervation from the tympanic plexus and the pharyngeal plexus. The most important component of the tubal innervation is the glossopharyngeal nerve as it plays the predominant role in tubal innervation. Sympathetic innervation of the tube depends on the sphenopalatine ganglion, otic gan-

glion, paired glossphyngeal nerves, petrosal nerves, and caroticotympanic nerve.[77]

Eden and Gannon 1987, Hecht et al 1993 and Ito 1987, describe the innervation of the tensor veli palatini muscle as coming from the ventromedial part of the ipsilateral trigeminal motor nucleus through the mandibular branch of the trigeminal nerve. The levator veli palitini muscle which is not involved as intimately with the dilatation of the ET, receives its innervation from the nucleus ambiguous through the vagus nerve.[53,78,79]

Cantekin et al 1979 has described conditions whereby trauma to the palate, the pterygoid bone, and the tensor veli palatini muscle can result in abnormal ET function.[48] Injury to the trigeminal nerve, or more specifically the mandibular branch of the nerve can result in either functional obstruction of the ET or chronic opening (patulous tube), as the innervation of the TVP muscle is from this nerve.[48,55]

If one determined that the only cause of OM was ET dysfunction, it would be clear that subluxation could play a significant role in the pathogenesis of OM. Compressive effects, irritation of the neural tissue, changes in axoplasmic transport all can significantly affect the actions of the nerves involved in ET dilatation.

CONCLUSION

To our knowledge this is the first time that tympanography has been used as an objectifying tool with respect to the efficacy of the chiropractic adjustment in the treatment of children with otitis media. As tympanography has been used extensively in the medical assessment of children with otitis media, it also serves as a bridge from which the chiropractic field and the medical field can begin to communicate with respect to otitis media. The results indicate that there is a strong correlation between the chiropractic adjustment and the resolution of otitis media for the children in this study. This pilot study can now serve as a starting point from which the chiropractic profession can begin to examine its role in the treatment of children with otitis media. Large scale clinical trials need to be undertaken in the field using tympanography as an objectifying measure. In addition, the role of the occipital adjustment needs to be examined. This study begins the process of examining the role of the vertebral cranial subluxation complex in the pathogenesis of otitis media, and the efficacy of the chiropractic adjustment in its resolution.

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REFERENCES

1. Crouteau N, et.al.Trends in medical visits and surgery for otitis media among children. *Am J Dis Child* 1990;144:535-538.
2. Schappert SM.Office visits for otitis media:United States. From Vital and Health Statistics of the Centers for Disease Control. 214:1-18: National Center for Health Statistics 1992.
3. Berman S,Roark R. Factors influencing outcome in children treated with anmtibiotics for acute otitis media. *Pediatr Infec Dis J* 1993;12:20-24.
4. Casselbrant ML, Kaleida PH, Rockette HE, et.al. Efficacy of antimicrobial prophylaxsis and of tympanostomy tube insertion for prevention of recurrent acute otitis media:Results of a randomized clinical trial. *Pediatr Infec Dis J* 1992; 11 :278-286.
5. Froehle RM.Ear infection:a retrospective study examining improvemnt from chiropractic care and analysis for influencing factors. *J Manipulative Physiol Ther* 1996;19:169-77.
6. Lim DJ,Bluestone CD, Klein JO. *Recent Advances in Otitis Media with Effusion.* Toronto:Decker,1984:1-4
7. Senturia BS, Bluestone CD,Klein JO et.al. Report of the Ad Hoc Committee on definition and classification of otitis media with effusion. *Ann Otol Rhinol Laryngol* 1980;89:3
8. Bluestone CD, Klein JO. *Otitis Media in Infants and Children* Philadelphia: W.B.Saunders 1995:1 -3
9. Bluestone CD.Beery QC,Andrus W. Mechanics of the eustachian tube as it influences susceptibility to and persistence of middle ear effusions in children. *Ann Otol Rhinol Laryngol* 1974; 83:27-34.
10. Kraemer MJ, Richardson MA, Weiss NS, et.al. Risk factors for persistent middle ear effusions. *JAMA* 1983; 249:1022-1024.
11. Bluestone CD, Beery QC. Concepts on the pathogenesis of middle ear effusions. *Ann Otol Rhinol Larygol* 1976; 85:182-186.
12. Fysh P. Upper respiratory infections in children: a chiropractic approach to management. *Int Review Chiro* 1990; Mar:29-31.
13. Schloss MD, Terraza O. Cholesteatoma in children. *J Otolaryngol* 1991; 20:43-45.
14. Juselius H, Kaltiokallio K. Complications of acute and chronic otitis media in the antibiotic era. *Acta Otolaryngol* 1972; 74:445-450.
15. Gates GA, Avery CA, Prihoda TJ, et.al. Effectiveness of adenoidectomy and tympanostomy tubes in the treatment of chronic otitis media with effusion. *N Engl J Med* 1987; 317:1444-14445.
16. Englehard D, Cohen D, Strauss N, et.al. Randomized study of myringotomy, amoxycillin / clavulanate, or both for acute otitis media in infants. *Lancet* 1989; 2:141-143.
17. Bluestone CD, Klein JO. *Otitis Media in Infants and Children.* Philadelphia: W.B.Saunders 1995: 89-92.
18. Bluestone CD, Klein JO.*Otitis Media in Infants and Children.* Philadelphia: W.B.Saunders 1995: 97-100.
19. Brooks DN. An objective method of deleting fluid in the middle ear. *J Int. Audiol* 1968; 7:280-284.

20. Nozza RJ, Bluestone CD, Kardatzke D, et al. Towards the validation of aural acoustic immittance measures for the diagnosis of middle ear effusion in children. *Ear Hearing* 1992; 13:442-453.
21. Fysh P. Chronic recurrent otitis media: case series of five patients with recommendations for case management. *J Clin Chiro Ped* 1996; 2:71-75.
22. Lim DJ, Bluestone CD, Klein JO. *Recent Advances in Otitis Media with Effusion*. Toronto: Decker, 1984; 6 2-64
23. Bluestone CD, Cantekin EI. Design factors in the characterization and identification of otitis media and certain related conditions. *Ann Otol Rhinol Laryngol* 1979; 88:13-27.
24. McMullen M. Assessing cervical subluxations in infants under six months of age. Articles on Pediatrics. *Int Review Chiro* 1994; 1:5-8.
25. Redwood D, ed. *Contemporary Chiropractic*. New York: Churchill Livingstone 1997; 124-126.
26. Hoekelman RA. Infectious illness during the first year of life. *Pediatrics* 1977; 119-121.
27. Teele DW, Klein JO, Rosner BA, et al. Epidemiology of otitis media during the first seven years of life in children in Greater Boston: A prospective cohort study. *J Infect Dis* 1989; 160:83-94.
28. Wright PF, McConnell KB, Thompson JM, et al. A longitudinal study of the detection of otitis media in the first two years of life. *Int J Pediatr Otorhinolaryngol* 1985; 10:245-252.
29. Fallon JM. *Textbook of Chiropractic and Pediatrics*. Arlington: ICA 1994; 28-79
30. Daly K, Giebink GS, Le CT, et al. Determining the risk for chronic otitis media with effusion. *Pediatr Inf Dis J* 1988; 7:471-475
31. Pukander J, Sipila M, Karma P. Occurrence and risk factors in acute otitis media. in Lim DJ, Bluestone CD, Klein JO, Nelson JD (Eds). Recent Advances in Otitis Media with Effusion. Burlington, Ontario, BC Decker 1984,9-13
32. Alho OP, et al. What is an "otitis-prone" child? *Int J Pediatr Otorhinolaryngol* 1991; 21 :201-209
33. Schappert SM. Office visits for otitis media: United States 1975-90. Vital and Health Statistics of the Centers for Disease Control/ National Center for Health Statistics 1992; 214:1-17.
34. Fazel RA, Preisball EN, Haley NJ, et al. Passive smoking and middle ear effusion among children in day-care. *Pediatrics* 1992; 90;228-232.
35. Strachan DP, Jarvis MJ, Feyerabend C. Passive smoking, salivary cotinine concentrations and middle ear effusion in 7 year old children. *Br Med J* 1989; 298:1549-1552.
36. Wanner A. Clinical aspects of mucociliary transport. *Am Rev Resp Dis* 1977; 116:73-125.
37. Nelson WL, Kurinsky JN, Kennedy DL, et al. Outpatient pediatric antibiotic use in the U.S: trends and therapy for otitis media. In *Program and Abstracts of the 27th Interscience Conference of Antimicrobial Agents and Chemotherapy*. Washington DC, American Society of Microbiology 1987.
38. Fosarelli P, Wilson M, DeAngelis C. Prescription medications in infancy and early childhood. *Am J Dis Child* 1987; 414:772-775.
39. Chandra RK. Prospective studies of the effect of breast feeding on incidence of infection and allergy. *Acta Paediatr Scand* 1979; 68:691-694
40. Committee on Environmental Health: Ambient air pollution: Respiratory hazards to children. *Pediatrics* 1993; 91:1210-1213.
41. Cunningham AS. Morbidity in breast-fed and artificially fed infants. *J Pediatr* 1977; 90:726-729.
42. Saarinen UM. Prolonged breast feeding as prophylaxis for recurrent otitis media. *Acta Pediatr Scand* 1982; 71 :567-571.
43. Bluestone CD, Stephenson JS, Martin LM. Ten year review of otitis media pathogens. *Pediatr Inf Dis J* 1992; 11:S7-S?
44. Finitzo T, Friel-Patti S, Chum K, et al. Tympanometric and otoscopy prior to myringotomy: Issues in diagnosis of otitis media. *Int J Ped Otorhinolaryngol* 1992; 101-110.
45. Brooks DN. Impedence bridge studies on normal and hearing impaired children. *Acta Otorhinolaryngol Belg*. 1974; 28:140-145.
46. Orchik DJ, Herdman S. Impedence audiometry as a screening device with school-age children. *J Aud Res* 1974; 14:283-286.
47. Margolis R, Heller J. Screening tympanometry: Criteria for medical referral. *Audiology* 1987; 26:197-208.
48. Cantekin EI, Doyle WJ, Reichert TJ, et al. Dilation of the eustachian tube by electrical stimulation of the trigeminal nerve. *Ann Otol Rhinol Laryngol* 1979; 88:40-51.
49. Yochum T. *Essential of Skeletal Radiology*. Baltimore: Williams & Wilkins, 1987; 190-198.
50. Knutsson F. The instability associated with disc degeneration in the lumbar spine. *Acta Radiol* 1944; 24:593-609.
51. Panjabi MM, et al. How does posture affect the coupling? *Spine* 1989; 14:1002-1003.
52. Bacher JA. The applied anatomy of the eustachian tube. *Laryngoscope* 1912; 22:21 -35
53. Hachi CS, Gannon PJ, Eden AR. Motor innervation of the eustachian tube muscles in the guinea pig. *Laryngoscope* 1993; 103: 1218-1226.
54. Lapin AJ. The relationship of the tensor tympani and tensor palati muscles. *Ann Otol Rhinol Laryngol* 1969; 792-796.
55. Honjo I, Ushiro K, Haji T, et al. Role of tensor tympani muscle in eustachian tube function. *Acta Otolaryngol* 1983; 329-332.
56. Skoner DP, et al. Nasal physiology and inflammatory mediator during natural pollen exposure. *Ann Allergy* 1990; 65:206-210.
57. Mygind N, Pedersen M. Nose, sinus and ear symptoms in 2" patients with primary ciliary dyskinesia. *Eur J Resp Dis* 1983; 64(Suppl 127):96-101
58. Bluestone CD. Eustachian tube obstruction in the infant with cleft palate. *Ann Otol Rhinol Laryngol* 1971; 80:1-10
59. Paradise JL, Bluestone CD, Felder H. The universality of otitis media in fifty infants with cleft palate. *Pediatrics* 1969; 44:35-42.
60. Barenkamp SJ, Shurin PA, Marchant CD, et al. Do children with recurrent Hemophilus influenza otitis become infected with a new organism or reacquire the original strain? *J Pediatr* 1988
61. Lantz CA. A review of the evolution of chiropractic concepts of subluxation. *Top Clin Chiro* 1995; 2:1.
62. Palmer BJ. The Subluxation Specific: The Adjustment specific. Davenport, Palmer School of Chiropractic 1934.
63. Rome PL. Usage of chiropractic terminology in the literature:296 ways to say subluxation:complex issues of the vertebral subluxation. Chiro Tech 1996; 8:49.
64. Lantz CA. The vertebral subluxation complex. *Int Rev Chiro* 1989; 45:37-45.
65. Gatterman MI. Foundation of Chiropractic Subluxation. St. *Louis: Mosby 1995:6.*
66. Fallon JM. *The Textbook of Chiropractic Pediatrics*. Arlington: ICA 1994; 78-96.
67. Fallon JM. *The Textbook of Chiropractic Pediatrics*. Arlington: ICA 1994: 89-92.
68. Lewit K. *Manipulative Therapy in Rehabilitation of the Locomotor System*. Butterworth-Heinemann: Oxford 1991 2nd ed.
69. Plaugher G. Textbook of Clinical Chiropractic. Baltimore: Williams & Wilkins 1993: 52-68.
70. Davis D. Respiratory manifestations of dorsal spine readiculitis simulating cardiac asthma. *Ann Intern Med* 1950; 32:954.
71. Marshall LL, et al. Chemical radiculitis: a clinical physiological and immunological study. *Clin Orthop* 1977; 129:61.
72. Korr IM. The spinal cord as organizer of disease processes. IV. Axonal transport and neurotrophic function in relation to somatic dysfunction. *J Am Osteopath Assoc* 1981; 80:451.
73. Sunderland S. *Nerves and Nerve Injuries*. Baltimore: Williams & Wilkins 1968.
74. Rydevik BL. The effects of compression on the physiology of nerve roots. *J Manipul Physiol Ther* 1992; 15:62.
75. Kent C. Models of vertebral subluxation: A review. *J Vert Sub Res* 1996; 1 :11.
76. Faye LJ. *Motion Palpation of the Spine*. Huntington Beach: Motion Palpation Institute 1983.
77. Proctor B. Embryology and anatomy of the eustachian tube. *Arch Otolaryngol Head Neck Surg* 1967; 86:503-526.
78. Eden A, Gannon P. Neural control of middle ear aeration. *Arch Otolaryngol Head Neck Surg* 1987; 113:133-137.
79. Ito J, et al. Localization of motor neurons innervating the eustachian tube muscles in cat. *Acta Otolaryngol* 1987; 104:108-112.