Scientific Article

The Relationship Between Acute Otitis Media and the Anatomic Form of the Hard Palate

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Abstract: ***Purpose:*** *Acute otitis media (AOM) is a serious health concern for millions of children. This study was conducted to determine the relationship between AOM and the shape of the hard palate.* ***Methods:*** *Intraoral examinations were performed on 175 pediatric dental patients ages 4-6. The palatal height was classified as high, medium or low. The accompanying parent completed a survey regarding their child's age, gender, overall health, history of AOM and presence of known risk factors for AOM.* ***Results:*** *Eighty five percent of the total sample had a positive history for AOM, with 76% experiencing AOM prior to age 1. High palatal vault was a significant finding in children that experienced AOM before age 1 (odds ratio 3.49). Logistic regression analysis revealed that children with high palatal vaults underwent tube placement more often than the rest of the study population (odds ratio 2.49).* ***Conclusions:*** *Our study revealed a relationship between the presence of high palatal vaults and early, recurrent acute otitis media in young children. Recognition of high palatal vault in children suffering from AOM, in the presence of other known risk factors, may guide health care professionals to identify an otitis media prone patient and aid in prevention of recurrence. (Pediatr Dent 2008;30:9-14) Received November 28, 2006 / Last Revision April 24, 2007 / Revision Accepted April 25, 2007.*

KEYWORDS: OTITIS MEDIA, EUSTACHIAN TUBE, HARD PALATE

Acute otitis media is one of the most common illnesses in children, accounting for 24.5 million office visits in a single year, and represents a significant health risk to young individuals.[1] The associated cost in the United States, including medical costs and lost wages, is estimated to be $3 billion to $5 billion per year.[2] According to the Third National Health and Nutrition Examination Survey (NHANES III), 70% of all children have at least one episode of otitis media and about 40% of children have had more than 3 episodes before the age of 6 years.[3] Overall, 83% to 90% of the US population is affected by this condition during childhood.[4,5]

Otitis media (**OM**) describes inflammation of the middle ear regardless of etiology or pathogenesis. Acute otitis media (**AOM**) describes middle ear inflammation with rapid onset and painful symptoms. Chronic otitis media with effusion describes collections of fluid within the middle ear that persists longer than 3 months after an episode of AOM.[6] Children suffering from AOM often exhibit systemic symptoms consistent with those of the common cold. Nasal drainage, coughing, and congestion are common findings. Otalgia, or ear pain, is another common finding that varies in severity from mild, local irritation to intense pain that causes sleep disturbances.[7] Otoscopic inspection of affected children typically reveals a thickened, immobile tympanic membrane that exhibits discoloration from yellow to red. Membrane rupture with purulent discharge is rare but diagnostic for AOM.[8]

The pathogenesis of AOM is related to abnormal Eustachian tube function.[9] The Eustachian tube provides communication between the nasopharynx and the middle ear complex. Its functions include: (1) ventilation of the middle ear to permit pressure equilibration; (2) clearance of secretions from the middle ear to the nasopharynx; and (3) protection of the middle ear from nasopharyngeal secretions.

The Eustachian tube is underdeveloped in infants and, hence, is less efficient at clearing secretions that may contribute to susceptibility for ear infections.

The average length of the Eustachian tube in infants and young children is about 18 mm (Figure 1). It follows a variable course ranging from horizontal to a 10-degree angle with respect to the horizontal plane. As the child grows, the tube doubles in length to about 31- 38 mm and repositions at a 30- to 40-degree angle with respect to the cranial base (Figure 2).

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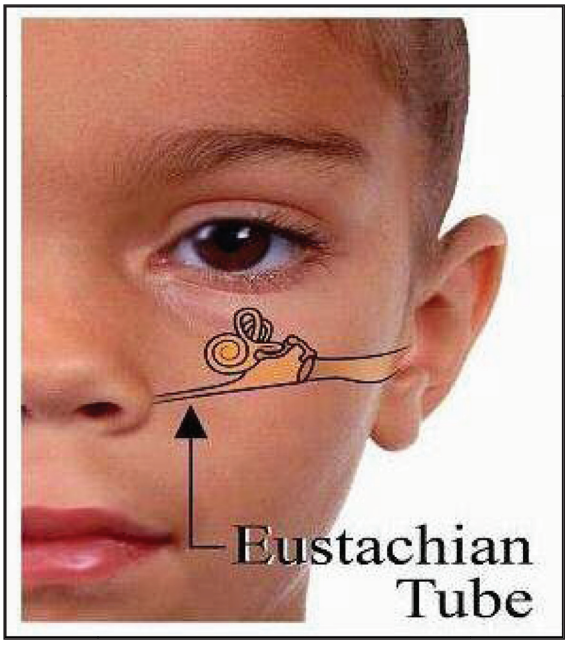

Figure 1. Position and angle of Eusstachian tube in children. Note the relative horizontal position of the tube compared to adults.

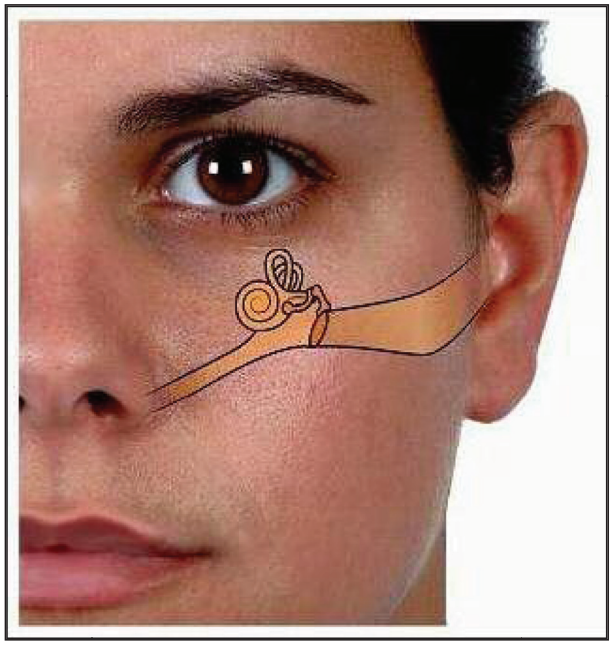

Figure 2. Position and angle of Eustachian tubes in adults. Note the more vertical position of the tube compared to children.

Additionally, the Eustachian tube moves superiorly during growth. In adulthood, it is commonly observed to be 10 mm superior to the hard palate.[10] This increase in angulation makes the Eustachian tube more efficient in clearing secretions, and may be one reason why ear infections are regarded as primarily a disease of infancy and early childhood.

If the Eustachian tube is not functioning properly, pressure equalization is not achieved and tissue secretions accumulate within the middle ear. If clearance functions are inhibited, these fluids may become contaminated with nasopharyngeal bacteria and AOM may develop.[11]

Clinical research has revealed several factors related to the incidence of AOM. Children born with a cleft palate are more likely to develop AOM.[12] Howie et al observed that "otitis prone" children experiencing AOM in their first year of life and those having siblings with a history of AOM are more likely to experience recurrent episodes of disease.[13] Male subjects experience significantly more single and recurrent bouts of AOM when compared to female subjects.[4] Approximately 34% of recurrent AOM cases are associated with exposure to tobacco smoke.[14] Pacifier use is associated with an increased incidence of OM.[15] Congenital anomalies, such as Down syndrome[16,17] and Turner syndrome,[18] are correlated with AOM. The association between malocclusion and OM is unclear, as some authors have reported no associations between malocclusion and OM and others have reported that children with deep dental overbites have a significantly increased risk for Eustachian tube dysfunction.[20] Human breast milk has a well-documented protective role against various infections in infants. For example, a 3-year study in Helsinki revealed that 26% of bottle-fed subjects had experienced multiple bouts of AOM, compared to 6% of the long-term breast milk group.[21]

Antimicrobial therapy is the most commonly utilized treatment. It is estimated that at least $5 billion is spent annually on antibiotics and treatment of AOM in children.[22] If antibiotics prove to be ineffective, myringotomy with insertion of tympanostomy tubes may be considered. The objectives of tube placement are to: (1) allow pressure equalization; (2) maintain a cushion of air within the middle ear; and (3) prevent spread of nasopharyngeal bacteria into this space.[23]

The physical, emotional, and financial costs of AOM are significant. They include the: (1) patient's individual pain and suffering; (2) emergence of resistant pathogenic micro-organisms resulting from indiscriminant use of antibiotics; and (3) ever-increasing financial burden on the health care system. Identifying additional risk factors to aid in recognition of AOM-susceptible individuals would be of considerable value.

In the present retrospective study, it was hypothesized that children with deeper palates possess a more horizontally positioned Eustachian tube, which makes them more susceptible to recurrent AOM. The aim of this clinical study was to investigate the relationship between the shape of the palate and the history of AOM.

Methods

The study's protocol was approved by the Institutional Review Board of Indiana University-Purdue University Indianapolis/ Clarian, Indianapolis, Ind. Children between ages 4 and 6 years

who presented for routine dental procedures to the Pediatric Dental Clinic at the School of Dentistry were recruited for the study. The study population also included patients from 2 private pediatric dentistry practices in central Indiana. Informed consent was obtained from the parent or guardian present, and the subjects had to be compliant during the clinical examination. Children with any systemic conditions that made them susceptible to ear infections were excluded from the study.

Calibration

A random sample of maxillary casts from the Pediatric Dental Clinic at the School of Dentistry of Indiana University was utilized to establish a range of: (1) shallow; (2) average; and (3) high palatal vault depths. A system of classification for palatal vault depth was created to clearly differentiate between various palatal forms. Examiner training and calibration of the study examiner (DMD) against a "gold standard" examiner (SJK) involved: (1) inspection of each cast separately for 30 seconds; and (2) recording the findings. This process was repeated until intraexaminer and interexaminer accuracy and repeatability were greater than 90% regarding the established standard. The calibration exercise itself consisted of training on 37 dental casts.

Classification for palatal vault form

A classification scheme for palatal vault height was developed. Based on the cross-sectional view of the palatal vault at the deepest point (Figures 3 and 4), different palatal shapes were classified as either medium, high/steep, or low/flat.

Class I (medium) characteristics.

1. This is the most common form.
2. The palatal slope (when it is viewed as a straight line connecting the gingival margin and the midpoint of the palate) forms an angle of 30 to 45 degree to the horizontal plane.
3. The palatal slope is characterized by a round curvature that forms a slight concavity.

Class II (high/steep) characteristics.

1. Patients present with a deep palate.
2. The palatal slope is steeper compared to that of the medium palate.
3. An angle greater than 45 degrees is created by the previously described landmarks.
4. The slope is usually round and pronounced (convex) at the coronal third.

Class III (low/flat) characteristics.

1. Patients present with a shallow palate.
2. The palatal slope is flatter compared to that of medium palate.
3. An angle less than 30 degrees is created by the previously described landmarks.
4. The palatal slope is usually short, and the mid-palate has a flat surface.

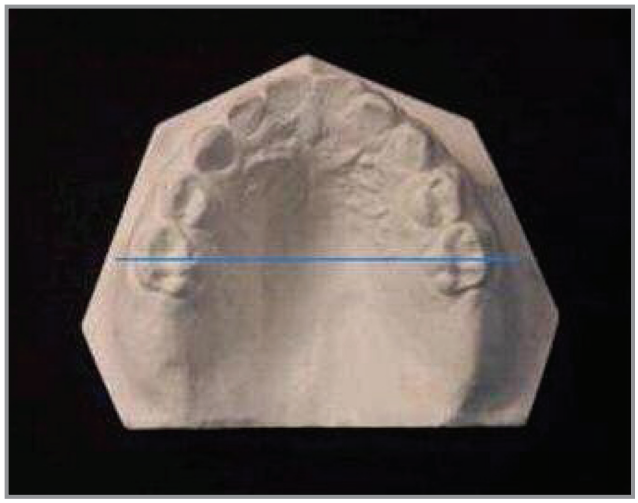

Figure 3. The blue-line represents the deepest point of palatal vault for cross-sectional view. The deepest point is independent of the dentition.

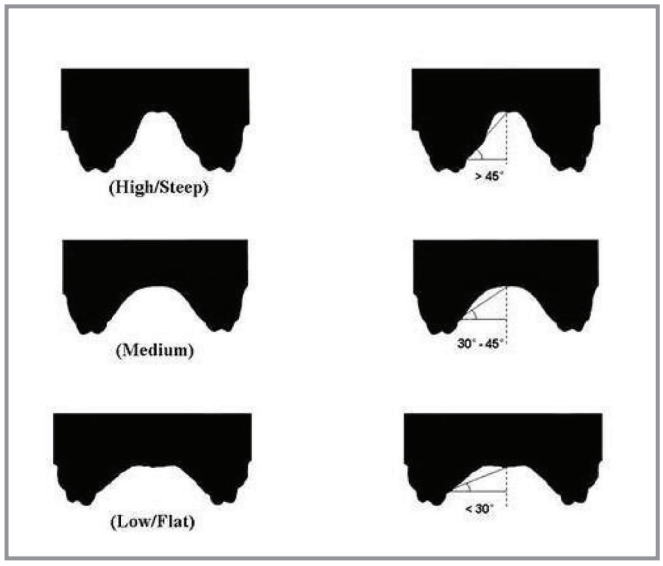

Figure 4. Classification of palatal vault form.

Clinical examination

The clinical examination of each subject's palatal vault was performed with a mouth mirror and a tongue depressor. Following the visual inspection by the examiner, the palatal vault height was recorded as: (1) low; (2) medium; or (3) high. All subjects were examined by the calibrated study examiner. A random subset of 20 subjects was also examined by the "gold standard" examiner to allow evaluation of interexaminer reproducibility during the study.

Completion of survey. During the clinical examination, the parent or guardian completed a questionnaire that covered the following pertinent information about each child subject: (1) age, race, and gender; (2) systemic health; (3) tobacco smoke exposure; (4) method of feeding during infancy; (5) history of intubation (placement of a breathing tube during any hospitalizations); (6) history of a finger-sucking habit and pacifier use; (7) history of acute OM; (8) age during initial episode of acute OM; (9) number of episodes of acute OM experienced; (10) treatment(s) rendered to manage episodes of acute OM.

Shapes of palatal vaults of children with a positive history of AOM were analyzed in relation to the: (1) age of first onset; (2) frequencies; and (3) modes of treatments. The relationship between known risk factors for AOM and the history of AOM of subjects were investigated.

Statistical methods. Intraexaminer and interexaminer agreement were assessed using weighted kappa statistics. Each risk factor from the survey was evaluated separately in single-variable logistic regression models for analyses of: (1) a history of recurrent AOM; (2) the occurrence of AOM before age 1; and (3) placement of tubes. Factors that were statistically significant at $P<.10$ were then included in multiple variable logistic regression models, and adjusted odds ratios were computed.

Table 2. SUBJECTS WITH POSITIVE HISTORY OF ACUTE OTITIS MEDIA (AOM) RELATIVE TO PALATAL VAULT FORM (N=175)

		Total	High/steep	Medium	Low/flat
Subject with positive history of AOM		148	38	106	4
First onset before age 1 year	N	112	34	74	4
	%	76	89	70	100
Multiple episodes (>3)	N	90	31	56	3
	%	61	82	53	75
Ear tube placement	N	34	17	26	1
	%	23	45	25	25

Table 3. ASSOCIATIONS RELATED TO RECURRENCE OF ACUTE OTITIS MEDIA (AOM) RELATIVE TO YOUNGER THAN 1 YEAR OF AGE AND PALATAL VAULT FORM

Risk	Adjusted odds ratio	95% confidence interval	*P*-value
AOM in first year	8.62	3.90, 19.04	<.001
High vs medium palatal vault	2.68	1.27, 5.67	.001

Table 4. ASSOCIATIONS RELATED TO SURGICAL INTERVENTION (TUBE PLACEMENT) RELATIVE TO YOUNGER THAN 1 YEAR OF AGE, MULTIPLE EPISODES OF ACUTE OTITIS MEDIA (AOM), AND HIGH PALATAL VAULT FORM

	Odds ratio	95% confidence interval	*P*-value
AOM before age 1	21.81	2.88, 165.06	.003
High of <3 episodes of AOM	3.32	2.02, 5.44	<.001
High palatal vault	2.49	1.15, 5.39	.02

Results

After the study examiner was trained, results of the calibration exercise—assessed using weighted kappa statistics—indicated that intraexaminer and interexaminer consistencies were satisfied. The interexaminer weighted kappa statistic was 0.72. The intraexaminer weighted kappa statistic for the study examiner was 0.72, and as a reference the intraexaminer weighted kappa statistic for the gold standard examiner was 0.80. Regarding the study's clinical examination phase, the interexaminer weighted kappa statistic was 0.73.

Table 1. DISTRIBUTION (N) OF HISTORY OF ACUTE OTITIS MEDIA (AOM) RELATIVE TO PALATAL SHAPE

		High/steep	Medium	Low/flat
History of AOM	Positive	38	106	4
	Negative	5	21	1

A total of 176 subjects was evaluated over a 3-month period. All parents agreed to have their children participate in the study when asked. One subject was excluded from statistical analysis because the subject's questionnaire was incomplete. A total of 148 subjects (85%) reported a positive history of AOM (Table 1), of which 76% suffered their first episode before their first birthday; 61% had experienced more than 3 bouts of AOM (Table 2).

Different modes of treatment were identified in the survey. More than one type of treatment may have been utilized for each subject. Antibiotic use was the most common method of treatment and was used 82% of the time. Among the subjects with a history of AOM, 23% reported a history of tube placement. Forty-five percent of subjects with high palatal vaults underwent tube placement due to multiple bouts of AOM. In contrast, only 25% of subjects with medium palatal vaults received surgical intervention. For 33 subjects with ear tube placement, all but 1 (33/34) had their first onset of OM before 1 year of age, and most of them reported multiple episodes of AOM (17% reported 3 to 6 episodes, and 72% reported >6 episodes).

After adjusting for occurrence of AOM in the first year (the only other significant risk factor for history of recurrent AOM), high palatal height was a significant risk factor for a history of recurrent AOM, with an odds ratio of 2.68 (95% confidence interval [CI]=1.27, 5.67; *P*=.001) compared to children with a medium palatal height (Table 3).

Among children with a history of AOM, those exposed to tobacco smoking and those with high palatal vaults tended to have their first experience with AOM before their first birthday. Among children with high palatal vaults compared to children with medium palatal vaults, the adjusted odds ratio for a history of AOM before 1 year of age was 3.49 (95% CI=1.14, 10.69; *P*=.03).

Logistic regression models indicated that children with high palatal height, AOM before 1 year of age, and multiple episodes of AOM tended to undergo myringotomy and tympanostomy tube placement procedures. The odds ratios are shown in Table 4.

Discussion

AOM poses a significant health risk to numerous susceptible children, and identifying risk factors at an early age may allow earlier intervention to reduce the incidence of recurrent AOM. While the pathogenesis of AOM is well understood, the ability to recognize susceptible individuals remains obscured. This study's results represent an additional piece of the puzzle in identifying susceptible individuals. The presence of a high palatal vault in young children is a significant finding in children with a history of multiple episodes of AOM and a history of AOM before 1 year of age.

This study's findings were similar to previously reported data regarding to the incidence of AOM in this population.[1-5] Data analysis of those subjects experiencing recurrent AOM with a history of the initial AOM episode before 1 year of age noted a significant association between high palatal vault form and recurrent AOM.

This study's data indicate that high palatal vault forms and tobacco smoke exposure (TSE) are significant findings among children experiencing AOM before their first birthday. While the focus of the relationship between TSE and AOM is slightly different than that investigated by others,[19,21] the authors' findings further support the association between TSE and increased risk for AOM.

The primary focus of this epidemiological investigation was to evaluate a possible relationship between the shape of a palatal vault and AOM experience in children. Finding a significant correlation from the data analysis, the authors elected to further evaluate treatment methods rendered in those children with high palatal vaults and with early and frequent AOM episodes. The logistic regression analysis indicates that these subjects with high palates and early, repeated AOM experiences tended to undergo tympanostomy tube placement more frequently than those without these conditions. If it is assumed that tympanostomy procedures are performed for the most severe or recurrent cases, this study's data suggest that the observation of a deep palatal vault (in conjunction with other known risk factors) may help identify children who are susceptible to early, recurrent AOM. Furthermore, the ability to better identify susceptible children may improve treatment selection for AOM.

Currently, antibiotic therapy is the most commonly utilized treatment and is consistent with our findings. It must be realized, however, that antibiotic therapy is often not definitive; some children may require multiple courses of antibiotics or the condition may recur. Improving the ability to identify susceptible children and the elimination of environmental risk factors such as tobacco smoke exposure and pacifier use could help reduce AOM recurrence. If the child at risk for recurrent AOM could be classified at the time of the first infection, more aggressive therapy could be initiated. We hypothesize that the palate's shape in the neonate could be used to alert the pediatrician of the child's predisposition to AOM. Looking at and even measuring the height of the palate could be an effective and noninvasive diagnostic aid. Benefits of improved treatment protocols for more susceptible individuals could include: (1) reduced pain and suffering from multiple AOM episodes; (2) reduced long-term costs by limiting repeated treatments; and (3) eliminating excessive antibiotic exposure.

Conclusions

Based on this study's results, the following conclusions can be made:

1. A significant positive correlation exists between the presence of a high palatal vault and early, recurrent bouts of AOM in young children.
2. While a cause-and-effect relationship is not inferred, this information should be considered along with other known risk factors related to AOM when assessing treatment options.

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Abstract of the Scientific Literature

Oral health knowledge, attitudes, and behaviors among Finnish schoolchildren

This study investigated whether the presence of active initial caries lesions among 11 to 12 year olds is associated with parental and child related factors and whether there are gender differences in these associations. A dental screening was completed on 1441 children. Data on knowledge, attitudes, and behaviors were gathered by means of questionnaires administered separately to children and parents. Children with self-reported poor oral health behaviors and children of parents with self-reported poor oral health behaviors were more likely to have an active initial caries lesion than children with good oral health behaviors and children of parents with good oral health related behaviors. Girls were more likely than boys to have caries if their parents reported having poor oral health behaviors. Poor oral health attitudes and behaviors among both children and their parents contributed to the presence of active initial caries lesions in children. Parental factors affect boys' and girls' health differently.

Comments: *The gender differences in how attitudes and behaviors impact boys' and girls' caries status suggest that transmitting the appropriate message to boys and girls is a challenge in planning oral health promotion interventions.* ***KMM***

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