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Chronic otitis media requiring ventilation tubes in tracheotomized ventilator dependent children ☆

John M. Palmisano*, Frank W. Moler, Susan M. Revesz, Joseph R. Custer, Charles Koopmann

Department of Pediatrics, Division of Pediatric Critical Care and Department of Otolaryngology, University of Michigan Medical Center, C.S. Mott Children's Hospital, 1500 E. Medical Center Drive, D-1220 MPB Box 0718, Ann Arbor, MI 48109-0718, USA

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Abstract

The occurrence of sinusitis and middle ear effusions has frequently been attributed to the obstruction of the sinus ostia and/or eustachian tube. In the intensive care unit setting, edema caused by the irritation from nasogastric, nasotracheal and orotracheal tubes has been associated with this pathology and has been responsible for occult sepsis in this population. Our investigation was performed to determine the risk of chronic otitis media with effusion necessitating myringotomy with tympanostomy tubes among tracheotomized, ventilator dependent children in a consecutive series of children admitted to our recently created stable ventilator unit. We retrospectively reviewed the medical records of all tracheotomized, chronically ventilator dependent children < 48 months of age who had been hospitalized in this unit from the initial opening in September 1990 to January 1993. Data collected consisted of patient demographics, gestational age, cognitive abilities, age at onset of mechanical ventilation, age at tracheostomy, age at myringotomy, presence of nasogastric and gastroenterostomy tubes and evidence of gastric-esophageal reflux. All children underwent a tracheostomy procedure subsequent to the onset of mechanical ventilation. Of these patients, 9/12 (75%) later required myringotomy with tympanostomy tube placement following the occurrence of chronic otitis media with effusion. Ventilation tubes for chronic otitis media with effusion were not required in 3 patients. Using a case control study design, we examined the need of myringotomy tubes for children requiring continuous mechanical ventilation versus those requiring night-time only ventilation. The risk of myringotomy tubes in the continuously ventilated group (9/9) was significantly greater than the risk in the intermittently ventilated group (0/3) $P < 0.01$. We conclude chronic otitis media with effusion is a common finding

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* Corresponding author, Tel.: 313 764 5302; Fax: 313 763 4208.

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among preschool-aged children who are tracheotomized and ventilator dependent. Routine periodic ENT evaluation may be indicated in all pediatric patients who require chronic mechanical ventilation. In this specific population of children, there may be a subset of patients who would benefit from prophylactic antibiotic therapy or tympanostomy tube insertion during the duration of positive pressure ventilation. Further prospective study is warranted.

Keywords: Otitis media; Tympanostomy; Myringotomy; Mechanical ventilation; Tracheostomy; Pediatrics

1. Introduction

Nasotracheal intubation has frequently been associated with a high incidence of sinusitis [1–11], middle ear infections [3,9,12], and occult sepsis [1,4,5,7,10]. These associations, generally confirmed by radiological or clinical evidence, have been strongly associated with mechanical ventilation [1,2,4,7–14]. The etiology of sinusitis and middle ear effusions has been attributed to obstruction of the sinus ostia and/or eustachian canal secondary to edema of adjacent tissue by nasogastric and endotracheal tubes. This may impair ventilation and drainage of the sinuses and eustachian tube and consequently would lead to infection. Although the edema is localized to the side which was cannulated [5,8,11,13], the contralateral side may also become inflamed. Therefore, factors other than localized edema are also likely to be involved.

Although chronic otitis media among infants and children with nasotracheal tubes has been reported [3,12], such an association has not been observed in a tracheotomized ventilated population. This investigation was performed to determine the incidence of chronic otitis media with effusion necessitating myringotomy with tympanostomy tube insertion among tracheotomized, ventilator dependent children.

2. Materials and methods

We retrospectively reviewed the medical records of all tracheotomized, ventilator dependent children who were admitted to the Stable Ventilator Unit at our hospital from its initial opening in September 1990 through January 1993. This 6 bed unit provides monitored care to stable hospitalized children who are ventilator dependent. A standard admission history and physical examination, including an otoscopic examination was performed at the time of hospitalization. Data collected consisted of patient demographics, gestational age, cognitive abilities, otoscopic evaluation, age of onset for mechanical ventilation, age at tracheostomy, age at myringotomy, presence of nasogastric and gastroenterostomy tubes and evidence of gastroesophageal reflux.

Data was entered and stored on an Excel file, version 3.0, (Microsoft Corporation, Redmond, WA.) and analysis was performed using SYSTAT version 5.0 (SYSTAT Inc., Evanston, IL.) for the Macintosh computer. Continuous variables are expressed as the mean ± S.D. A Fisher Exact test was utilized to compare the risk of myringotomy tubes in patients requiring continuous mechanical ventilation to those with intermittent mechanical ventilation.

3. Results

Within the period of review, 13 tracheotomized, ventilator dependent children (7 male patients, 6 female patients) were identified. One child was excluded who underwent myringotomy and tympanostomy at the time of her cleft palate repair. Of the 12 patients reviewed, 9 were begun on mechanical ventilation within 3 weeks of birth. Their underlying diagnosis and descriptive data are summarized in Table 1. The remaining children ($n = 3$) required mechanical ventilation following events which occurred beyond 3 weeks of age; motor vehicle accident ($n = 1$), hemidiaphragmatic paralysis; intraoperatively ($n = 1$) and central hypoventilation syndrome ($n = 1$). All children underwent a tracheostomy procedure subsequent to the onset of mechanical ventilation (mean = 2.9 months following mechanical ventilation; range = 1 week–10 months).

While the regularity or frequency of examination varied among patients, the first documentation of otitis media with effusion was not noted to occur until after the tracheostomy. This time interval between the tracheostomy procedure and documentation of otitis media ranged from 2.1–19.3 months (mean 10.2 months). The mean age at the placement of ventilation tubes among this population was 21.7 months (range = 10.4–45.5 months). The time between the tracheostomy and tympanostomy procedure ranged from 2.2–36.8 months (mean = 13.6 months). Clinical evidence of concurrent sinusitis was apparent in 5 patients of which 4 (80%) had a nasogastric tube in place when the otitis media was diagnosed. Among all patients, 10/12 (83%) had gastric esophageal reflux, frequent aspiration or swallowing disorders. The estimated gestational age at birth was 36.1 weeks (range = 26–42 weeks). Developmental delay and blunted cognitive abilities, assessed either by standardized testing or by clinical examination, were noted during routine follow-up examination among 9/12 patients (75%).

Using a case control study design, we examined the need of myringotomy tubes for children requiring continuous mechanical ventilation versus those requiring night-time only ventilation. The risk of myringotomy tubes in the continuously ventilated group (9/9) was significantly greater than the risk in the intermittently ventilated group (0/3) $P < 0.01$. Nine of 12 (75%) required bilateral myringotomy with tympanostomy tube placement for chronic otitis media with effusion following the tracheotomy.

Ventilation tubes were not required in the remaining 3 patients who received mechanical ventilation. In these patients mechanical ventilation was necessary only during periods of sleep. Of these patients, 2 have not demonstrated any evidence of otitis media. The remaining patient (patient 1), was noted to have bilateral otitis media with a purulent discharge associated with a febrile illness at the time of death. Two patients (patients 4,5) have since undergone retympanostomies.

4. Discussion

We hypothesize that the incidence of chronic otitis media with effusion, necessitating tympanostomy tubes, may be causally related to the inability to equalize the pressure within the eustachian canal during prolonged mechanical venti-

Table 1
Descriptive data of tracheotomized, ventilator dependent children

Patient	Sex	Wgt. (kg)	EGA (wks)	Diagnosis	Continuous mechanical ventilation	Age (mo) onset of mechanical ventilation	Age (mo) trache-ostomy	Age (mo) documentation of otitis media with effusion	Age (mo) tympan-ostomy	Latent time to tympanostomy (mo)	NG tube	G tube	Develop-mental delay	Sinu-sitis
1	F	8.3	37	CCHD, hemidiaphragmatic paralysis	[d]	0.7	2.7	24.3	[a]	–	+	+	+	+
2	M	17.3	40	Central nuclear myopathy	+	35.0	35.7	39.8	45.5	9.8	+	+	+	+
3	M	7.7	36	Thanatophoric dwarfism	+	0.0	8.5	27.7	27.9	19.5	–	+	+	–
4	F	44.0	40	Spondyloepiphyseal dysplasia	+	0.0	1.1	18.4	37.9	36.8	–	+	+	+
5	M	10.8	40	Multiple congenital anomalies, [b] partial conjoint twin	+	6.2	8.2	10.1	10.4	2.2	–	+	–	–
6	M	9.7	31	Bronchopulmonary dysplasia, bronchomalacia, (CPR)	+	0.0	1.0	14.2	18.1	17.1	–	+	+	–
7	M	4.3	26	Bronchopulmonary dysplasia, tracheomalacia, (CPR)	+	0.0	4.0	12.1	12.2	8.1	–	+	+	–
8	F	12.3	39	Central hypoventilation syndrome, Hirschsprungs disease	+	0.0	2.3	13.3	14.2	11.9	–	+	+	–
9	M	7.0	42	VATER	+	0.0	1.9	12.1	13.1	11.1	–	+	+	–
10	F	14.0	26	Bronchopulmonary dysplasia, reactive airway disease	+	0.0	9.9	15.9	15.7	5.8	+	+	+	+
11	M	42.8	40	Motor vehicle accident, cervical fracture (C-2 quadraplegia)	[d]	42.8	43.0	–	[c]	–	+	–	–	+
12	F	4.0	38	Central hypoventilation syndrome, Hirschsprungs disease	[d]	0.1	0.6	–	[c]	–	–	–	–	–
Mean (±S.D.)	0.58	15.2 (13.7)	36.1 (5.5)			0.58 (0.51)	9.9 (14.7)	18.8 (9.3)	21.7 (12.6)	13.6 (10.2)	0.25	0.92	0.73	0.42

Abbreviations: CCHD, complex congenital heart disease; CPR, cardiopulmonary resuscitation (at birth); EGA, estimated gestational age; G tube, gastroenterostomy feeding tube; NG tube, nasogastric tube; VATER, acronym for vertebral defects, anal atresia, tracheoesophageal fistula with atresia, radial upper limb hypoplasia and renal defects; [a]patient expired; evidence of otitis media during clinical examination; [b]congenital heart disease (d-transposition of the great vessels), abdominal viscera duplication, pelvic and extremity duplication; [c]no evidence of otitis; [d]mechanical ventilation for sleep only.

lation. We believe the high incidence of chronic otitis media in this population has not been previously reported for several reasons. Firstly, the formation of the stable ventilator unit has created a homogeneous population of children. Secondly, the majority of these patients developed significant respiratory insufficiency at birth and underwent tracheostomy at a young age and thus may have been prone to subsequent problems. Thirdly, these children frequently require prolonged hospitalizations, thus experiencing a greater opportunity to acquire nosocomial respiratory infections. Other possible explanations which may predispose the child to chronic otitis media may include immobility, supine position, otitis prone age (shorter length and more horizontal position of the eustachian tube), prematurity, craniofacial abnormalities, neuromuscular disease, immunodeficiency, frequent hospitalizations, medications, bacterial colonization, frequency of respiratory tract infections or the high incidence of gastroesophageal reflux in this group. All the above conditions might interfere with the normal function of the eustachian tube and equalization of middle ear pressure.

It is interesting to note that at the time of this study, 2 of 3 patients who required mechanical ventilation during periods of sleep only (patients 1,11,12) did not yet demonstrate any middle ear pathology after the tracheostomy. Although we are unsure as to why, we suspect that chronic otitis media with effusion requiring tympanostomy may be associated with continuous mechanical ventilation among this population. The mechanism responsible may be whether eustachian tube dysfunction in this group is due to a change in airflow dynamics through the upper airway or colonization of the upper airway with bacterial flora. It is possible, however, that patients who received continuous mechanical ventilation were hospitalized longer and were more likely to be observed to have middle ear effusion representing an observation bias.

5. Conclusion

Otitis media is a common finding among preschool-aged children. Although the majority of children whom we report may have been predisposed to recurrent ear infections secondary to their primary disease process or trauma, the episodes of recurrent or chronic otitis media were not diagnosed until following the tracheostomy. Thus, we believe that children who required tracheotomies should be closely monitored for chronic middle ear effusions while dependent upon positive pressure mechanical ventilation. Further prospective investigation is warranted to determine the etiology or etiologies of chronic otitis media in tracheotomized patients who require positive pressure ventilation. Also, prospective studies concerning control of gastroesophageal reflux may help evaluate the importance of this variable.

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