International Journal of Pediatric Otorhinolaryngology 81 (2016) 29–32

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Factors related to persisting perforations after ventilation tube insertion

Ashley P. O'Connell Ferster [a,*], April Michelle Tanner [a], Kodjo Karikari [b], Christopher Roberts [b], Derek Wiltz [a], Michele M. Carr [c]

[a] Department of Surgery, The Pennsylvania State University, College of Medicine, 500 University Drive, Hershey, PA 17033, USA
[b] The Pennsylvania State University, College of Medicine, 500 University Drive, Hershey, PA 17033, USA
[c] Department of Surgery and Department of Pediatrics, The Pennsylvania State University, College of Medicine, 500 University Drive, Hershey, PA 17033, USA

ARTICLE INFO

Article history:
Received 27 May 2015
Received in revised form 24 November 2015
Accepted 25 November 2015
Available online 7 December 2015

Keywords:
Ventilation tubes
Tympanostomy
Tympanic membrane perforation

ABSTRACT

Objective: Over a million ventilation tubes are placed annually in the United States, making this one of the most commonly performed procedures in the field of medicine. Certain factors increase the risk of persistent tympanic membrane perforation following the extrusion of short term ventilation tubes. Persistent perforations may fail to heal on their own, necessitating surgical closure to avoid conductive hearing loss. It is important to detect factors that may predict children who are at increased risk for persistent perforations.

Methods, outcomes data and statistical analysis: This study was a retrospective chart review that involved 757 patients between 2003 and 2008. The patients studied were within the age of 2 months–17 years, and all had short term tubes placed. The chart data also included demographic information, comorbidities, and information related to tube insertion and follow-up care. Chi-square, *t*-test, and multivariate logistic regression were conducted to compare variables between patients with perforations and those without.

Results: Data from 757 patients was analyzed, showing that perforation rate is associated with rhinorrhea, operative tube removal, aural polyps, and otorrhea (OR 1.72, 8.16, 4.69, and 1.72 respectively). The absence of otorrhea decreased the likelihood of TM perforations and no significant differences were found in gender, total number of sets of tubes, type of tube, use of nasal steroids, adenoidectomy, or nasal congestion.

Conclusion: Our findings suggest that children with rhinorrhea, otorrhea, aural polyps, or prolonged intubation requiring operative tube removal should be identified clinically as children at risk of persisting perforation.

1. Introduction

One in every 15 children will require placement of tympanostomy tubes by 3 years of age [1]. Because of its frequency, the Otolaryngologist should be aware of predictive factors that affect the long-term sequelae of tympanostomy tube placement. Being able to predict and educate caregivers on potential risks that occur following tube placement will allow the Otolaryngologist to provide better patient care.

One of the primary benefits of ventilation tube placement is the prevention of conductive hearing loss, thus enabling normal speech and language development. As middle ear effusions resolve, hearing levels are improved by an average of 5–12 dB [1,2]. An important outcome for the Otolaryngologist to monitor following tympanostomy tube placement is the continued integrity of the tympanic membrane (TM). Tympanostomy tubes typically extrude as the eardrum grows, leaving behind a fully intact and functional TM; however, persistent TM perforations do occur at a reported incidence of 2.2% [3]. Risk factors for persistent TM perforation include the surgical removal of tubes, otorrhea, long-term tube placement, multiple sets of tubes, and prolonged retention of tubes [4]. While other studies have investigated factors that impact TM

* Correspondence to: Department of Surgery, Division of Otolaryngology—Head and Neck Surgery, Penn State Milton S. Hershey Medical Center, 500 University Drive, MC H091, P.O. Box 850, Hershey, PA 17033, USA. Tel.: +1 717 531 6718; fax: +1 717 531 6160.
E-mail addresses: aoconnell2@hmc.psu.edu (A.P. O'Connell Ferster), kkarikari@hmc.psu.edu (K. Karikari), croberts2@hmc.psu.edu (C. Roberts), derekwiltz@ololcollege.edu (D. Wiltz), mcarr@hmc.psu.edu (M.M. Carr).

http://dx.doi.org/10.1016/j.ijporl.2015.11.028
0165-5876/

perforations, we sought to determine any association between nasal symptoms and subsequent TM perforations.

2. Materials and methods

After an Institutional Review Board approval from Penn State Hershey Medical Center was obtained for this study, a retrospective chart review of 757 consecutive pediatric patients was conducted. All patients included in the study had bilaterality to their disease process. Patients who required myringotomy and ventilation tube insertion or tympanoplasty for perforations status-post tube insertion between the years of 2003 and 2008 were included in the study. Persistent perforations included those that persisted 6 months after extrusion of the ventilation tubes from the tympanic membrane. The patients studied were aged from 2 months to 17 years and most had Armstrong grommets placed. Indications for ventilation tube insertion were 4 or more acute episodes of otitis media in 6 months, 5 or more episodes of otitis media over the last year, or persistent effusions associated with a hearing loss in both ears for at least 3 months or in 1 ear for at least 6 months.

Operative technique used for tube placement included general anesthesia and an anterior inferior quadrant radial incision. The middle ear was suctioned in all patients. Rarely irrigation with saline was used if a thick effusion was present that would not clear with suction. All patients had ofloxacin drops placed post-operatively. Tube removal was offered if the tubes were still in place 3 years after insertion. Adenoidectomy was typically offered with a patient history of persistent nasal symptoms in the presence of a large adenoid or with the third set of ventilation tubes.

Details of patient demographics including date of birth, date of first and most recent tube insertion, presence and type of effusion at insertion, total number of tube sets placed, spontaneous extrusion or non-extrusion of the tube, length of follow-up, gender, presence of cleft palate, trisomy 21, or other syndromes, rhinorrhea, nasal congestion (nasal obstruction by history), adenoidectomy date, use and compliance with nasal steroids, presence of otorrhea, frequency of otorrhea, and the presence of aural polyps were abstracted from the medical records.

Otorrhea was further classified by frequency of episodes, ranging from one time per year up to six or more times per year. Charts were excluded if there was only one follow-up visit after ventilation tube placement. Patients were stratified according to tympanic membrane perforation and compared using univariate statistical tests, including chi-square and *t*-tests as appropriate. Multivariate logistic regression was used to model the effects of covariates on the statistics. Our primary outcome was determining the factors associated with persistent tympanic membrane perforations after ventilation tube placement. Data was analyzed with SPSS 20.

3. Results

A total of 757 charts were identified as having myringotomy and ventilation tube placement or tympanoplasty for perforations following earlier tube placement between the years of 2003 and 2008. Twenty-five had undergone tympanoplasty during the time of the study. Seven hundred and thirty-two had undergone ventilation tube insertion during the time of the study. Of the latter group, 10.5% reported subsequent TM perforations. The mean age at first set of tube insertion among children with TM perforations was 4.05 years, while the mean age of those without TM perforations was 3.26 years, which was significantly different ($p < 0.05$). Demographic and clinical summary data appears in Table 1. The groups (tube insertion and tympanoplasty) were pooled for subsequent statistical analysis. Forty-one percent of all patients were female, and there was no significant difference in TM perforation incidence seen between genders. Those with TM perforations had a mean of 1.5 sets of tubes placed, while those without subsequent perforations had 1.48. The age at adenoidectomy was notably higher in those with TM perforations than those without TM perforations, with a mean of 7.1 years vs. 4.6 years, respectively; however this did not result in a significant difference because of wide variance.

Table 1
Patient and clinical characteristics.

Variable	All patients ($N = 757$)	Children with TM perforations ($N = 102$)	Children without TM perforations ($N = 655$)	*p* value
Age (mean in years)				
1st tube placement	3.36	4.05	3.26	.008
Adenoidectomy	4.99	7.11	4.69	.383
Last tube placement	4.26	4.95	4.17	.876
Sex				
Female	312	46	266	.390
Male	445	56	389	
Number of sets of tubes				
Only 1	509	64	445	.786
2 sets	177	25	152	
3 or more sets	71	13	58	
Type of effusion at first tube insertion				
Mucoid	240	20	220	.564
Serous	86	11	75	
Purulent	50	6	44	
No effusion	320	95	295	
Tube removal	47	24	23	.005
Rhinorrhea	322	53	269	.048
Nasal congestion	321	45	276	.775
Adenoidectomy	281	36	245	.194
Nasal steroids	238	40	198	.232
No episodes of tube otorrhea	425	48	377	.032
Otorrhea 2–5x/year	169	34	135	.019
Otorrhea $\geq$ 6x/year	33	6	27	.550
Tympanic membrane polyp	38	15	23	<0.001
Syndromes				
Trisomy 21	23	5	18	.998
Cleft palate	40	7	33	
Other	28	5	23	

Of the patients noted to have TM perforations, the average age at diagnosis was 6.7 years. The perforation size was noted to be an average of 30% of the surface area of the TM for both left and right TMs. We found that children requiring tube removal were more likely to have perforations (24% vs. 3.7%) than those with spontaneous tube extrusion. Of the 322 patients with reported chronic rhinorrhea, 53 (16.5%) presented with TM perforations as compared to the 48 of the 420 (11.4%) without rhinorrhea. There was no significant difference noted between use of nasal steroids and perforations; however, more nasal symptoms and less compliance with nasal steroids were present in the perforation group. In the subgroup of patients that were prescribed nasal steroids (29%), noncompliance with nasal steroids was present in 3.9% of the perforation group and 2.7% in the non-perforation group. Nasal congestion was not related to increased TM perforations.

Those with TM perforations were more likely to report greater than one episode of otorrhea than those without perforations. Fifty-four of the 269 (53%) patients reporting otorrhea were diagnosed with a TM perforation, compared to 48 of 377 (47%) who