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Original Article

Effects of Adenoidectomy and Adenotonsillectomy on Tympanostomy Tube Reinsertion Based on Korean Population–Based National Sample Cohort Data

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OBJECTIVES: We evaluated the effects of adenoidectomy and adenotonsillectomy (AT) on tympanostomy tube (TT) reinsertion using population-based retrospective cohort data to confirm the association of adenoidectomy or AT with TT reinsertion reported in several previous studies.

MATERIALS and METHODS: This study used data from the National Health Insurance Service National Sample Cohort in Korea. We selected patients who underwent TT insertion between the ages of 0 and 9 years from 2006 to 2015. Patients were divided into the following groups: group 1, TT insertion only; group 2, TT insertion with adenoidectomy; and group 3, TT insertion with AT. The number of TT reinsertions was analyzed.

RESULTS: There were 745 patients in group 1, 115 in group 2, and 251 in group 3. There were 1,019 cases of total TT insertion and 336 of reinsertion in group 1, 169 of total TT insertion and 31 of reinsertion in group 2, and 343 of total TT insertion and 50 of reinsertion in group 3. The rates of TT reinsertion were significantly lower in groups 2 and 3 than in group 1. The risks of TT reinsertion in groups 2 and 3 were significantly lower than the risk in group 1 in both univariate and multivariate Cox regression analysis.

CONCLUSION: TT reinsertion was significantly lower in the TT insertion with adenoidectomy and TT insertion with AT groups than in the TT insertion only group. We confirmed the effects of adenoidectomy and AT on reduction of the rate of repeated TT insertion by analysis of population-based data.

KEYWORDS: Tympanostomy tube insertion, adenoidectomy, adenotonsillectomy, otitis media with effusion, otitis media, population-based study

INTRODUCTION

Otitis media (OM) is the most common medical disease in children.[1–4] Acute OM (AOM) is characterized by the rapid onset of signs and symptoms of middle ear inflammation (i.e., otalgia and bulging of the eardrum), whereas OM with effusion (OME) is characterized by fluid in the middle ear with no signs or symptoms of acute infection.[2,5–8] Recurrent AOM and chronic OME are the most common indications for tympanostomy tube (TT) insertion.[3,9,10]

TT insertion, adenoidectomy, and adenotonsillectomy (AT) are the most commonly performed surgeries in children.[11] Tonsillectomy is indicated for obstructive sleep disordered breathing and may be recommended for recurrent throat infections with frequent episodes and specific signs, based on recent clinical practice guidelines.[11,12] TT insertion is recommended for chronic bilateral OME with hearing difficulty, chronic OME with symptoms, and recurrent AOM with middle ear effusion; it may be performed in at-risk children with unilateral or bilateral OME that is unlikely to resolve rapidly or in at-risk children with chronic OME.[10,11,13]

Several studies have been reported regarding the effects of adenoidectomy, tonsillectomy, or AT on recurrent AOM or OME. Many studies have reported that adenoidectomy has an effect on the occurrence of recurrent AOM or OME, thus reducing TT reinsertion;

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these findings are reflected in the current clinical practice guidelines in the United States. The American Academy of Otolaryngology–Head and Neck Surgery, American Academy of Pediatrics, and American Academy of Family Physicians presented the clinical practice guideline for OME in 2004, which was updated by the American Academy of Otolaryngology–Head and Neck Surgery in 2016.[5,8] In this recent guideline, adenoidectomy is not recommended for OME in the absence of a distinct indication, such as nasal obstruction and chronic adenoiditis, in children younger than 4 years of age; TT insertion, adenoidectomy, or both are recommended for OME in children aged 4 years or older.[5, 14,15]

In this study, we evaluated the effects of adenoidectomy and AT on the rate of TT reinsertion using population-based retrospective cohort data to confirm the association of adenoidectomy or AT with TT reinsertion reported in several previous studies.

MATERIALS AND METHODS

Patients

This study included data from the National Health Insurance Service National Sample Cohort in Korea, which is a 2% representative subsample of the entire National Health Insurance Service database from 2006 to 2015. From the national sample cohort data, patients between the ages of 0 and 9 years were selected if they were undergoing TT insertion; patients were divided into 3 groups as follows: group 1, TT insertion only; group 2, TT insertion with adenoidectomy; and group 3, TT insertion with AT. Patients who had previously undergone adenoidectomy or AT before TT insertion were assigned to groups 2 and 3, respectively. Patients were tracked from the time of first TT insertion through 2015. The number of TT reinsertions was compared among the groups. Patients were excluded if they exhibited congenital diseases that could influence the incidence of OM.

Patients undergoing adenoidectomy or AT after TT insertion were reassigned to groups 2 or 3, regardless of concurrent TT insertion; subsequently, patients were tracked in their reassigned groups. The analysis was performed using the number of surgeries (i.e., TT insertion, TT insertion with adenoidectomy, and TT insertion with AT) instead of the number of patients in each group; some patients underwent TT insertion several times or were reassigned to another group after adenoidectomy or AT during the study period.

MAIN POINTS

- Many studies have reported that adenoidectomy has an effect on the occurrence of recurrent acute otitis media or otitis media with effusion, thus reducing tympanostomy tube (TT) reinsertion.
- The rate of TT reinsertion was significantly lower in the TT insertion with adenoidectomy and TT insertion with adenotonsillectomy (AT) groups than the TT insertion only group in this study.
- We confirmed the effects of adenoidectomy and AT on reduction of the rate of repeated TT insertion in pediatric patients by analysis of population-based data.

The National Health Insurance Service encompasses the entire population of Korea; thus, the total number of patients in the national sample cohort represents the overall Korean population. Therefore, the results of this study are a reasonable representation of the entire Korean population.

This study was performed in accordance with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The Institutional Review Board of the authors' institution approved this study (NHIMC 2018-07-024). The requirement for written informed consent was waived by the Institutional Review Board of the authors' institution because of the retrospective nature of the study.

Data analysis

From the time of first TT insertion through 2015, the number of subsequent TT reinsertions were compared among groups 1, 2, and 3. The total number of TT insertions was used for analysis of TT reinsertion because multiple repeated TT insertions could be performed in the same patient. The analysis used claim codes for surgery and diagnostic codes from the International Classification of Diseases.

Definition of disease

Diagnostic codes from the International Classification of Diseases used in this study were Q17 (other congenital malformations of ear), Q18 (other congenital malformations of face and neck), Q30–34 (congenital malformations of the respiratory system), Q35–37 (cleft lip and cleft palate), and Q90–99 (chromosomal abnormalities, not elsewhere classified) for congenital diseases that could influence OM.

Statistical Analysis

Demographic factors were compared among groups using the chi-square test. The number of TT reinsertions was compared among groups using the chi-square test, as well as time-dependent Cox proportional hazards modeling with univariate and multivariate analyses to evaluate hazard ratios (HRs). Because some patients could undergo TT insertion several times and be reassigned to another group after adenoidectomy or AT during the study period, a time-dependent model was applied. Statistical analysis was performed using SAS 9.4 (SAS Institute, Cary, NC, USA). In all analyses, $p<0.05$ was considered to indicate statistical significance.

RESULTS

From 2006 through 2015, 745 patients (453 males and 292 females) were assigned to group 1, 115 (68 males and 47 females) were assigned to group 2, and 251 (145 males and 106 females) were assigned to group 3. The numbers of patients in group 2 significantly differed between those aged <3 years and those aged ≥3 years; numbers of patients in group 3 significantly differed between those aged <4 years and those aged ≥4 years. There were no significant differences in demographic characteristics (e.g., sex, residence, and household income) among the groups (Table 1).

There were 1,019 total TT insertions and 336 reinsertions in group 1, 169 total TT insertions and 31 reinsertions in group 2, and 343 total TT insertions and 50 reinsertions in group 3. The rates of TT reinsertion were significantly lower in groups 2 and 3 than in group 1 ($p<0.001$) (Table 2). The risks of TT reinsertion in group 2 (HR=0.544, 95% confidence interval [CI] = 0.359–0.822, p=0.0039) and group 3 (HR=0.386,

Table 1. Demographic characteristics of patients in each group

		Group 1 (TT insertion only)		Group 2 (TT insertion with adenoidectomy)		Group 3 (TT insertion with AT)		
		n	%	n	%	n	%	p
Age (years)	0-1	6	0.81	0	0.00	0	0.00	< 0.0001[1]
	1-2	67	8.99	0	0.00	0	0.00	
	2-3	64	8.59	7	6.09	5	1.99	
	3-4	78	10.47	12	10.43	14	5.58	
	4-5	101	13.56	20	17.39	47	18.73	
	5-6	121	16.24	27	23.48	65	25.90	
	6-7	126	16.91	17	14.78	64	25.50	
	7-8	80	10.74	17	14.78	30	11.95	
	8-9	50	6.71	7	6.09	17	6.77	
	9-10	52	6.98	8	6.96	9	3.59	
Sex	Male	453	60.81	68	59.13	145	57.77	0.6851
	Female	292	39.19	47	40.87	106	42.23	
Residence	Seoul (capital)	136	18.26	20	17.39	49	19.52	0.9961
	Metropolitan	165	22.15	26	22.61	55	21.91	
	City (small and medium)	391	52.48	61	53.04	127	50.60	
	County	53	7.11	8	6.96	20	7.97	
Household income[2]	0%-30% (lowest)	51	7.20	14	12.50	20	8.47	0.3225
	30%-60%	148	20.90	22	19.64	52	22.03	
	60%-90%	312	44.07	41	36.61	90	38.14	
	90%-100% (highest)	197	27.82	35	31.25	74	31.36	
Total		745	100	115	100	251	100	

AT: adenotonsillectomy; TT: tympanostomy tube.
[1]p<0.05.
[2]The sum of household income in each group is less than the total in each group because of missing values.

95% CI=0.272–0.546, p<0.0001) were significantly lower than the risk in group 1, based on univariate Cox regression analysis. The risk of TT reinsertion was significantly lower in older patients than in younger patients based on the univariate Cox regression analysis (HR=0.939, 95% CI=0.886–0.995, p=0.0342). The risks of TT reinsertion in group 2 (HR=0.559, 95% CI=0.363–0.861, p<0.0084) and group 3 (HR=0.358, 95% CI=0.248–0.516, p<0.0001) were significantly lower than the risk in group 1, based on the multivariate Cox regression analysis, after controlling for confounding factors (e.g., sex, age, residence, and household income) (Table 3).

DISCUSSION

There have been a number of studies regarding the associations of adenoidectomy or AT with repeated TT insertion. In a randomized controlled trial, Oomen et al. [16] reported that there was no effect of AT on middle ear status. However, a number of other studies indicated that adenoidectomy reduced the rate of repeated TT insertion. In a meta-analysis, Mikals and Brigger [17] reported that TT insertion with adenoidectomy could reduce the risk of repeated TT insertion in children aged ≥4 years. In a meta-analysis, Boonacker et al.[2] reported that adenoidectomy showed the greatest benefits in children aged ≥4 years with persistent OME . In a systematic review, Wallace et al. [18] reported that TT insertion and adenoidectomy reduced the duration of OME. Wang et al. [13] analyzed Taiwanese population-based retrospective cohort data; they found that adenoidectomy had a preventive effect on TT reinsertion, in comparison to TT alone, especially in children aged >4 years at the time of first TT insertion. Beyea et al. [3] reported that adenoidectomy or tonsillectomy was beneficial for reducing risk of multiple TT insertion in children aged <4 years, in addition to those aged ≥4 years, in their retrospective population-based cohort study of 193,880 patients. Hao et al. [19] reported that TT insertion with adenoidectomy was more effective in children with OME than TT insertion alone; the results were the same for children aged <4 years.

Several studies compared the effects of adenoidectomy with that of AT in terms of the rates of OM and TT reinsertion. Maw [20] reported that adenoidectomy and AT had significant effects on OME; however,

Table 2. Number of TT reinsertions in each group according to age

	Group 1 (TT insertion only)			Group 2 (TT insertion with adenoidectomy)			Group 3 (TT insertion with AT)		
Age (years)	n[1]	TT reinsertion	%	n[1]	TT reinsertion	%	n[1]	TT reinsertion	%
0-1	6	4	66.67	0	0	—	0	0	—
1-2	69	22	31.88	0	0	—	0	0	—
2-3	80	25	31.25	8	1	12.50	5	0	0
3-4	96	40	41.67	15	2	13.33	15	2	13.33
4-5	128	50	39.06	25	6	24.00	51	12	23.53
5-6	161	54	33.54	38	10	26.32	78	12	15.38
6-7	172	53	30.81	26	5	19.23	88	10	11.36
7-8	122	33	27.05	27	4	14.81	47	8	17.02
8-9	85	26	30.59	15	3	20.00	33	5	15.15
9-10	100	29	29.00	15	0	0	26	1	3.85
Total	1,019	336	32.97	169	31	18.34	343	50	14.58

AT: adenotonsillectomy; TT: tympanostomy tube.
[1]Total number of TT insertions.

Table 3. HRs for TT reinsertion in time-dependent Cox proportional hazards model with univariate and multivariate analysis

		Univariate analysis				Multivariate analysis			
		HR	95% CI		p	HR	95% CI		p
Group	Group 1 (TT insertion only)	1	1	1		1	1	1	
	Group 2 (TT insertion with adenoidectomy)	0.544	0.359	0.822	0.0039[1]	0.559	0.363	0.861	0.0084[1]
	Group 3 (TT insertion with AT)	0.386	0.272	0.546	<0.0001[1]	0.358	0.248	0.516	<0.0001[1]
Age		0.939	0.886	0.995	0.0342[1]	0.957	0.904	1.013	0.1312
Sex	Male	1	1	1		1	1	1	
	Female	0.935	0.728	1.200	0.5978	0.899	0.697	1.160	0.4123
Residence	Seoul (capital)	1	1	1		1	1	1	
	Metropolitan	1.297	0.906	1.858	0.1554	1.409	0.972	2.044	0.0705
	City (small and medium)	1.032	0.744	1.433	0.8487	1.018	0.714	1.452	0.9203
	County	0.717	0.420	1.223	0.2221	0.760	0.421	1.373	0.3636
Household income		0.954	0.838	1.085	0.4725	0.966	0.849	1.100	0.6064

AT: adenotonsillectomy; CI: confidence interval; HR: hazard ratio; TT: tympanostomy tube.
[1]p<0.05.

AT did not significantly increase the effect relative to adenoidectomy. In a randomized control trial, Paradise et al.[21] found that AT was slightly more effective than adenoidectomy for persistent or recurrent OM. However, the effects of adenoidectomy and AT were modest and persisted for 1 year in both groups. Coyte et al.[1] analyzed the hospital discharge records of 37,316 children. They reported that TT insertion with adenoidectomy and TT insertion with AT at the time of initial TT insertion significantly reduced the rates of TT reinsertion and readmission because of OM; TT insertion with AT reduced the rates of TT reinsertion and readmission to a greater extent than TT insertion with adenoidectomy. Kadhim et al.[22] analyzed 51,373 children and found that TT insertion with adenoidectomy and TT insertion with AT reduced the rate of further TT insertion. In their study, the risk of second TT insertion was slightly lower in the TT insertion with AT group than in the TT with adenoidectomy group (odds ratios = 0.43 and 0.45, respectively). Park[4] reported that TT insertion with adenoidectomy or TT insertion with AT was effective in reducing the rate of TT reinsertion; moreover, the rate of repeated TT insertion was significantly lower in the TT insertion with AT group than in the TT insertion with adenoidectomy group. Overall, the effect of AT on OM and TT reinsertion was comparable to or greater than that of adenoidectomy in many studies; however, the increase was slight in several studies. Therefore, tonsillectomy is not recommended to reduce the rate of repeated TT insertion unless there are definite indications, considering the risks of postoperative complications and additional costs.

Analysis of risk factors revealed that younger age was a risk factor for TT reinsertion. Klopp-Dutote et al.[23] reported that age <4 years at TT insertion was a significant risk factor for serous OM recurrence. The higher risk of TT reinsertion in younger children is attributed to the frequency of OME and recurrent AOM in younger children.

The reduction in the rate of Eustachian tube occlusion with adenoid hypertrophy and removal of biofilm as a source of infection are presumably responsible for the reduced risk of OM after adenoidectomy or AT. Biofilms are organized complex communities of metabolically quiescent bacteria attached to surfaces[4, 6]; they contribute to the onset of chronic adenotonsillitis and OM.[4] The adenoid is located in the nasopharynx; adenoid hypertrophy can influence the occurrence of OM because of its occlusion of the nasopharyngeal Eustachian tube orifice. The reduced rate of multiple TT insertions after AT can be attributed to improved Eustachian tube function and reduction of bacterial burden in the nasopharynx and oropharynx.[3]

However, Park[4] reported that adenoid size was not associated with the occurrence of OME. The benefits of adenoidectomy are related to improvements in nasopharyngeal microflora after the removal of pathogenic bacteria in biofilm with adenoid tissue, rather than reduction in adenoid volume.[5] Skoloudik et al.[14] reported that the relationship between the adenoid and torus tubarius was more important than the size of the adenoid in OME. Els et al.[24] reported that adenoid hypertrophy in lateral postnasal radiographs and OME were not correlated; moreover, the biofilm may be associated with the development of OME. OM may be related to infection not only in the nasopharynx but also in the oropharynx; thus, AT may be more effective against recurrent AOM and OME than adenoidectomy alone.[21] Therefore, additional tonsillectomy could reduce the source of bacteria to a greater extent relative to adenoidectomy alone. Although several studies indicated that AT was more effective than adenoidectomy alone in reducing the rate of repeated TT insertion, the additional effect was minimal; the risks, complications (e.g., hemorrhage), and costs of tonsillectomy should also be considered. Thus, additional tonsillectomy should be recommended only when there are other definite indications (e.g., obstructive sleep disordered breathing and frequent throat infection with specific signs).

This study had several limitations. First, claim codes for TT insertion, adenoidectomy, and AT were used; individual medical records could not be reviewed. However, patients undergoing surgery had claim codes for each surgery, thus ensuring the accuracy of the data. Because claim codes for surgery were more accurate than diagnostic codes and we focused on the effects of adenoidectomy or AT on TT reinsertion, we used claim codes for surgery in this study. Second, we could not compare the rate of TT reinsertion between older and younger age groups because the numbers of cases of TT insertion with adenoidectomy and of TT insertion with AT were small in patients aged <4 years. Third, adenoidectomy or AT was not performed simultaneously with TT insertion in some patients. However, we included all of these patients to investigate the effects of concurrent and subsequent adenoidectomy or AT on TT reinsertion. Although there have been several studies regarding the association between adenoidectomy or AT and TT reinsertion, we performed the analyses using population-based cohort data from our country to confirm the previously reported relationships.

CONCLUSION

The rate of TT reinsertion was significantly lower in the TT insertion with adenoidectomy and TT insertion with AT groups than the TT insertion only group. We confirmed the effects of adenoidectomy and AT on reduction of the rate of repeated TT insertion in pediatric patients by analysis of population-based data.

Ethics Committee Approval: This study was performed in accordance with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The Institutional Review Board of the authors' institution approved this study (NHIMC 2018-07-024).

Informed Consent: Informed consent is not necessary due to the retrospective nature of this study.

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Conflict of Interest: The authors have no conflict of interest to declare.

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