

Original Article

Tonsillotomy is comparable to tonsillectomy in the management of children with obstructive sleep-disordered breathing

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Received May 2, 2016; Accepted September 26, 2016; Epub November 15, 2016; Published November 30, 2016

Abstract: The study was to compare the long term efficacy of tonsillotomy (TT) and tonsillectomy (TE) in children with obstructive sleep-disordered breathing (OSDB) and explore the risk factors of recurrent snoring. In the prospective non-randomized study, 65 children with OSDB underwent TE, while the other 50 children with OSDB underwent TT. Humoral (IgG, IgA and IgM) and cellular immunity (T cell and B cell) were tested preoperatively and 12 months postoperatively. The long-term outcome of the patients in each group was compared 12 months postoperatively. IgG, IgM, IgA, T-cell ratio and B-cell ratio were not significantly different between the TT group and the TE group pre- and post-operatively. The TT group had significantly lower incidence of postoperative pain than the TE group. There were not significant differences in the incidence of recurrent tonsillitis, recurrent snoring, revision surgery, and tonsillar hyperplasia between the two groups postoperatively. The incidences of allergy history and recurrent upper respiratory tract infection were significantly higher in the children with recurrent snoring than the asymptomatic children postoperatively. TT is comparably effective to TE in the children with OSDB. History of allergy and recurrent upper respiratory tract infection might be risk factors of snoring relapse postoperatively.

Keywords: Hypertrophic tonsils, obstructive sleep-disordered breathing, tonsillitis, tonsillotomy, tonsillectomy, immunological function

Introduction

Obstructive sleep-disordered breathing (OSDB) is defined as a spectrum of breathing disorders during sleep with habitual and loud snoring, and upper airway obstruction as special features [1]. One of its primary causes is adenotonsillar hypertrophy [2]. Tonsillectomy (TE) refers to complete removal of tonsillar tissue from the tonsillar fossa and is one of most common surgeries for OSDB [3]. Besides, TE has also been reported to completely remove tonsillar tissue in children with obstructive sleep apnea syndrome (OSAS) due to recurrent tonsillitis [4].

Tonsillotomy (TT) or partial TE reducing the tonsil hypertrophy to remove the airway obstruction, has been proposed as an alternative procedure to TE. It has been proved that TT results in less postoperative pain, better food intake

and earlier recovery of normal diet in children with OSAS compared to TE [5, 6]. Long-term follow-up survey (10 years) also evidences that TT is an valid alternative procedure to TE [7]. Likewise, there is evidence that partial TE is comparable to total TE for removing airway obstruction in children with obstructive sleep apnea hypopnea syndrome (OSAHS) [8]. Furthermore, TT using endoscopic microdebrider is reported to be as effective to reduce intracapsular tonsil as conventional TE in the treatment of OSDB. It leads to less postoperative pain and earlier return to normal life [9]. However, there is another voice speaking that compared with TE, TT might put children with OSAS at higher risk of recurrent tonsillar hypertrophy postoperatively [10, 11]. In light of these discordant findings, more studies are in need to study and compare TT and TE in order to provide guidance for clinical practice.

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This prospective non-randomized study was conducted to compare TT with TE in the management of children with OSDB as a result of hypertrophic tonsils. The children were followed up for 12 months to evaluate the long-term efficacy of TT and TE. Possible factors related to postoperative snoring relapse was also investigated. Additionally, it has been found that partial TE does not appear to affect the humoral and cellular immunity of children with OSAHS [12]. Therefore, serological examination was performed to measure serum immunoglobulin levels (IgG, IgA and IgM), T cell and B cell preoperatively and postoperatively. The study would offer more useful guidance on clinical application of TT and TE.

Methods

Patients

This prospective non-randomized study was conducted in Nanjing Pediatric Hospital affiliated to Nanjing Medical University and approved by local Ethics Committee. Sixty-five children who suffered from OSDB with obstructive hypertrophic tonsils underwent TE in the hospital from July 2011 to December 2011. The 65 children were defined as TE group including 21 females and 44 males with a median age of 5 years old (interquartile range, 4-5.5). Besides, 50 children suffering from OSDB underwent TT in the same hospital from January 2012 to June 2012 and were defined as TT group. The TT group included 24 females and 26 males with a median age of 6 years old (interquartile range, 4-6.25).

These patients in the TT and TE groups had signs and syndromes of OSDB, such as history of snoring for 3 months or longer [13, 14], mouth breathing, intermittent sleep apnea and restless sleeping with tonsillar hypertrophy. Children with adenoidal hypertrophy, recurrent tonsillitis, peritonsillar abscess formation or suspected tonsillar tumor were excluded from the survey. The degree of tonsil hypertrophy was scored from 1+ to 4+ based on the decreased percentages in pharyngeal lumen diameter [15-17]: 1+, 0-25%; 2+, 26-50%; 3+, 51-75%; 4+, 76%-100%. All patients in the study had tonsil hypertrophy scored 3-4+ preoperatively. Parents of these enrolled children agreed with the survey and offered written informed consent.

Surgical technique

TE or TT surgery was conducted using plasma radiofrequency knife (Evac 70 Xtra HP, ArthroCare Company, USA) with Micro Power Systems (Medtronic Company, USA) [18, 19]. TT and TE procedures were performed by experienced surgeons (≥ 5 year experience). During the TT procedure, the reduced volume of tonsillar tissue in each child was decided by the surgeons based on the preoperative size of enlarged tonsillar tissue. Approximately a third to a half of the tonsillar tissue was resected to remove the airway obstruction, which was in accordance with a previous study [20]. The tonsils were completely removed during the TE procedure.

Serology test

A peripheral blood sample of 4 mL was taken from each child preoperatively and 12 months postoperatively. Serum IgG, IgA and IgM was assayed by Rate scatter nephelometry using BNII automated protein analyzer (SIEMENS, Germany). T cell and B cell in blood sample were measured by flow cytometry (Becton, Dickinson and Company, UAS). T-cell and B-cell ratio was defined as the ratio of total T cell or B cell in total lymphocytes.

Follow-up

Postoperative pain and hemorrhage were recorded immediately after the surgery. Twelve months following the surgery, these children returned to the hospital for review. Under the guidance of doctors, the children or their parents were required to answer questions concerning the following terms: family history of allergies developing eczema, asthma and allergic rhinitis; recurrent upper respiratory tract infection preoperatively (≥ 6 times a year); recurrent tonsillitis postoperatively; tonsil hyperplasia (protruding over the pharyngopalatine arch); snoring; revision surgery. The parents of the children understood these questions correctly. No patient was lost in the follow-up.

Statistical analysis

IBM SPSS 19 software was used for statistical analysis. Mann-Whitney test was used for comparison of non-normally distributed data. Categorical data between the two groups was compared by Pearson chi-square test or Fi-

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Table 1. Baseline data of patients in TT and TE groups

		TT	TE	χ^2 or Z-value	P-value
Median age (interquartile range)		5 (4-5.5)	6 (4-6.25)	1.702	0.089
Gender	Female	24	21	2.922	0.081
	Male	26	44		
History of allergy	No	31	41	0.014	0.906
	Yes	19	24		
History of recurrent upper respiratory tract infection	No	46	59	0.000	1.000
	Yes	4	6		
IgG	Normal	46	55	1.441	0.230
	Abnormal	4	10		
IgA	Normal	47	63	0.581	0.446
	Abnormal	3	2		
IgM	Normal	47	61	0.001	0.973
	Abnormal	3	4		
T cell ratio	Normal	37	50	0.131	0.717
	Abnormal	13	15		
B cell ratio	Normal	42	55	0.008	0.928
	Abnormal	8	10		

Non-normally distributed data were expressed as medium (Interquartile range). TT, tonsillotomy; TE, tonsillectomy.

sher's exact test continuity correction test if appropriate. $P < 0.05$ suggested significant difference.

Result

Baseline characteristics of the patients in the TE and TT groups

Baseline characteristics of the TE and TT groups were summarized in **Table 1**. The TE group (n=65) consisted of 21 females and 44 males, while the TT group included 24 females and 26 males. The two groups had no significant difference in gender ($P = 0.087 > 0.05$). The median age of the TT and TE groups was 5 years old (interquartile range, 4-5.5) and 6 years old (interquartile range, 4-6.25), respectively. There was also no significant difference in the mean age between the two groups ($P = 0.089 > 0.05$). Differences of history of allergy and recurrent upper respiratory tract infection between the two groups did not reach significance ($P = 0.906$; $P = 1.000$). The two groups also did not have significant difference in pre-operative humoral immunity (IgG, IgA and IgM) and cellular immunity (T-cell and B-cell).

Immediately postoperative complications

Postoperative pain was reported in 13 (20%) cases of the TE group and 3 (6%) cases of the

TT group. The incidence of postoperative pain was significantly higher in the TE group than that in the TT group ($P = 0.032 < 0.05$). Post-operative hemorrhage occurred in 3 (4.61%) cases of the TE group and no case of the TT group. No significant difference was observed in the incidence of postoperative hemorrhage between the two groups ($P = 0.124 > 0.05$).

Follow-up 12 months postoperatively

These patients were checked 12 months post-operatively (**Table 2**). In the TE group, all patients had tonsil hypertrophy scored 1+ post-operatively, 5 of which reported snoring, but they did not require revision surgery. In the TT group, 6 children reported snoring. All but 4 patients had tonsil hypertrophy scored 1+ post-operatively. The 4 patients had tonsillar hyperplasia scored 2-4+, 2 of which were 3-4+ and needed revision surgery. As shown in **Table 2**, differences were not significant in the incidences of recurrent tonsillitis postoperatively, tonsillar hyperplasia (2-4+), recurrent snoring and revision surgery between the TT group and the TE group ($P > 0.05$).

Humoral and cellular immunity of children post-operatively

In order to detect whether TT or TE affected the humoral immunity of children, IgG, IgA and IgM

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Table 2. Summary of the follow-up 12 months post-operatively

Parameter	TE (n=65)		TT (n=50)		P-value
	Yes	No	Yes	No	
Recurrent tonsillitis	0	65	2	48	0.187
Tonsillar hyperplasia	0	65	4	46	0.071
Snoring	5	60	6	44	0.646
Revision surgery	0	65	2	48	0.187

TT, tonsillotomy; TE, tonsillectomy. Tonsillar hyperplasia: score 2-4+.

Table 3. Humoral and cellular immunity in TT and TE groups 12 months postoperatively

		TT	TE	χ^2	P-value
IgG	Normal	48	58	1.795	0.18
	Abnormal	2	7		
IgA	Normal	45	60	0.19	0.663
	Abnormal	5	5		
IgM	Normal	49	62	0.576	0.448
	Abnormal	1	3		
T cell ratio	Normal	40	55	0.419	0.517
	Abnormal	10	10		
B cell ratio	Normal	45	58	0.018	0.894
	Abnormal	5	7		

TT, tonsillotomy; TE, tonsillectomy.

in serum was assayed 12 months postoperatively. The age of children in both groups ranged from 2 to 12 years old. The normal value of IgG, IgA and IgM for 2-6-year-old children was 6.6-10.39 g/L, 0.58-1 g/L and 1.1-1.8 g/L, respectively. The normal value of IgG, IgA and IgM for 7-12-year-old children was 7.91-13.07 g/L, 0.85-1.71 g/L and 1.2-2.26 g/L, respectively. Based on the normal values of IgG, IgA and IgM in serum of different age groups: 2-6 years and 7-12 years (**Table 3**), the serological results of these parameters were divided into 3 categories: above, below or within the normal range. As shown in **Table 3**, there was no significant difference in IgG, IgA and IgM between the TT group and the TE group 12 months postoperatively ($P>0.05$).

In order to detect the cellular immunity of patients, T-cell and B-cell ratio of patients was also compared between the TT group and the TE group. Based on the normal value of T cell ratio and B cell ratio (59-84%; 7-22%), the children were divided into 3 categories: above, below or within the normal ranges. Difference

was not significant in the T cell ratio and the B cellratio between the two groups post-operatively ($P>0.05$, **Table 3**).

Factors associated with recurrent snoring

We further attempted to evaluate the factors associated with postoperative recurrent snoring (**Table 4**). In the 104 children without recurrent snoring, 34 (32.7%) had history of allergy and 3 (2.9%) had history of recurrent upper respiratory tract infection. In contrast, in the 11 children with snoring, 9 (81.8%) had history of allergy and 7 (63.6%) had recurrent upper respiratory tract infection. The snoring patients had significantly increased incidences of history of allergy and recurrent upper respiratory tract infection than the asymptomatic patients ($P=0.004$; $P=0.000$).

Discussion

TE has a long history of development dating back to ancient Greece BC [21]. It has been increasingly recognized as an effective treatment for tonsil enlargement-induced OSAS [4]. However, TE has a few disadvantages including heavy postoperative hemorrhage and pain, high cost of surgery, difficulties in food intake postoperatively and loss of lymphoid organs [22-24]. For children with OSAS, TT has been proposed as a superior procedure over TE because it not only removes airway obstruction but also reservestonsillar tissue remnants [25]. The present study aimed to compare the long term efficacy of TT and TE in children with OSDB, and explore the risk factors of recurrent snoring postoperatively. The study found that TT was a valid alternative to TE in children with OSDB.

TT surgery has several disadvantages. For instance, varied incidence of relapsing tonsillar hyperplasia has been reported after TT, often with concomitant upper respiratory tract obstruction as a cause of subsequent surgery [23, 26]. Moreover, the tonsillar tissue remnants after TT might result in peritonsillar abscesses [27]. We should mention that there are also multiple advantages of TT over conventional TE. TT brings in decreased risk of postoperative haemorrhage, less postoperative pain and faster recovery to normal diet and activities [5, 6]. In line with this finding, the study found that the TT group had markedly de-

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Table 4. Investigation on factors associated with snoring relapse postoperatively

Parameter	Snoring children (n=11)		Asymptomatic children (n=104)		P-value
	Yes	No	Yes	No	
History of allergies	9	2	34	70	0.004
History of recurrent Upper respiratory tract infection	7	4	3	101	0.000

creased incidence of postoperative pain than the TE group. Postoperative haemorrhage occurred only in the TE group (3 cases). However, the incidence of postoperative haemorrhage was insignificantly different between the two groups. It might be due to limited sample size of this study.

Follow up analysis unveiled that there were insignificant differences between the two groups in the incidences of recurrent tonsillitis postoperatively, recurrent snoring, revision surgery and hyperplasia of the tonsils. It suggests that TT is as effective as TE in the management of children with OSDB. Similarly, Eviatar *et al.* have also demonstrated no significant discrepancy in recurrent tonsillitis, recurrent obstruction and snoring between the TT and TE groups in 10 years postoperative follow-up [7]. Moreover, the current study showed that regardless of surgery type, the incidences of history of allergy and recurrent upper respiratory tract infection were significantly elevated in the patients with snoring compared to the asymptomatic patients postoperatively. It suggests that history of allergy and recurrent upper respiratory tract infection might be risk factors of postoperative snoring relapse. Likewise, upper respiratory tract infections and history of allergy have been reported to be risk factors of postoperative tonsillar regrowth [8]. There is a rich body of evidence that bacteria located in tonsil core and allergy are associated with the development of tonsillitis and tonsillar hypertrophy [28, 29]. TE should be recommended for children with tonsillar hypertrophy and concomitant frequent respiratory tract infection or allergy history.

Increasing studies have suggested that the difference of postoperative immunological function of children is not significant between TT and TE [23, 30]. The study also showed that IgG, IgM, IgA, T cell ratio and B cell ratio were not significantly different between the TT group

and the TE group before and one year after surgery. These evidences lead to a conclusion that TT or TE does not affect the immunological function of children in long term. Recently, it has been reported that the cellular immunity of children with OSAHS does not differ between partial TE and total TE pre- and post-operatively, but the IgG, IgM and IgA is markedly reduced 1 month after TE but slightly reduced 1 month after TT, and then increased to normal levels 3 months after TE or TT [12]. Nonetheless, another study reported that the levels of IgG, IgM, IgA, C3 and C4 are not significantly different 1 month postoperatively between partial TE and total TE in children with OSAHS [8]. These paradoxical results might be attributed to small sample size of these studies. The study only compared IgM, IgA, T-cell ratio and B-cell ratio 12 months postoperatively. Future studies would choose more time points in a large number of patients. Another limitation of the study is that it is not a randomized study. Further randomized study is warranted to verify the results of the study.

Collectively, the study suggests that TT is comparably valid to TE for treating OSDB and causes decreased incidence of postoperative pain. Therefore, TT is recommended as a viable option for the children with OSDB, especially for those who are extraordinarily sensitive to postoperative pain. History of allergy and recurrent upper respiratory tract infection might be risk factors of postoperative snoring relapse.

Disclosure of conflict of interest

None.

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