

A questionnaire-based comparative study of postoperative quality of life between laryngotracheal separation and tracheoesophageal diversion

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Purpose Whether tracheoesophageal diversion (TED) is preferable to laryngotracheal separation (LTS) is unclear. This study examined the need for tracheoesophageal anastomosis by reviewing complications after TED and LTS and administering a questionnaire on postoperative quality of life.

Patients and methods Medical records of TED/LTS cases performed at a single institution from 2003 to 2015 were retrospectively reviewed and a questionnaire was administered to parents of patients at an outpatient visit.

Results A total of 40 TED and 18 LTS cases were included. Complications occurred in six TED cases and one LTS case, with no significant differences between groups ($P = 0.42$). A total of 22 parents of patients (TED 16 cases; LTS six cases) completed the questionnaire. Voice production was reported in three TED cases and two LTS cases. Patients indicated that suctioning was 'decreased' in 13 and 'unchanged' in two TED cases, but 'decreased' in one and 'unchanged' in five LTS cases ($P = 0.0055$). Readmissions

were 'increased' in one and 'decreased' in 14 TED cases, but 'decreased' in three and 'unchanged' in three LTS cases ($P = 0.015$).

Conclusion Postoperative complication rate was equivalent between groups, and the numbers of suctioning and readmissions were decreased in the TED group. Therefore, tracheoesophageal anastomosis should be performed more commonly. *Ann Pediatr Surg* 14:47–50 © 2018 Annals of Pediatric Surgery.

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Introduction

Impaired swallowing function, which is frequently associated with neurologically impaired children, causes intractable aspiration pneumonia that requires frequent hospitalization, deteriorates the family's quality of life (QOL), and sometimes is fatal. Tracheoesophageal diversion (TED) [1] and its modified procedure, laryngotracheal separation (LTS) [2], were introduced by Lindeman [1] and were preferably performed as an antiaspiration procedure in pediatric patients. Both procedures can control aspiration completely by separating the alimentary tract from the respiratory tract, but it is unclear as to which is favorable, TED or LTS. TED is technically more complicated and its operative time is longer than that of LTS as TED requires tracheoesophageal anastomosis. However, there are concerns with LTS related to food or secretion pooling in the blind end of the proximal trachea, which could cause halitosis or significant coughing [3]. In addition, TED theoretically allows phonation by esophageal speech but LTS sacrifices phonation.

The aim of this study was to examine the need for tracheoesophageal anastomosis by retrospectively reviewing early postoperative complications and administering a postoperative QOL questionnaire to parents at a clinic visit.

Patients and methods

Medical records of patients who underwent TED or LTS at our institution from October 2003 to June 2015

were retrospectively reviewed and data on the patients' primary disease, surgical procedure (TED or LTS) performed, age at surgery, pre-existing tracheotomy, and early (within 30 days) postoperative complications were collected. A questionnaire on postoperative QOL was administered to parents (Table 1) by outpatient clinicians at a regular clinic visit from July 2015 to November 2015. Patient consent was confirmed by the fact that they answered the questionnaire.

The details of the TED and LTS procedures are similar to the methods introduced by Lindeman and colleagues [1,2]. TED is our standard procedure, but LTS is performed when there is a concern about failure of the tracheoesophageal anastomosis due to malnutrition or in which a tension-free tracheoesophageal anastomosis would seem to be difficult due to severe scoliosis or a pre-existing high tracheotomy.

Statistical analysis was performed using the Wilcoxon rank-sum test for nonparametric data, or Fisher's exact test for contingency tables, using commercially available software (JMP Pro 11.0.0; SAS Institute Japan Ltd., Tokyo, Japan). Those who did not answer the questionnaire were excluded from each contingency table analysis. P value less than 0.05 were considered to be statistically significant.

This retrospective observational study was approved by the Research Ethics Committee of the Graduate School of Medicine and Faculty of Medicine. The University of Tokyo (protocol no. 2996-1).

Table 1 Questionnaire on postoperative quality of life for parents

	Question	Answer
Q1	Did your child produce a sound before surgery?	Yes/No/Not sure
Q2	Does your child produce a sound at present?	Yes/No
(To the parent who answered 'Yes' for the Q2)		
Q2-a	Is the sound intentionally produced?	Yes/No/Not sure
Q2-b	Is the sound used as a communication tool or a barometer for child's health condition?	Yes/No
Q3	How has your child's halitosis changed after surgery?	Improved/Worsened/Unchanged
Q4	Did the surgery make it possible to take something orally?	Yes/No/Unchanged
(To the parent who answered 'Yes' for the Q4)		
Q4-a	Are you aware that food residue was suctioned from the mouth sometime after oral intake?	Yes/No/Not sure
Q5	How has your child's salivation changed after surgery?	Increased/Decreased/Unchanged
Q6	How has the total number of oral, nasal, and tracheal suctionings changed?	Increased/Decreased/Unchanged
Q7	How has the number of readmissions changed after surgery?	Increased/Decreased/Unchanged
Q8	Are you satisfied with the surgery?	Satisfied/Slightly satisfied/Neither/Slightly dissatisfied/Dissatisfied

Table 2 Patients' characteristics

	TED (N=40)	LTS (N=18)	P value
Primary disease			
Neurologically impaired	34	13	0.5271
Myopathy	3	2	
Chromosomal abnormality	1	2	
Others	2 ^a	1 ^b	
Age at surgery (months)	163.5 (9–369)	167.5 (6–428)	0.66
Pre-existing tracheotomy [n (%)]	20 (50)	8 (44)	0.78
Postoperative complications [n (%)]	6 (15)	1 (6)	0.42
Surgical site infection	4	0	
Failure of tracheoesophageal anastomosis	1	0	
Granulation at tracheostomy orifice	1	0	
Postoperative hemorrhage	0	1	

Data are shown as median (range).

LTS, laryngotracheal separation; TED, tracheoesophageal diversion.

^aCornelia de Lange syndrome one case, arthrogyriposis one case.

^bShprintzen–Goldberg syndrome one case.

Results

A total of 58 patients (TED 40 cases; LTS 18 cases) were included in this study. Patients' characteristics and postoperative complications are shown in Table 2. Backgrounds of the patients – that is, primary disease, age at surgery, and pre-existing tracheotomy – were similar between the two groups. Postoperative complications occurred in six (15%) TED cases [surgical site infection (SSI) in four cases; failure of tracheoesophageal anastomosis in one case; granulation at the tracheostomy orifice in one case] and one LTS case (6%; postoperative hemorrhage). A cure was achieved through local care and antibiotics in three of the SSI cases and the case with failure of tracheoesophageal anastomosis, but in the remaining SSI case dehiscence of the tracheocutaneous anastomosis resulted, which required reanastomosis. Granulation or postoperative hemorrhage resolved with conservative care in those affected patients. The incidence of complications and the ratio of pre-existing tracheotomy were not significantly different between the two groups ($P=0.42$ and 0.78 , respectively).

Many of the patients who underwent TED or LTS at our hospital were followed at referral hospitals, but 22

patients regularly visited our clinic and their parents completed the questionnaire (TED 16 cases; LTS six cases). The results of the questionnaire are shown in Table 3. Voice production was seen in three of the 16 (19%) TED cases and two of the six (33%) LTS cases. Voice was used as a communication tool or a barometer for the child's health condition in all cases except for one LTS case. The number of daily suctionings, which included oral, nasal, and tracheal suctioning, were indicated as 'decreased' in 13 and 'unchanged' in two of the TED cases, but 'decreased' in one and 'unchanged' in five of the LTS cases ($P=0.0055$). The number of admissions after surgery was 'increased' in one and 'decreased' in 14 of the TED cases, but 'decreased' in three and 'unchanged' in three of the LTS cases ($P=0.015$). There were no significant differences in impact of the procedures on halitosis, oral intake, and salivation as well as postoperative satisfaction between the two groups.

Discussion

In this study, the need for tracheoesophageal anastomosis was assessed by comparing the complications and postoperative QOL between TED and LTS. First, the complication rates in the TDS group (15%) and the LTS group (6%) were equivalent. There has been concern over increased risks for complication in TDS, as that procedure is more complicated compared with LTS. However, no study has compared the complication rates between the TDS and LTS. The complication rates after LTS or TDS were reported to range from 2.5 to 43% [4–10]; therefore, our results for these procedures were satisfactory. A pre-existing tracheotomy is said to increase the risk for complications [5–7,10], but it did not affect our results as the percentages of patients with a prior tracheotomy were not statistically different between groups.

Second, as for the frequency of suctioning of secretions, no study has compared the frequency of suctioning between TDS and LTS, but several studies showed that both procedures resulted in a decrease in the number of

Table 3 Results of the questionnaire for parents

			TED* (N = 16)	LTS† (N = 6)	P value
Child's age at time of questionnaire			175 (102 to 311) mo	243.5 (93 to 305) mo	0.40
Period after surgery			61.5 (4 to 144) mo	49.5 (11 to 106) mo	0.94
Question	Answer		TED	LTS	P value
Q1	Phonation before surgery	Yes/No/Unanswered	7/8/1	6/0/0	0.0456
Q2	Phonation at present	Yes/No	3/13	2/4	0.5853
Q2-a	Intentional phonation	Yes/No	2/1	2/0	–
Q2-b	Used for communication	Yes/No	3/0	1/1	–
Q3	Halitosis after surgery	Improved/Worsened/Unchanged	1/2/13	0/0/6	0.5214
Q4	Oral intake possible	Yes/No/Unchanged	9/0/7	3/0/3	1.0
Q4-a	Suction of food residue	Yes/No/Unanswered	1/7/1	0/3/0	1.0
Q5	Salivation after surgery	Increased/Decreased/Unchanged	3/3/10	1/1/4	0.9838
Q6	Number of suction	Increased/Decreased/Unchanged/Unanswered	0/13/2/1	0/1/5/0	0.0055
Q7	Number of readmissions	Increased/Decreased/Unchanged/Unanswered	1/14/0/1	0/3/3/0	0.015
Q8	Satisfaction rating	Satisfied/Slightly satisfied/Neither/Slightly dissatisfied/Dissatisfied/Unanswered	14/0/1/0/0/1	6/0/0/0/0/0	1.0

Data are shown as median (range).

*TED: tracheoesophageal diversion; †LTS: laryngotracheal separation.

suctions [4,5,11]. However, in the current study, the number of suction as noted by parents in the questionnaire was decreased in most of the patients who underwent TED, but remained unchanged in most of the patients who underwent LTS. The reason was unclear, but the question in our questionnaire included oral, nasal, and tracheal suctioning. This wording might be considered a little vague and has affected the results. One parent actually answered that the number of tracheal suction had increased but that the number of nasal and oral suction had decreased (this case was classified as 'unanswered' as we could not determine whether the total number of suction had decreased or increased).

Third, the number of readmissions after surgery was indicated to have decreased in most of the patients in the TED group, but was unchanged in half of the patients in the LTS group. These procedures theoretically enable complete control of aspiration and their efficacy – that is, reduction of readmission for aspiration pneumonia has been reported [4–6]. Although in the LTS group three parents indicated that the number of readmissions had been 'unchanged', one of these children had been admitted several times for treatment of infected decubitus and associated myelitis, and the second case, a patient with 18 trisomy, had been admitted for epilepsy, respiratory failure, and vomiting after surgery. The third case had been admitted for Botox injection for severe scoliosis and preparation to introduce home mechanical ventilation. Aspiration was not the reason for postoperative readmission in these patients. The focus of the present study was the postoperative QOL by each procedure. Thus, all readmissions irrespective of the reason were assessed. Postoperative readmission only by respiratory infection would be helpful for revealing the postoperative status of each procedure.

Although TED allows postoperative phonation theoretically, these anti-aspiration procedures (i.e. both TED and LTS) usually sacrifice phonation. This issue is very serious for parents and often makes their decision for the child to undergo the procedure difficult. Three (19%) cases in the TED group could produce a sound and the parents used it

as a barometer for the child's health condition. Surprisingly, two (33%) cases in the LTS group also could produce a sound, and each parent felt the phonation was intentional. More surprisingly, one of the patients, whose primary disease was Shprintzen–Goldberg syndrome, could blow bubbles through a straw but the mechanism was unclear. It may support and benefit parents who are reluctant for their children to undergo these surgeries to introduce these cases during their decision making.

One of the concerns about LTS is pooling of secretions or food residue in the subglottic pocket, which is formed by closure of the proximal end of the divided trachea without anastomosis. A case with significant coughing triggered by food pooling in the pocket was reported [3]. On the contrary, Yamana *et al.* [8] reported that neither halitosis nor irritable coughing due to pooled secretions in the blind pouch occurred among their patients who underwent LTS. In addition, they confirmed by barium swallow radiography that the accumulated secretions drained from the pouch within 40 min by swallowing or changing patient's posture [8]. Baron *et al.* [12] also claimed that such pooling was not a problem as the secretions simply flow out when the patient lies down. We also observed no patients with problems related to subglottic pooling such as worsened halitosis nor suctioning of food residue after the LTS procedure.

One of the limitations of this study is the small number of patients, as well as participants in the questionnaire survey, because the majority of patients who underwent these procedures were unexpectedly followed by referral hospitals. The questionnaire, which was conducted face to face, could result in bias. If the survey had been conducted in an anonymous manner, the results might have been different. Selection bias could also exist as this was not a randomized prospective study. Indeed, LTS was performed in cases with malnutrition or severe scoliosis, which might have affected the results.

In conclusion, no problems related to pooling in the blind end of the proximal trachea were observed in the LTS group. The postoperative complication rates were equivalent between the TED and LTS groups, and some patients after LTS as well as TED could

produce sounds. However, the numbers of suction and readmissions were decreased in the TED group. Therefore, tracheoesophageal anastomosis (i.e. TED) should be performed more commonly.

Conflicts of interest

There are no conflicts of interest.

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