

Tracheoesophageal diversion *versus* total laryngectomy for intractable aspiration

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Abstract

This study evaluates the outcome and surgical stress associated with surgery for intractable aspiration. A retrospective review was conducted to compare the results between tracheoesophageal diversion and total laryngectomy. The operative time, intra-operative bleeding, time until drain removal, feeding conditions and surgical complications were compared between the two groups. Of the 19 patients, 31.6 per cent underwent tracheoesophageal diversion and 68.4 per cent received total laryngectomy. The operative time and drain insertion periods were statistically shorter in the tracheoesophageal diversion group, while the amount of intra-operative blood loss was smaller in the tracheoesophageal diversion group. The complication rate and the feeding conditions before and after surgery for the two groups did not show any statistically significant difference. Tracheoesophageal diversion was thus found to be a simple, safe, and reliable therapeutic modality for the control of intractable aspiration. Moreover, it induced less surgical stress than total laryngectomy.

Key words: Aspiration; Laryngectomy; Trachea; Oesophagus/surgery

Introduction

Intractable aspiration can cause life-threatening pulmonary infections. It usually results from a loss of laryngeal protective function due to an impairment of the laryngeal motor activity and/or sensation.¹ Tracheotomy and the insertion of a tracheal cannula fitted with a balloon cuff has been used to secure the airway and prevent aspiration of food, but this method is still inadequate and only palliative. In addition, several radical therapeutic procedures have been described for the control of intractable aspiration.^{2–6} The procedure should be simple and definitive because patients with intractable aspiration usually have an impaired respiratory function and their general condition is poor. Total laryngectomy is a reliable procedure for the definitive separation of the upper digestive and respiratory tracts.^{2,3} Tracheoesophageal diversion, however, has been reported to be a promising alternative surgical procedure for intractable aspiration.^{4,5} However, there have been few reports demonstrating the optimal therapeutic modalities for the control of intractable aspiration.

We performed total laryngectomy on 13 patients from 1991 to 1998, and tracheoesophageal diversion on six patients from 1999 to 2003. In this study; the outcomes of total laryngectomy were compared with

those of tracheoesophageal diversion for the treatment of intractable aspiration.

The findings are reported as a retrospective study regarding the following measures: operative data (operative time, intra-operative bleeding, time until drain removal), outcome (aspiration, changes in nutrition status), and complications.

Materials and methods

Nineteen patients who underwent total laryngectomy or tracheoesophageal diversion between August 1991 to March 2003 at Yokohama Municipal Citizen's Hospital were reviewed. Table I lists the medical problems associated with intractable aspiration for which we performed either total laryngectomy or tracheoesophageal diversion. All surgical procedures were performed under general anaesthesia.

Total laryngectomy was performed to preserve the maximal amount of hypopharyngeal mucosa and oesophageal mucosa to facilitate a complication-free closure. A suction drain was placed in the wounds of all patients.

The surgical techniques for tracheoesophageal diversion have been well described by Eisele *et al.*^{1,7} Briefly, the trachea is divided horizontally between the fourth and the fifth tracheal rings. The proximal tracheal segment is anastomosed in an end-

TABLE I
CAUSES OF ASPIRATION IN 19 PATIENTS TREATED WITH SURGERY

Disorder	Number of patients	
	Total laryngectomy	Tracheoesophageal diversion procedures
Cerebrovascular accidents		1
Degenerative neurologic disorders		
ALS	10	1
OPCA	3	
Metabolic CNS disorders		1
Cerebral palsy		3
Total	13	6

ALS = amyotrophic lateral sclerosis; OPCA = olivopontocerebellar atrophies; CNS = central nerve system

to-side fashion to anterior oesophagotomy. The distal tracheal segment is brought out to the skin as a tracheostoma. Three of six patients who had undergone prior tracheotomy were indicated to have a modification of tracheoesophageal diversion described by Krespi *et al.*⁸ In this modification procedure, the trachea is divided horizontally between the second and the third tracheal rings or at the level of a pre-existing tracheostomy. The inferior half of the cricoid, as well as the first and second tracheal rings, were resected while carefully maintaining the mucosal integrity. The superior tracheal mucosal flap should be easily anastomosed to the inferior aspect of oesophagotomy.⁸ A suction drain was placed in four of the six patients.

The following clinical data concerning the surgical procedures were examined: operative data (operative time, intra-operative bleeding, time until drain removal), outcome (aspiration, changes in nutrition status), and complications.

The data are shown as means \pm S.D. The statistical differences were analyzed by the nonparametric Chi-square and Mann-Whitney U tests. Probability values of less than 0.05 were considered to be statistically significant.

Results

Although the underlying diseases varied as shown in Table I, all of the patients suffered from intractable aspiration and the chance of recovery of their laryngeal protective function was considered to be nil.

The patient characteristics for the entire series of patients, shown in Table II, did not significantly differ between the two groups. The patient age was higher in the total laryngectomy group, but the difference was not statistically significant.

Table III documents the operative procedures for the two groups. The mean operating time for tracheoesophageal diversion was 146.5 minutes (range, 104–182 min) compared with 222.8 minutes for total laryngectomy (range, 154–285 min; $p < 0.05$). The mean intra-operative bleeding for tracheoesophageal diversion was 53.0 mL (range, 10–193 mL) compared with 183.1 mL for total laryngectomy (range, 60–380 mL; $p < 0.05$).

The time until drain removal for tracheoesophageal diversion was 2.0 days (range, 0–5 days) compared with 4.4 days for total laryngectomy (range, 3–5 days; $p < 0.05$).

Table IV shows the outcomes and complications in the two groups. Aspiration was successfully prevented in all 19 patients. The feeding conditions before and after surgery did not significantly differ between the two groups. Complications occurred only in the total laryngectomy group. Fistula formation was noted in three total laryngectomy cases, all of which closed after treatment.

Discussion

Some surgeons believe that laryngectomy remains the surgical procedure of choice for intractable aspiration because of the poor prognosis regarding recovery of the laryngeal protective function in these patients.^{2,3,9} Total laryngectomy was performed in 13 patients from 1991 to 1998. The reason why this

TABLE II
PATIENT'S CHARACTERISTICS

	Total laryngectomy (n = 13)	Tracheoesophageal diversion procedures (n = 6)	<i>p</i> value
Age (years)	Median = 56.7 Range = 33–71 SD = 11.6	Median = 39.7 Range = 19–81 SD = 24.7	0.09
Gender			
Male	9	3	
Female	4	3	0.75
Prior tracheotomy			
Yes	9	3	
No	4	3	0.75

SD = standard deviation of the mean

TABLE III
OPERATIVE DATA

	Total laryngectomy (n = 13)	Tracheoesophageal diversion procedures (n = 6)	p value
Operative time, min	222.8 ± 38.4	146.5 ± 33.8	0.0029
Intra-operative bleeding, ml	183.1 ± 95.7	53.0 ± 71.9	0.0066
Time until drain removal, days	4.4 ± 0.7	2.0 ± 1.9	0.0124

Mean ± SD

procedure was chosen was that the operating team were familiar with laryngectomy for laryngeal neoplasms and considered the total laryngectomy procedure to be simple and reliable. In 1999, tracheoesophageal diversion was performed for the first time at this hospital. This procedure was found to be simpler and less invasive than total laryngectomy. Moreover, tracheoesophageal diversion was also preferred by family members and/or patients because the larynx is preserved; therefore, hope for a subsequent reversal exists.⁷ Therefore, tracheoesophageal diversion for intractable aspiration has been performed since 1999.

Many reports have described surgical procedures for the control of intractable aspiration, however, no convincing evidence in the literature has yet been presented regarding the optimal procedure in view of surgical stress. Therefore this retrospective study tried to determine whether total laryngectomy or tracheoesophageal diversion was more advantageous for the control of intractable aspiration.

In this series, all of the patients suffered from intractable aspiration. The patient characteristics shown in Table II did not significantly differ between the two groups.

This study showed a significant superiority of tracheoesophageal diversion over total laryngectomy regarding the operative time, intra-operative bleeding, and time until drain removal. Although a suction drain was placed in the wound in four of six patients undergoing tracheoesophageal diversion, the drainage contents consisted almost completely of serobloody fluid and the amount was small in all patients. It may therefore be that the drain is unnecessary in tracheoesophageal diversion. The outcome of the two procedures; the prevention of aspiration and changes in nutritional status, did not show any statistically significant differences. Even though the complication rate did not show any statistically significant difference between the two procedures, no complications occurred in tracheoe-

sophageal diversion. These results suggest that tracheoesophageal diversion is simple, safe, and reliable.

It was not possible to compare the post-operative periods regarding the nutritional status for the two procedures. Most of the patients in the pre-operative nil by mouth (NPO) group remained in the NPO group post-operatively, because their swallowing functions were impaired by underlying diseases even though aspiration had been corrected post-operatively.

Although it was not possible to compare the cosmetic aspect between two procedures, it is evident that tracheoesophageal diversion was superior to total laryngectomy since the laryngeal prominence is preserved and the length of the incision is shorter for tracheoesophageal diversion.

Eisele *et al.* performed both tracheoesophageal diversion and laryngotracheal separation to manage intractable aspiration in 31 patients.⁷ They recommended the use of tracheoesophageal diversion in patients with no prior tracheotomy. Tracheoesophageal diversion is also favoured over laryngotracheal separation because tracheoesophageal anastomosis allows secretions and oral intake that have passed into the larynx to drain into the oesophagus. As a result, pooling in the subglottic tracheal pouch is avoided. Laryngotracheal separation was used in cases with prior tracheotomy because this prevents a high tension anastomosis from the tracheal stump to the oesophagus while also making it easier to mobilize the tracheal stump due to local inflammation, scar tissue, and fibrosis.

Laryngotracheal separation is one of the ideal surgical procedures for intractable aspiration.⁶ One disadvantage of this procedure is that the oral side of the tracheal stump can break down. The incidence of fistula formation is relatively high (17 to 38 per cent).^{7,10-12} Although most of these fistulae can be controlled by conservative therapy, this complication rate seems to be unacceptable for most severely ill patients.

TABLE IV
OUTCOME AND COMPLICATION

	Total laryngectomy (n = 13)	Tracheoesophageal diversion procedures (n = 6)	p value
Aspiration	0	0	
Changes in nutrition status			
NPO to NPO	4	4	
PO to PO	9	2	0.14
Complication	3	0	0.2

NPO = nothing by mouth; PO = per os

- **This paper evaluates the outcomes and surgical stress associated with surgery for intractable aspiration by retrospectively comparing the results between tracheoesophageal diversion and total laryngectomy**
- **Tracheoesophageal diversion was found to be simple, safe and reliable and less stressful than total laryngectomy**

Krespi *et al.* successfully performed modified tracheoesophageal diversion in five patients with prior tracheotomy.⁸ In this modification procedure, the inferior half of the cricoid, as well as the first and second tracheal cartilages, were resected. This procedure made it easier to mobilize the tracheal stump and ensured the anastomosis from the tracheal stump to the oesophagus. They also reported a patient with fistula complication which was surgically treated. We successfully performed this modified tracheoesophageal diversion in three patients with prior tracheotomy. Therefore, the overall rate of fistula complication in the modification of tracheoesophageal diversion was 12.5 per cent.

Moreover, a recent report suggested the possibility of preserving phonation by using a speech prosthesis in association with the tracheoesophageal diversion.¹³

Further studies are necessary to elucidate which procedure is the best among the various procedures available for the control of intractable aspiration.

Conclusion

The operative time and drain inserting periods were statistically shorter in the tracheoesophageal diversion group than in the total laryngectomy group. The intra-operative blood loss was also statistically less in the tracheoesophageal diversion group. The outcome and complication rate of the two procedures did not show any statistically significant difference. Our study showed tracheoesophageal diversion to be superior to total laryngectomy in view of surgical stress. We therefore recommend tracheoesophageal diversion as a surgical procedure of choice for the control of intractable aspiration.

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