

## Drainage of the tracheal blind pouch created by laryngotracheal separation

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**Abstract** Laryngotracheal separation is a simple and reliable operation for the treatment of patients with repetitive and intractable aspiration; however, it is apprehended that pooling in the tracheal blind pouch may cause postoperative complications. In the present study, we examined drainage of the blind pouch created by laryngotracheal separation. Fourteen patients aged 3–63 years with repetitive aspiration pneumonia underwent laryngotracheal separation by the modified Lindeman procedure. A barium swallow was performed 10–30 days after surgery. X-rays of the lateral view of the neck were taken at 6 and 24 h after the swallow, and then every 24 h until the contrast medium cleared. The contrast medium in the blind pouch cleared within 24 h in nine patients. In the remaining five, the clearance time was  $\leq 48$  and  $\leq 72$  h in two patients each, and 96 h in one patient. The clearance time in patients aged under 20 years was  $\leq 24$  h, while middle-aged to elderly patients showed prolonged clearance time. No late complications of the blind pouch, such as infections, were observed. The potential risk of complications caused by

pooling in the tracheal blind pouch in laryngotracheal separation is prevented presumably due to the slow but continuous turnover of pooling material. This result supports the validity and usefulness of laryngotracheal separation for the treatment of intractable aspiration.

**Keywords** Laryngotracheal separation · Aspiration pneumonia · Tracheal blind pouch · Barium swallow · Contrast medium · Drainage

### Introduction

Repetitive and intractable aspiration pneumonia is a serious and potentially fatal problem for patients with impaired swallowing. A variety of neuromuscular disorders and laryngopharyngeal diseases may compromise swallowing function. There are several procedures for the surgical management of intractable aspiration: glottic closure [1, 2], supraglottic closure [3, 4], tracheoesophageal diversion [5], laryngotracheal separation [6], and total laryngectomy. Of these procedures, tracheoesophageal diversion and laryngotracheal separation are most widely used. Both operations are reliable, involve minimal surgical invasion, and allow for the possible restoration of phonation. However, there are certain disadvantages inherent in these procedures: impracticability for tracheostomized patients and potential risk of anastomosis dehiscence in tracheoesophageal diversion, and pooling in the tracheal blind pouch in laryngotracheal separation. At our institution, we have been performing laryngotracheal separation rather than tracheoesophageal diversion because the former is simpler and easier than the latter. In the present study, we examined the drainage of pooling material in the tracheal blind pouch created by laryngotracheal separation.

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**Table 1** Summary of patients' profiles

Case	Age/sex	Primary disease	Prior tracheostomy	Clearance time of contrast medium (h)	Postoperative transoral ingestion	Complication
1	3/M	Hypoxic ischemic encephalopathy	(+)	≤24	None	Tracheostomal stenosis
2	43/F	Cerebral palsy	(−)	≤24	Full amount of pureed diet	Dehiscence of blind pouch
3	24/M	Hypoxic ischemic encephalopathy	(+)	≤48	A small amount of water	None
4	33/F	Epilepsy	(+)	≤24	Moderate amount of water, pudding	None
5	56/M	ALS	(+)	≤72	None	None
6	14/M	Psychomotor retardation	(−)	≤24	1/3 amount of liquid-pureed diet	Subcutaneous emphysema
7	36/M	Cerebral palsy	(−)	≤24	A small amount of soft diet	Subcutaneous emphysema
8	15/M	Psychomotor retardation	(−)	≤24	A small amount of liquid diet	None
9	22/M	Meningitis	(−)	≤72	None	None
10	4/F	Traumatic subdural hematoma	(+)	≤24	None	Tracheostomal stenosis
11	24/M	Cerebral palsy	(+)	≤6	Moderate amount of water	None
12	26/F	DRPLA	(−)	≤48	Full amount of pureed diet	None
13	13/F	Cerebral palsy	(−)	≤24	1/2 amount of pureed diet	None
14	63/F	ALS	(−)	≤96	1/3 amount of liquid diet	None

ALS amyotrophic lateral sclerosis, DRPLA dentatorubral-pallidoluyisian atrophy

## Patients and methods

Fourteen consecutive patients with repetitive aspiration pneumonia who underwent laryngotracheal separation were enrolled in this study. The patients' profiles are summarized in Table 1. They were eight males and six females, ranging in age from 3 to 63 years with an average age of 26.9 years. Their primary diseases were cerebral palsy in four cases; hypoxic–ischemic encephalopathy, psychomotor retardation, and amyotrophic lateral sclerosis in two cases each; and epilepsy, meningitis, traumatic subdural hematoma, and dentatorubral-pallidoluyisian atrophy in one case each. Six patients had previously undergone tracheostomy.

The operative procedure was performed as described by Lindeman et al. [6], and modified by Yamana et al. [7]. Briefly, the trachea was transected between the second and third tracheal rings, and the proximal tracheal stump was closed with vertical mattress sutures using a polyfilament absorbable thread. The resultant blind pouch was reinforced by bilateral superiorly-based sternohyoid muscle flaps. The distal tracheal stump was sewn to the cervical skin to create a permanent tracheostoma.

All patients underwent barium swallow 10–30 days after surgery. Ten to 20 ml of 150% (w/v) barium sulfate was poured into the mesopharynx via a 14-French transnasal catheter. X-rays of the lateral view of the neck were taken at 6 and 24 h after the swallow. When the barium sulfate remained in the tracheal blind pouch at 24 h, additional

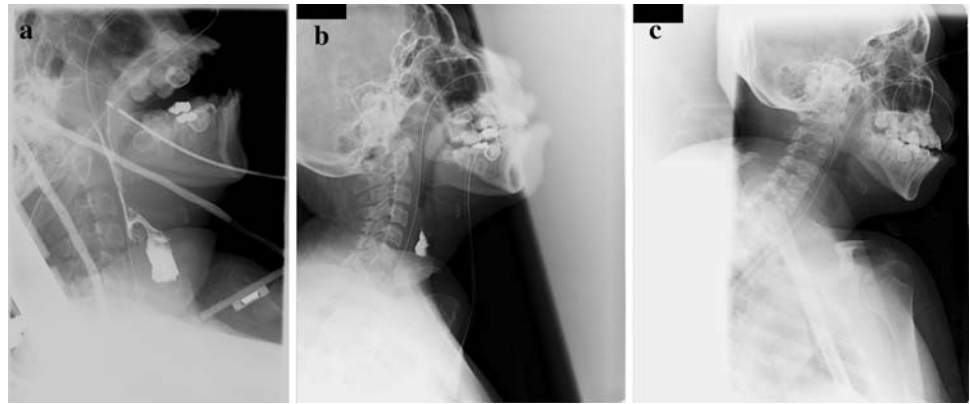
X-rays were taken every 24 h until the contrast medium cleared.

This study was approved by the Institutional Review Board of the University of Occupational and Environmental Health.

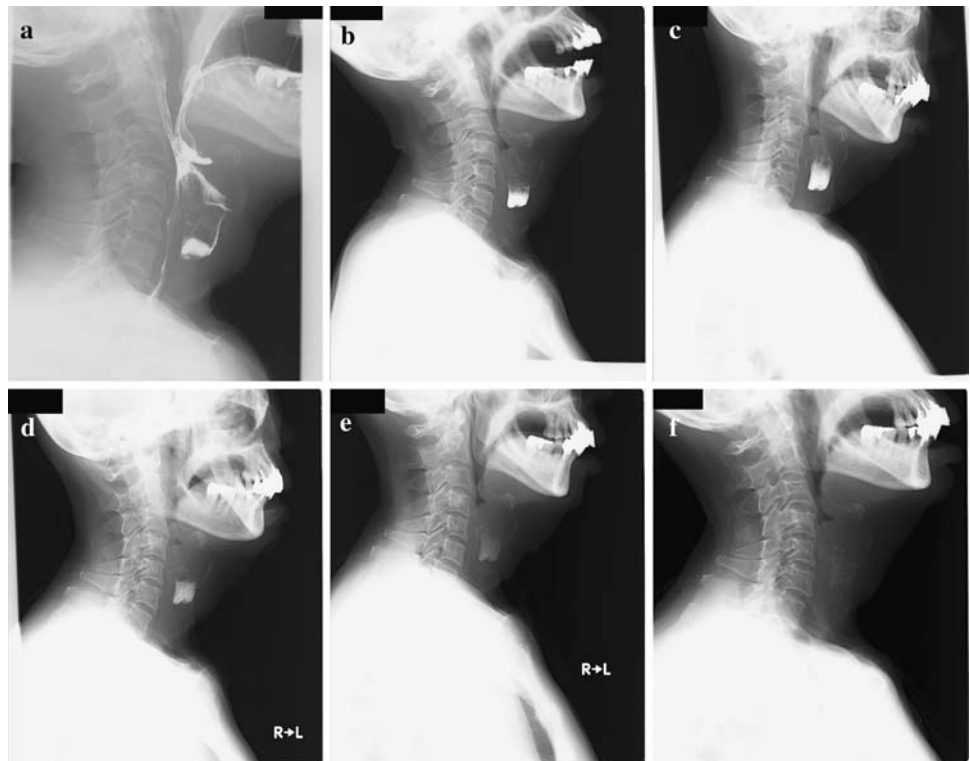
## Results

Barium swallow X-rays are exemplified in Figs. 1 and 2, and the clearance time for contrast medium, postoperative transoral ingestion and complications are summarized in Table 1. The contrast medium in the blind pouch cleared within 24 h in nine patients. In the remaining five, the clearance time was ≤48 and ≤72 h in two patients each, and 96 h in one patient. The clearance time in patients aged under 20 years was ≤24 h, while middle-aged to elderly patients (Cases 5 and 14) showed prolonged clearance time. Ten patients became capable of transoral ingestion to different degrees after surgery, two of which were able to ingest full amounts of a pureed diet (Cases 2 and 12). There was no obvious relationship between the ability to perform transoral ingestion and the clearance time of the contrast medium. Five patients suffered from postoperative complications: subcutaneous emphysema occurred in two cases, but subsided with conservative local care; one patient (Case 2) developed wound dehiscence of the tracheal blind pouch and required reoperation for closure; two infant patients

**Fig. 1** Barium swallow X-rays of Case 13. Contrast medium cleared within 24 h. **a** Immediately after barium swallow, **b** at 6 h after barium swallow, **c** at 24 h



**Fig. 2** Barium swallow X-rays of Case 14. Contrast medium cleared within 96 h. **a** Immediately after barium swallow, **b** at 6 h after barium swallow, **c** at 24 h, **d** at 48 h, **e** at 72 h, **f** at 96 h



(Cases 1 and 10) showed late-onset tracheostomal stenosis, which was treated by placing a tracheal cannula. Late complications of the blind pouch, such as infections, were not observed in any of the patients.

## Discussion

Several different techniques have been used to date for the surgical management of intractable aspiration. Total laryngectomy is the most reliable operation for the prevention of aspiration, but the loss of the larynx, and therefore the irreversibility of the loss of phonation, causes considerable mental stress in patients and their families. In glottic closure performed as per Montgomery [1], the vocal cords are

sutured together via median laryngotomy. A weak point of this technique is the considerable incidence of suture dehiscence in the closed vocal cords. Direct surgical invasion of the thyroid cartilage and vocal cords is another disadvantage of this operation. Sasaki et al. [2] introduced a variation of Montgomery's operation, in which a triple-layer laryngeal closure was performed using the sternohyoid muscle flap. However, their procedure is somewhat complicated, and still involves direct surgical invasion of the glottis. Supraglottic closure has been documented by Habal and Murray [3] and Biller et al. [4]. Habal and Murray [3] closed the larynx at the supraglottic level by suturing the epiglottis to the arytenoids, while Biller et al. [4] sewed up the arytenoids and aryepiglottic folds at midline with a small opening at the epiglottic tip to preserve phonation. A

major drawback of these two procedures is the high incidence of postoperative suture dehiscence.

Compared to the above operations, tracheoesophageal diversion and laryngotracheal separation are most commonly preferred because of their reliability in blocking aspiration, minimal surgical invasion of the larynx, and the reversibility of the loss of phonation. Tracheoesophageal diversion was first described by Lindeman [5]. He anastomosed the proximal end of the separated trachea to the cervical esophagus end-to-side, and brought the distal tracheal end to the skin, creating a permanent tracheostoma. This procedure completely separates the airway from the digestive tract while preserving the larynx. Secretions, foods, and drinks that passed through the larynx drain into the esophagus. This operation has been shown to be effective and reliable, but nevertheless has some disadvantages: the potential risk of anastomosis dehiscence leading to an esophageal fistula, and the difficulty of its application in patients with prior tracheostomy. In order to overcome these limitations, Krespi et al. [8] removed the tracheal rings and inferior half of the cricoid cartilage, and sutured the freed tracheal mucosa to the esophagus. Nakasaki et al. [9] proposed a double-layer suture to strengthen the anastomosed site. However, both of these procedures are complex and laborious to perform.

Immediately following Lindeman's original report of his procedure, he and his co-workers reported its modification, laryngotracheal separation [6], in which they simply closed the proximal end of the severed trachea, creating a blind pouch in patients who had previously received tracheostomy and therefore could not undergo tracheoesophageal diversion. Laryngotracheal separation is a simpler and easier procedure than tracheoesophageal diversion, but it is apprehended that pooling materials in the blind pouch may cause complications.

One of the most significant advantages of laryngotracheal separation over tracheoesophageal diversion is that laryngotracheal separation is readily applicable even to patients with prior tracheostomy. Furthermore, laryngotracheal separation is simple and easy to perform without surgical invasion of the esophagus, thereby eliminating the risk of esophageal fistula. The safety and reliability of laryngotracheal separation were subsequently confirmed by Baron and Dedo [10]. Additionally, several other authors have tested laryngotracheal separation in children [11–15], as well as in adults [7, 16–20], finding that this operation is as safe, effective, and reliable as tracheoesophageal diversion. Although tracheal fistula of the blind pouch may occasionally occur in the early postoperative period, it can be well managed by conservative or surgical treatment without severe complications. In the present study, one patient developed dehiscence of the tracheal blind pouch, which was surgically closed, and her clinical course was uneventful

thereafter. No late complications of the tracheal blind pouch were observed in any of the present patients, nor, to the best of our knowledge, have any such complications been previously documented.

The present study showed that contrast medium pooling in the blind pouch cleared within 6–96 h, indicating slow but continuous drainage of the pouch. Late complications such as infections of the tracheal blind pouch are presumably prevented by this ceaseless turnover of pooling material. This finding suggests that the potential risk caused by pooling in the pouch is negligible, and provides further evidence in favor of the validity and usefulness of laryngotracheal separation.

## Conclusion

We examined the drainage of the tracheal blind pouch created by laryngotracheal separation in 14 patients with repetitive aspiration pneumonia. Contrast medium pooling in the pouch cleared within 6–96 h, and no late complications of the blind pouch were observed. We conclude that laryngotracheal separation is as reliable and effective as tracheoesophageal diversion for the treatment of intractable aspiration.

**Conflict of interest statement** We declare that there is no conflict of interests as to the manuscript entitled “Drainage of the tracheal blind pouch created by laryngotracheal separation”.

## References

1. Montgomery WW (1975) Surgery to prevent aspiration. *Arch Otolaryngol* 101:679–682
2. Sasaki CT, Milmo G, Yanagisawa E, Berry K, Kirchner JA (1980) Surgical closure of the larynx for intractable aspiration. *Arch Otolaryngol* 106:422–423
3. Habal MB, Murray JE (1972) Surgical treatment of life-endangering chronic aspiration pneumonia. Use of an epiglottic flap to the arytenoids. *Plast Reconstr Surg* 49:305–311. doi:10.1097/00006534-197203000-00011
4. Biller HF, Lawson W, Baek SM (1983) Total glossectomy: a technique of reconstruction eliminating laryngectomy. *Arch Otolaryngol* 109:69–73
5. Lindeman RC (1975) Diverting the paralyzed larynx: a reversible procedure for intractable aspiration. *Laryngoscope* 85:157–180. doi:10.1288/00005537-197501000-00012
6. Lindeman RC, Yarrington CT Jr, Sutton D (1976) Clinical experience with the tracheoesophageal anastomosis for intractable aspiration. *Ann Otol Rhinol Laryngol* 85:609–612
7. Yamana T, Kitano H, Hanamitsu M, Kitajima K (2001) Clinical outcome of laryngotracheal separation for intractable aspiration pneumonia. *ORL J Otorhinolaryngol Relat Spec* 63:321–324. doi:10.1159/000055766
8. Krespi YP, Quatela VC, Sisson GA, Som ML (1984) Modified tracheoesophageal diversion for chronic aspiration. *Laryngoscope* 94:1298–1301. doi:10.1288/00005537-198410000-00007

9. Nakasaki H, Sugihara T, Tajima T, Mitomi T, Osamura Y, Onoda N, Fujii K (1991) Tracheoesophageal anastomosis for intractable aspiration pneumonia. *Ann Thorac Surg* 51:23–29
10. Baron BC, Dedo HH (1980) Separation of the larynx and trachea for intractable aspiration. *Laryngoscope* 90:1927–1932. doi:[10.1288/00005537-198012000-00002](https://doi.org/10.1288/00005537-198012000-00002)
11. Cohen SR, Thompson JW (1987) Variants of Mobius' syndrome and central neurologic impairment. *Ann Otol Rhinol Laryngol* 96:93–100
12. Lawless ST, Cook S, Luft J, Jasani M, Kettrick R (1995) The use of a laryngotracheal separation procedure in pediatric patients. *Laryngoscope* 105:198–202. doi:[10.1288/00005537-199502000-00017](https://doi.org/10.1288/00005537-199502000-00017)
13. Cook SP, Lawless ST, Kettrick R (1996) Patient selection for primary laryngotracheal separation as treatment of chronic aspiration in the impaired child. *Int J Pediatr Otorhinolaryngol* 38:103–113. doi:[10.1016/S0165-5876\(96\)01422-X](https://doi.org/10.1016/S0165-5876(96)01422-X)
14. Takamizawa S, Tsugawa C, Nishijima E, Muraji T, Satoh S (2003) Laryngotracheal separation for intractable aspiration pneumonia in neurologically impaired children: experience with 11 cases. *J Pediatr Surg* 38:975–977. doi:[10.1016/S0022-3468\(03\)00137-4](https://doi.org/10.1016/S0022-3468(03)00137-4)
15. Manrique D, Settanni FA, Campones do Brasil Ode O (2006) Surgery for aspiration: analysis of laryngotracheal separation in 23 children. *Dysphagia* 21:254–258. doi:[10.1007/s00455-006-9048-1](https://doi.org/10.1007/s00455-006-9048-1)
16. Snyderman CH, Johnson JT (1988) Laryngotracheal separation for intractable aspiration. *Ann Otol Rhinol Laryngol* 97:466–470
17. Eisele DW, Yarrington CT Jr, Lindeman RC (1988) Indications for the tracheoesophageal diversion procedure and the laryngotracheal separation procedure. *Ann Otol Rhinol Laryngol* 97:471–475
18. Eisele DW, Yarrington CT Jr, Lindeman RC, Larrabee WF Jr (1989) The tracheoesophageal diversion and laryngotracheal separation procedures for treatment of intractable aspiration. *Am J Surg* 157:230–236. doi:[10.1016/0002-9610\(89\)90534-5](https://doi.org/10.1016/0002-9610(89)90534-5)
19. Eibling DE, Snyderman CH, Eibling C (1995) Laryngotracheal separation for intractable aspiration: a retrospective review of 34 patients. *Laryngoscope* 105:83–85. doi:[10.1288/00005537-199501000-00018](https://doi.org/10.1288/00005537-199501000-00018)
20. Zoccratto OB, Savassi-Rocha PR, Paixao RM, Salles JM (2006) Laryngotracheal separation surgery: outcome in 60 patients. *Otolaryngol Head Neck Surg* 135:571–575. doi:[10.1016/j.otohns.2006.05.018](https://doi.org/10.1016/j.otohns.2006.05.018)