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Dysphagia

Surgery for Aspiration: Analysis of Laryngotracheal Separation in 23 Children

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Abstract. The aim of this study was to analyze the efficacy of laryngotracheal separation (LTS) in eliminating aspiration in children by comparing pre- and postoperative conditions. This prospective study used an internal control group. Children with neurologic impairment and a diagnosis of chronic aspiration were subjected to LTS at the Associação de Assistência à Criança Deficiente (AACD). Twenty-three children had undergone LTS with the modified Lindeman technique. All of them gained complete control of aspiration. Frequency of hospitalization, number of respiratory infections, and level of secretion were statistically reduced. After surgery only 21.7% of the children were capable of oral intake exclusively. LTS is an effective and safe technique that can be used in children resulting in aspiration control in 100% of the patients and without repercussions in the respiratory secretion and pulmonary infections.

Key words: Aspiration — Surgery — Dysphagia — Pneumonia — Neurological diseases — Larynx.

The term aspiration describes a variety of situations in which there is intake of liquid or solid material into the lower airway and lungs. Clinical manifestations range from small focal inflammation to life-threatening respiratory abnormalities and lung diseases. The level of aspiration and the clinical repercussions resulting from it indicate the type of treatment to be proposed [1].

If restriction of oral feeding and treatment of gastroesophageal reflux disease are not enough to prevent respiratory complications and lung infections from aspiration, it is necessary to surgically isolate the lower respiratory airway from the upper aerodigestive airway to prevent aspiration of saliva and secretions.

The ideal surgical procedure to treat chronic aspiration, especially in children, should completely prevent aspiration with one operation, be safely conducted in small structures, preserve the integrity of the larynx without causing damage or scars that prevent growth, allow phonation, and can be reversed. Considering all these aspects, the technique of preference in children for many authors [2–6] is laryngotracheal separation (LTS) as modified by Lindeman [7, 8]. Lindeman [7] proposed a procedure to control aspiration with the preservation of larynx and the ability to reverse the procedure. The trachea was sectioned transversely, the proximal segment was anastomosed to the esophagus, and the distal segment was sutured to the cervical skin [7]. In patients who have had a tracheotomy, Lindeman et al. [8] closed the proximal trachea in a dead-end shape.

Cohen and Thompson [3] were the first to use the LTS procedure in children. Others used this technique in children with neurologic disorders [4–6].

The purpose of this study was to analyze the results of LTS in children with respect to aspiration control, complications, and repercussions in the control of lung infections.

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Method

Between October 1997 and October 2002, 23 children from Associação de Assistência à Criança Deficiente (AACD) had undergone LTS with the Lindeman modificaton to control chronic aspiration. It was a prospective study and children were selected from patients of the ambulatory of otorhinolaryngology. The inclusion criteria were diagnosis of neurologic disease and no oral communication, clinical manifestations suggestive of chronic aspiration (recurrent lung infection and tracheobronchial and/or upper airway hypersecretion level), complete restriction of oral feeding for a minimum period of three months, diagnosis of oropharyngeal aspiration confirmed by videoendoscopy and swallowing videofluoroscopy, and previous treatment for gastroesophageal reflux disease.

Anthropometric assessment was conducted by comparing weight relative to age at the moment of surgery, with values defined by the National Center for Health Statistics. Children whose weight was up to 10% below the 5th percentile were classified as having mild malnutrition and below 20%, severe malnutrition.

Lung infections was characterized by the presence of fever, respiratory symptoms, or both, and evidence on a chest X-ray of parenchymatous infiltrate [9]. We compared the number of lung infection episodes and days of hospital stay in the 12 months before surgery and the number of episodes in the 12 months after LTS.

Secretion level was characterized by the number of aspiration probes used per day to mechanically remove secretions from nasal, oral, pharyngeal, and/or tracheal cavities.

Preoperative chest computed tomography (CT) was conducted in all children and the abnormalities were classified as mild if located in one lung lobe, moderate if in up to two lung lobes, and severe if in three or more lung lobes (Figs. 1–3).

On the 15th day after the surgery, we orally administered 5 ml of distilled water with methylene blue and performed flexible tracheoscopy to exclude or confirm the presence of aspiration.

Surgical Procedure

We performed LTS [8] with a more proximal tracheal section, at the first tracheal ring (Fig. 4), and reinforcement in the suture, with harvesting and dislocation of sternohyoid muscle flap to the proximal trachea, as previously reported [6] (Figs. 5 and 6).

Statistical Analysis

For statistical analysis of results, we used the Kruskal-Wallis test, Mann-Whitney test, Pearson's chi-squared test, and Student's *t* test. In all of them we adopted the level of significance of 5% (0.05) for null hypothesis rejection. If the calculated statistics rendered a significant value, we added an asterisk (*) to characterize it.

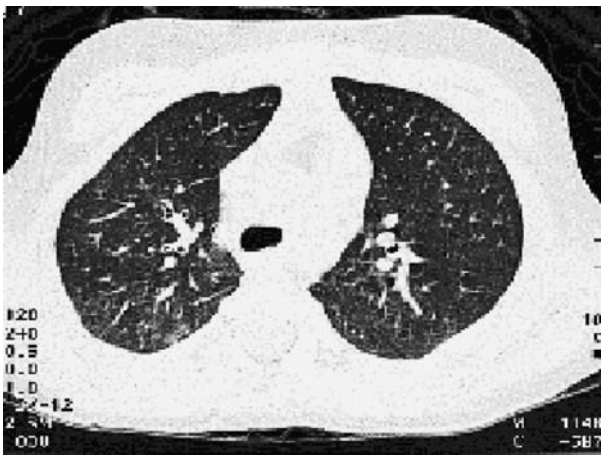

Fig. 1. Chest CT scan with mild abnormalities.

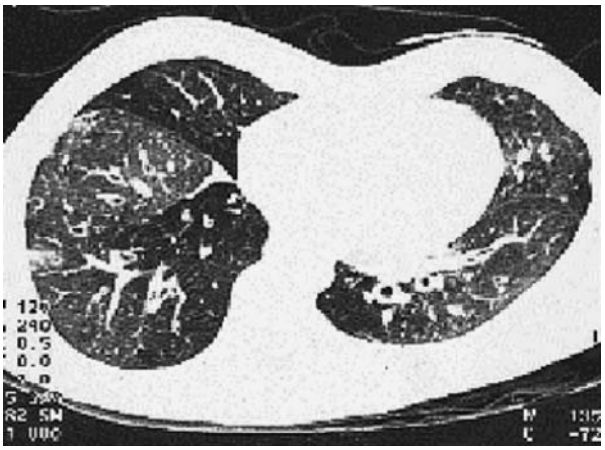

Fig. 2. Chest CT scan with moderate abnormalities.

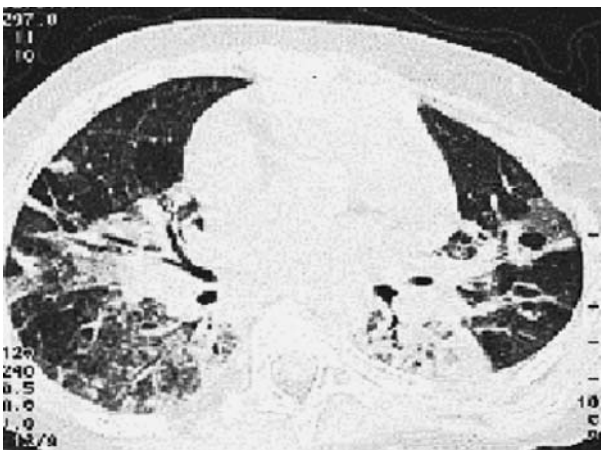

Fig. 3. Chest CT scan with severe abnormalities.

Results

The diagnosis of chronic nonprogressive encephalopathy (CNPE) was made in 16 children (69.6%) and chronic progressive encephalopathy (CPE) in 7 children (30.4%). Nineteen children (82.5%) had seizures. The minimum age of our patients was 11 months and the maximum age was 14 years (mean age = 6 years and 7 months). Fourteen children (60.9%) had prior tracheotomy and 19

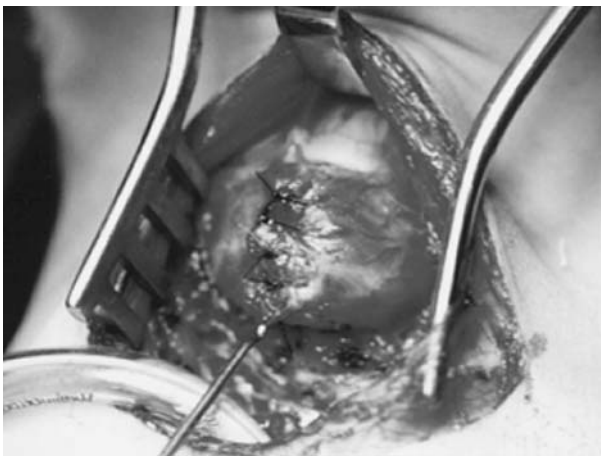

Fig. 4. LTS: Section at first tracheal ring and closed in a dead-end shape.

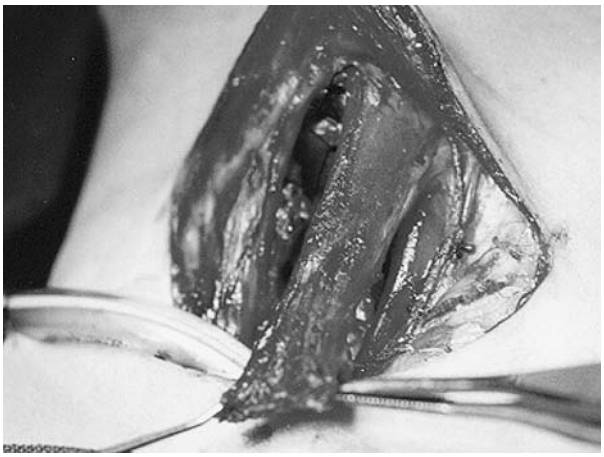

Fig. 5. LTS: Sternohyoid muscle flap.

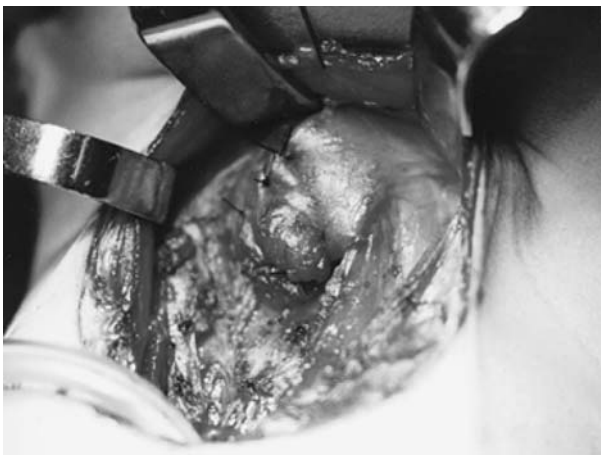

Fig. 6. LTS: Suture of muscle flap to protect proximal trachea.

children (82.6%) had undergone gastrostomy and fundoplication before LTS. The time period for prior procedures ranged from 2 months to 5 years and 2 months (mean = 2 years). Thirteen children (56.5%) were malnourished preoperatively and eight (34.8%) had severe malnutrition.

The length of hospital stay for the LTS procedure ranged from 2 to 40 days (mean = 10.1 days) and up to 15 days in 20 patients (87.0%). All children had controlled aspiration after the procedure and they were maintained with a postoperative tracheal cannula and were able to be discharged from the hospital.

Tracheocutaneous fistula was observed in four patients, three in the early postoperative period between the fourth and fifth day. Fistula resolution was complete, with surgical treatment in two patients. The presence of fistula was not statistically related to the age of the child at LTS, severe malnutrition, or prior tracheotomy.

Five children (21.7%) progressed postoperatively with oral diet, with removal of gastrostomy in two children and nasoenteral tube in three children. Postoperative progression to only an oral diet was more frequent in patients with a nasoenteral tube than in patients with gastrostomy. The number of preoperative lung infection episodes was 4–20 per year (mean = 10.5 episodes/year). Postoperatively, the mean was one episode of lung infection per year. The difference between the number of pre- and postoperative lung infection episodes was statistically significant (Table 1).

The number of preoperative days in the hospital as a direct result of respiratory infection ranged from 8 to 330 days, with 12 children (52.1%) in the hospital more than 60 days per year. Postoperatively, 13 children (56.5%) were not hospitalized for respiratory infection. The difference between the number of pre- and postoperative hospital days for lung infection was statistically significant (Table 1).

Preoperative secretion level, assessed by frequency of suction for removal of secretions, ranged from 8 to 60 aspirations (mean = 27.9 times a day). Postoperatively, the suction frequency ranged from 1 to 20 times (mean = 4.8 times). The difference in the pre- and postoperative secretion rates was statistically significant (Table 1).

The frequency of postoperative pulmonary infections was statistically significantly related to the level of lung abnormality detected at chest CT scan. All patients that had more than four lung infection episodes per year had marked abnormalities in chest CT scan. The main CT scan findings were bronchial wall thickness, bronchiectasia, ground-glass opacity, and lung fibrosis.

Postoperatively, three patients died after the 15th month of followup.

Table 1. Means ± SD of respiratory infection, hospitalization, and level of respiratory secretion pre-LTS and post-LTS

	Pre-LTS	Post-LTS	*p* value
Respiratory infection (episodes/year)	10.6 ± 4.8	2.0 ± 2.5	< 0.001
Hospitalization (days/year)	88.4 ± 76.1	6.0 ± 9.7	< 0.001
Respiratory secretion (suctions/day)	28.0 ± 17.4	4.8 ± 4.4	< 0.001

$p < 0.001$*.

Discussion

Our series comprised the largest number of children (23) in such a study so far. Operation-related morbidity was low, with few complications and limited time of hospitalization, compatible with data in the literature [10]. Tracheocutaneous fistula occurred in 17.4% of the operated children, but in publications on LTS in children, there is no report of fistula. In adults, the incidence of fistula ranged from 16.6% to 38.2% of the cases [10, 11] and it was associated with tracheostomy and malnutrition. Our findings failed to corroborate the findings in adult studies but, because of the relatively small study number and the rarity of this complication, we did not demonstrate a difference between adults and children in this regard. To avoid or reduce this complication, we used a muscle flap as a protection barrier, and, to make the procedure easier in children, the occlusion was done more proximal at the first tracheal ring because of the flexibility of the tracheal cartilages in children and the better mucous flap to dissection in the subglottic area.

All operated subjects maintained a permanent tracheal cannula because we did not consider it safe for them not to have it owing to lack of head control. Other authors reported that the cannula was necessary in 85.7% of the children after LTS [4].

The success of the procedure in controlling aspiration was 100%, similar to that in other reports [5, 6]. No other described technique has such high success rate. This technique preserved the integrity of larynx, was safe to be performed in children, and has proven efficacy. We use the ambulatory flexible tracheoscopy with methylene blue by mouth after the surgery to exclude aspiration.

The main disadvantage of LTS is interruption of vocal production [3], but our inclusion criteria for treatment was that there be no oral communication, similar to almost all other series reported in the literature [5, 6].

The minimum age for surgery of the children in our study was 11 months. In the studies reported in the literature, the minimum age in which LTS was performed was two months [4]. Technically, LTS can be performed safely in very small and low-weight children.

It is estimated that one third of children with severe neurologic afflictions are malnourished [12]. In our series, even though they had feeding tubes, malnutrition was present in about half the children. Postoperatively, use of the tube persisted in 78.3% of the children and in the literature persistent use ranged from 16.7% to 56% [10, 11]. Reestablishing oral feeding after control of aspiration is probably difficult because swallowing is a process that involves many variables and is especially affected by an underlying neurologic disorder.

In our study, all patients were in proper condition to be discharged from the hospital and postoperative infections were significantly reduced with LTS, but the severity of the findings on preoperative chest CT scans correlated with the frequency of postoperative lung infection.

Three patients died during postoperative followup. Deaths were not a direct result of the surgery but rather a progression of the underlying disease, similar to the reports of others [5, 6].

Conclusion

Laryngotracheal separation (LTS) is an effective and safe technique that can be used in children with chronic encephalopathy, reaching aspiration control in 100% of the children, with reduction in frequency of hospitalization, pulmonary infection, and level of respiratory secretion.

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