MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2020; 26: e919962
DOI: 10.12659/MSM.919962

Received: 2019.09.07
Accepted: 2019.12.19
Available online: 2020.01.22
Published: 2020.03.11

The Value of Thoracic Lavage in the Treatment of Anastomotic Leakage After Surgery for Type III Esophageal Atresia

Authors' Contribution:
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Statistical Analysis C
Data Interpretation D
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Source of support: Departmental sources

Background: The aim of this study was to define whether the addition of thoracic lavage to chest drainage was more efficient than the use of chest drainage alone in the treatment for anastomotic leaks in type III esophageal atresia.

Material/Methods: The clinical data of 42 patients with anastomotic leakage treated with the addition of thoracic lavage from January 2012 to March 2019 in our hospital were analyzed retrospectively. The clinical data of 50 patients with anastomotic leakage treated without thoracic lavage from March 1999 to December 2011 in our hospital were selected as controls.

Results: The duration of fistula healing, mechanical ventilation, hospitalization in intensive care unit, and gastric tube intubation in the thoracic lavage group were significantly shorter than those in the non-lavage group. The cost of hospitalization and the incidence of severe pneumonia were significantly lower in the thoracic lavage group than in the non-lavage group. The diameter of the anastomotic opening after anastomotic fistula healing was wider in the thoracic lavage group than in the non-lavage group.

Conclusions: The technique of thoracic lavage is simple, economical and convenient and can effectively promote the healing of anastomotic fistulas, accelerate postoperative recovery in children and reduce the cost of treatment.

MeSH Keywords: **Esophageal Atresia • Hospitals, Pediatric • Postoperative Complications**

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/919962

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Background

Congenital esophageal atresia is a serious and common alimentary tract malformation in newborns with an incidence of approximately 1/2500 to 1/4000 [1–3]. Among these malformations, cross type III is the most common type, accounting for approximately 85% of the cases, and surgery is the only treatment [4]. Anastomotic leakage is the most common and serious complication, and it profoundly affects postoperative recovery in children [5]. When anastomotic leakage occurs, the thoracic drainage fluid is thick and easily blocks the tube, which leads to serious empyema and sepsis and threatens the life of children. How to effectively address anastomotic leakage and improve the cure rate is still a hot topic in the field of pediatric surgery. The majority of cases of anastomotic leakage can be healed by strengthening the closure of thoracic drainage, keeping the drainage tube unobstructed, fasting, parenteral nutrition support, anti-infection, and so on; however, the healing rate is slow, the treatment time is long, there are many complications, and the cost is high [6,7]. In this study, we summarized the experience and clinical effect of thoracic lavage for the treatment of anastomotic leakage after surgery for type III esophageal atresia to assess whether the addition of thoracic lavage to chest drainage was more efficient than the use of chest drainage only for the treatment of anastomotic leaks in type III esophageal atresia.

Material and Methods

This study was approved by the ethics committee of our university and strictly adhered to the tenets of the Declaration of Helsinki. The guardians of all patients signed an informed consent form before thoracic lavage.

Patients

The clinical data of 42 patients with anastomotic leakage treated by the addition of thoracic lavage from January 2012 to March 2019 in our hospital were analyzed retrospectively. The clinical data of 50 patients with anastomotic leakage treated without thoracic lavage from March 1999 to December 2011 in our hospital were selected as controls. After the operation, a No. 20 silicone thoracic drainage tube (approximately 0.8 cm in diameter) was placed near the anastomotic orifice in all patients; fluid was drawn from the seventh intercostal space of the right axillary midline.

Anastomotic leakage and severity of anastomotic leakage

Anastomotic leakage was diagnosed upon symptoms, such as dyspnea, pale complexion and fever, and when viscous mouth water, milk, or contrast medium (esophagogram) were found in the chest drainage tube [8,9]. The severity of anastomotic leakage was classified as major when clinical symptoms such as anhelation, dyspnea or cyanosis were obvious, and the respiratory sounds of the affected side were weakened, and with a large pneumothorax or hydropneumothorax upon chest radiography; otherwise, leaks were considered minor [8,9]. Severe pneumonia was diagnosed, upon the symptoms of irritating or lethargy, refusing to eat, depression of lower chest wall, and cyanosis [10].

Treatment of the non-lavage group

Anastomotic leakage was managed only by conservative treatment, which included chest-tube drainage, suspension of feeding and total parenteral nutritional support, and administration of broad-spectrum antibiotics [11].

Treatment of the thoracic lavage group

We added thoracic lavage to the treatment of anastomotic leakage on the basis of conservative treatment of the non-lavage group. After anesthesia, we routinely disinfected and draped the surgical area. A 2.5 cm longitudinal transverse incision was made in the midclavicular line, in the second intercostal space. We cut the skin, subcutaneous tissue and muscle and then entered the intrapleural tissue. Under direct vision, a No. 20 silicone thoracic drainage tube (approximately 0.8 cm in diameter) was placed near the anastomotic orifice. Then, we closed the chest incision layer by layer. A 3-way switch was connected to the drainage tube, with 1 switch for the drainage bottle and 1 switch for thoracic lavage. Because the chest cavity of newborns is small, negative pressure suction should be performed before washing to absorb the gas in the chest cavity to avoid too much of an increase in chest pressure when liquid rushes in. Rinsing was performed with 10 mL warm saline at a time; then, pumping was initiated so that there was no liquid. Then, rinsing was performed with 10 mL warm saline, and pumping was again initiated. With this method, washing was performed 4 or 5 times until the washing solution from the pump was clear. During washing, the drainage tube could be rotated approximately 90° to avoid blockage of the lateral foramen due to pulmonary tissue. Thoracic lavage should be performed 3 times a day. If the anastomotic leakage is serious, the time of thoracic lavage can be increased. During the process of thoracic lavage, the amount of liquid and gas that is pumped should be more than or equal to the amount of washing liquid to avoid the accumulation of liquid in the chest cavity and to avoid affecting ventilation in children. Continuous drip irrigation is not recommended; if the liquid cannot flow out in time, excessive thoracic pressure is easily produced, resulting in a greater risk of ventilation and blood flow disorders because the chest cavity of newborns is small.

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Table 1. General data comparison of two groups.

	Lavage group	Non-lavage group	*P* value
Number of patients	42	50	
Gestational age (weeks)	38.8±3.2	38.1±4.1	0.823
Age (days)	2.1±0.9	2.5±1.2	0.925
Body weight (g)	2568±865	2779±712	0.851
Premature infants	6	8	0.556
Type III A/Type III B	14/28	14/36	0.580
Severity of anastomotic leakage			
Minor leaks	27	30	0.673
Major leaks	15	20	
Congenital heart disease			
Atrial septal defect	9	11	0.947
Ventricular septal defect	6	8	0.820
Patent ductus arteriosus	12	15	0.881
Hemoglobin after surgery (g/L)	138±25.8	149±20.4	0.737
Albumin after surgery (g/L)	33.2±5.1	34.7±7.2	0.793

Table 2. Comparison of postoperative conditions between the two groups.

	Lavage group	Non-lavage group	*P* value
Duration of mechanical ventilation (days)	4.4±1.6	6.5±2.9	0.032
Duration of intensive care(days)	6.8±2.7	9.6±3.6	0.039
Time elapsed until fistula healing (days)	8.6±2.6	12.3±4.1	0.022
Time of gastric tube pulled out (days)	12.1±4.2	15.5±5.8	0.028
Cost of hospitalization (1000 USD)	4.3±1.2	6.8±1.8	0.045
Severe pneumonia (number of patients)	10	22	0.043
Redo surgery (number of patients)	0	0	
Deaths (number of patients)	2	2	0.858
Diameter of anastomotic opening (cm)	0.50±0.21	0.38±0.25	0.045

Diagnosis of anastomotic leakage healing

The children breathed smoothly, had no fever, had a ruddy complexion, and had no drainage fluid in the thoracic drainage tube and no contrast medium leakage apparent upon esophagography [8,9]. An esophagogram was performed in all children after anastomotic leakage healing. The anastomotic position was located from the esophagogram (contrast medium leakage position) before anastomotic leakage healing, and then the esophageal diameter was measured as the "diameter of anastomotic opening".

Statistical analysis

Continuous data are presented as the mean±standard deviation and range. The continuous data were all in accordance with a normal distribution according to Kolmogorov-Smirnov test and were statistically analyzed with independent sample *t*-tests. Qualitative data were compared with the chi-square test. A P value of <0.05 was defined as statistically significant.

Results

All the patients' general data are shown in Table 1. There were no statistically significant differences between the 2 groups in

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terms of gestational age, body weight, age, type of esophageal atresia, type of congenital heart disease, severity of anastomotic leakage, hemoglobin or albumin after esophageal atresia curative surgery, which indicated that the 2 groups were homogeneous and comparable.

Four patients died after the operation (2 patients in the thoracic lavage group and 2 patients in the non-lavage group) because there was a large amount of anastomotic leakage and the lung infections were serious; the rest of the patients were cured. No patients underwent reoperation. Time elapsed until fistula healing, duration of mechanical ventilation, intensive care hospitalization and gastric tube intubation, in the thoracic lavage group were significantly shorter than those in the non-lavage group ($P<0.05$). The cost of hospitalization (the total cost of treatment incurred by a patient from admission to discharge) was significantly lower in the thoracic lavage group than in the non-lavage group ($P<0.05$). The incidence of severe pneumonia after the operation was significantly lower in the thoracic lavage group than in the non-lavage group ($P<0.05$). The diameter of the anastomotic opening after anastomotic fistula healing in the pleural thoracic lavage group was wider than that in the non-lavage group ($P<0.05$). (Table 2).

Discussion

Different scholars have different opinions on the treatment of anastomotic leakage. Liyang et al. [12] believe that conservative measures, including continuous chest drainage and parenteral nutrition, are optimal; these measures were mainly used in children with good conditions and a small amount of leakage. Sptiz [6] and Zhao et al. [9] summarized experience with the treatment of esophageal atresia and he came to the same conclusion. And, our results were in accordance with theirs. However, the conventional drainage was easy to clog, and the efficiency was very poor, which would lead to longer treatment time and higher cost was higher. Strengthening thoracic drainage and maintaining unobstructed drainage tubes was the key to treat anastomotic fistulas. As suggested by Zheng [13], we added thoracic lavage to chest drainage to strengthen thoracic drainage and maintain unobstructed drainage in our study, which has achieved good clinical results. Time elapsed until fistula healing, duration of mechanical ventilation, intensive care hospitalization, and gastric tube intubation in the thoracic lavage group were significantly shorter than those in the non-lavage group ($P<0.05$).

When treating a severe anastomotic fistula, the amount of leaking liquid and gas produced every day is large, and the fluid is mostly viscous. The conventional thoracic drainage tube is not enough to drain all the fluid, and blockage of tube can often occur [14]. The result is a continuous increase in accumulation and gas, which would lead to many complications, such as infection, pneumothorax, and slowing the healing of anastomosis. The purpose of reoperation has been not to repair an anastomotic stoma but to release the adhesion around the fistula and to place the drainage tube in an ideal position. Because edema resulting from an esophageal anastomotic stoma after stage I anastomosis was serious; the tension of the stoma was high, and the material was small. The suture cannot effectively close the fistula. Therefore, the focus of our neonatal surgeons is with how to more effectively implement drainage in order to reduce the complications caused by anastomotic fistulas and to control anastomotic fistulas as soon as possible.

Through thoracic lavage, we can drain the leaking viscous fluid in time to avoid the accumulation of viscous liquid in the thoracic cavity and to reduce the incidence of infection, which can favor the healing of the anastomotic mouth and benefit the recovery of respiratory function in children. Therefore, duration of fistula healing, mechanical ventilation, intensive care hospitalization, and gastric tube intubation time in the thoracic lavage group were significantly shorter than those in the non-lavage group; also, the incidence of severe pneumonia after operation was significantly lower in the thoracic lavage group than in the non-lavage group.

Thoracic lavage can effectively shorten the duration of anastomotic fistulas, so nasal feeding can be resumed as soon as possible. Even with a small amount of gastroesophageal reflux in the chest, the milk residue can be washed via pleural lavage to avoid the continuous fermentation of severe thoracic infection. This technique can effectively reduce the cost of treatment for the family ($P<0.05$). Studies have shown that the risk of esophageal stricture in children with anastomotic fistulas is significantly higher than that in children without anastomotic fistulas due to continuous leakage, increasing inflammatory reactions, and scar formation at the anastomotic site [15,16]. Thoracic lavage can drain clean fluid in time and can reduce leakage accumulation at the site of the anastomotic fistula, which can effectively shorten the duration of the anastomotic fistula and reduce the inflammatory reaction at the anastomotic site. Therefore, scar formation can be lessened, and the appearance of anastomotic narrowing can be reduced to a certain extent. In this study, the diameter of the anastomotic fistula in the thoracic lavage group was significantly wider than that in the non-lavage group ($P<0.05$). However, this study did not carry out further medium and long-term follow-up evaluations of these patients and could not evaluate the significance of thoracic lavage in patients with anastomotic leakage. This is a major limitation of this study. Next, we will follow these patients for a long time to further study the effect of thoracic lavage on medium- and long-term complications. There are several additional limitations in this study. First, this was a retrospective study with a small sample size. Second,

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this was a single-center study, and more research from multiple centers is mandatory to assess the effectiveness of this technique in further studies.

Conclusions

The technique of thoracic lavage in patients with anastomotic leakage after surgery esophageal atresia is simple, economical and convenient, and it can effectively promote the healing of anastomotic fistulas, accelerate postoperative recovery in children and reduce the cost of treatment. This technique is worth implementing in clinical practice.

Ethics approval and consent to participate

This study was approved by the ethics committee of our university and strictly adhered to the tenets of the Declaration of Helsinki. In addition, all patients' guardians signed an informed consent form before thoracic lavage.

Acknowledgements

We highly acknowledge the contribution by the participating doctors: Dianming Wu, Yifan Fang, Bing Zhang, Mingkun Liu, Jiancai Chen, Jianxi Bai, and Wen-chen Xu.

Conflict of interests

None.

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