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Primary esophageal anastomotic using mattress suturing technique in cases of esophageal atresia with fistula

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Abstract
Background: Esophageal atresia (EA) is a common congenital malformation occurring in approximately 1 in 2500−3000 lives births. Developed countries have survival rates of 90% for newborns with esophageal atresia, whereas developing countries have a much lower percentage. We report the suturing technique in EA on the mortality outcomes from newborns with EA in Tarakan General Hospital, Jakarta, Indonesia. The study was to investigate two different suturing techniques to identify the advantages and disadvantages for esophageal atresia patients who underwent primary esophageal anastomosis based on clinical manifestations and early complications post operation.
Method: From 2016 to 2022, we collected 25 research samples from Tarakan General Hospital in the form of newborns with esophageal atresia. The study was analyzed using descriptive and analytical statistics.
Result: A total of 25 EA cases were included in the study, and all underwent primary esophageal anastomosis. In Tarakan General Hospital, the average age of patients with esophageal atresia underwent thoracotomy was 18.28±5.77 days. There were 14 females (56%) and 11 males (44%), respectively, among the newborns with EA. The most common type of EA was EA with distal tracheoesophageal fistula (TEF) or EA type C, which had 23 cases (92%) while Waterston B had 16 cases (64%). Mattress suture was used in 11 patients (44%), whereas simple suture was used in the remaining patients. Sepsis and leakage occurred among 14 (56%) and 5 (20%) patients, respectively. As shown by bivariate analysis, sepsis is substantially associated with mortality (p<.05), while the occurrence of anastomotic leakage was significantly lower in mattrass suture than simple suture (p<.05). Sepsis incidence significantly lower in mattrass suture (27.3%, 3/11 patients) compared to simple suture (78.6%, 11/14 patients) (OR: 9.78, 95% CI: 1.55-61.64, p<.05). There were no prognostic factors associated with the mortality of newborns with EA in a multivariate analysis of mortality outcome.
Conclusion: Mattrass suture is significantly associated with a lower incidence of anastomotic leakage and sepsis. At Tarakan General Hospital, neonatal mortality with esophageal atresia was high, and sepsis was the most common cause of mortality. An esophageal anastomosis leak and suture type are two additional factors of mortality.

Keywords: Esophageal atresia, mattress suture, leakage, sepsis, mortality

1. Introduction
Esophageal atresia (EA) is a common congenital malformation occurring in approximately 1 in 2500−3000 lives births. Developed countries have survival rates of 90% for newborns with esophageal atresia, whereas developing countries have a much lower percentage. We report the suturing technique in EA on the mortality outcomes from newborns with EA in Tarakan General Hospital, Jakarta, Indonesia. An essential component of successful anastomosis healing is anastomotic technique [1]. The single layer simple suture method with various esophageal lengthening techniques has long been the main esophageal anastomosis technique in cases of EA with TEF [2]. The study was to investigate two different suturing techniques to identify the advantages and disadvantages for esophageal atresia patients who underwent primary esophageal anastomosis based on clinical manifestations and early complications post operation.

2. Method
From 2016 to 2022, we collected 25 research samples from Tarakan General Hospital in the form of newborns with esophageal atresia. The study was analyzed using descriptive and analytical statistics. The methods use was univariate and multivariate analysis. The assignation of the group was based on the surgeon's preference.

An attending pediatric surgeon performed the thoracotomy and anastomosis procedure. The stitches were made by an 5-0 absorbable suture with the following positions; at 6 o'clock direction, 12 o'clock, in the posterior and anterior direction of the esophagus. Additional sutures can be added in between the posterior and 6 o'clock or 12 o'clock direction.

3. Result

3.1 Characteristics of Patients with Esophageal Atresia

A total of 25 EA cases were included in the study, and all underwent primary esophageal anastomosis. In Tarakan General Hospital, the average age of patients with esophageal atresia underwent thoracotomy was 18.28±5.77 days. There were 14 females (56%) and 11 males (44%), respectively, among the newborns with EA. The most common type of EA was EA with distal tracheoesophageal fistula (TEF) or EA type C, which had 23 cases (92%) while Waterston B had 16 cases (64%). Mattress suture was used in 11 patients (44%), whereas simple suture was used in the remaining patients. Sepsis and leakage occurred among 14 (56%) and 5 (20%) patients, respectively.

Table 1: Characteristics of patients with Esophageal Atresia from Tarakan Regional General Hospital

Variables	N (%)	Mean (SD)	Med (Min-Max)
Age			
		18.28±5.77	17 (6-30)
≤2 weeks	7 (28)		
>2 weeks	18 (72)		
Gender			
Female	14 (56)		
Male	11 (44)		
Type of Atresia			
A	2 (8)		
C	23 (92)		
Waterson Type			
A	7 (28)		
B	16 (64)		
C	2 (8)		
Type of Suture			
Mattress	11 (44)		
Simple	14 (56)		
Sepsis Incidence			
Sepsis	14 (56)		
Not Sepsis	11 (44)		
Anastomotic Leak			
Leakage	5 (20)		
Not Leakage	20 (80)		
Mortality			
Survive	13 (52)		
Died	12 (48)		

3.2 Association Between Independent Variables and Mortality

As shown by bivariate analysis, sepsis is substantially associated with mortality (p<.05), while the occurrence of anastomotic leakage was significantly lower in mattrass suture than simple suture (p<.05). Sepsis incidence significantly lower in mattrass suture (27.3%, 3/11 patients) compared to simple suture (78.6%, 11/14 patients) (OR: 9.78, 95% CI: 1.55-61.64, p<.05).

Table 2: Association between independent variables and mortality outcome

Variables	Mortality (N, %)	*p*-value	OR (95% CI)
Age			
≤2 weeks (7)	3 (42)	0.55	1.33 (0.23-7.74)
>2 weeks (18)	9 (50)		
Gender			
Female (14)	7 (50)	1.00	1.2 (0.24-5.84)
Male (11)	5 (45.5)		
Type of Atresia			
A (2)	1 (50)	0.74	0.91 (0.051-16.49)
C (23)	11 (47.8)		
Waterson Type			
A (7)	4 (57.1)	0.83	-
B (16)	7 (43.8)		
C (2)	1 (50)		
Type of Suture			
Mattress (11)	3 (27.3)	0.15	4.8 (0.86-26.78)
Simple (14)	9 (64.3)		
Sepsis Incidence			
Sepsis (14)	12 (85.7)	0.00	-
Not Sepsis (11)	0 (0)		

Leakage Incidence			
Leakage (5)	4 (80)	0.14	6.00 (0.56-63.98)
Not Leakage (20)	8 (40)		

Table 3: Association between type of anastomotic suture and outcome

	Anastomotic Leakage			Sepsis Incidence		
	(N, %)	p-value	OR (95% CI)	(N, %)	p-value	OR (95% CI)
Type of Suture						
Mattress (11)	0 (0%)	0.04	-	3 (27.3%)	0.02	9.78 (1.55-61.64)
Simple (14)	5 (35.7%)			11 (78.6%)		

3.3 Multivariate Analysis

There were no prognostic factors associated with the mortality of newborns with EA in a multivariate analysis of mortality outcome.

Table 4: Multivariate analysis of the association between independent variables and Mortality outcome

Variables	Mortality	*p*-value
OR (95% CI)		
Type of Suture (Simple)	-	0.99
Leakage	0.80 (0.037-17.19)	0.88
Sepsis	-	0.99

4. Discussion

Esophageal atresia is one of the most prevalent anomalies of the gastrointestinal tract. It is estimated that EA affect 1 case in 3000–4500 live newborns. A study conducted in a single centre study in Indonesia by Gaol *et al*. stated found the incidence of AE is 1.51% in a period year of 2015 to 2020, with the average of 8 days [3]. We anastomosed the esophagus with a mean age of 18 days (18.28±5.77) with a reasoning of doing a preoperative procedure first such as gastrostomy to minimalized gastric reflux and tracheal aspiration. Around 7 days after the gastrostomy procedure and the condition of the neonates were stabilized, then we would have done the thoracotomy procedure to anastomose the esophagus. Furthermore, our institution is a national referral hospital, so the delay in the delivery referral time cannot be avoided.

Our study found that Type C Esophageal Atresia was the most common type of Esophageal Atresia in our center, and the most common Waterston type was Waterston B. A study done in Algeria by Bouguermouh *et al*. identified EA with a distal TEF (type C), the most common type, which occurred in 67% patients.[4] A single center study in Indonesia found Type C Esophageal Atresia was found in 90.3% of all children with esophageal atresia, with Waterston B was the most common Waterston type with 51.6% [3].

An incidence of anastomotic leakage and sepsis were found in our patients. Anastomosis leakage might increase the incidence of pneumonitis and sepsis, leading to a higher mortality risk [2]. A study done by Li *et al*. in 2017 found a higher incidence of prematurity, low birth weight (<2500 g), and long gap length were found in the nonsurvivor group of Esophageal Atresia. Mortality rate was influenced by NRDS, respiratory failure, anastomotic leak, postoperative sepsis, pneumothorax, and shock. The mortality of EA patients may be decreased with the use of proper preoperative assessments, excellent surgical skills, and postoperative care [5].

The sepsis incidence was found in our study after the thoracotomy procedure, beside the anastomotic leakage incidence. The incidence of sepsis was found in 56% neonates undergone the thoracotomy. According to the research conducted in the same institution from 2015 to 2021, the primary cause can be caused by the leakage, considering there was a correlation between the etiology of sepsis, leakage, and perforation on the outcome of esophageal atresia (p-value <0.001; r: 0.915) [3]. The delay of the operation time can be caused by other factor such as the delay of referral time, due to the status of our institution as a national referral hospital. A study in India by Upadhyaya *et al*. found all the mortalities in their ultralong gap esophageal atresia group were due to septicaemia following anastomotic leakage. An important predictor of the prognosis of esophageal atresia with tracheoesophageal fistula is the distance between the two esophageal pouches [6, 7].

The single layer simple suture method with various esophageal lengthening techniques has long been the main esophageal anastomosis technique in cases of EA with TEF. We used mattress suture as a suturing method to prevent the incidence of anastomosis leakage. The esophageal anastomosis is frequently carried out under considerable tension. An early esophageal anastomotic dehiscence can develop from anastomotic sutures pulling through the esophageal tissue as a result of excessive tension. Research done by Tandon *et al*. in 2009 used this mattress suture technique in 32 patients with Esophageal Atresia with Tracheoesophageal Fistula. The study compared the postoperative complications and impact on survival. It was found that in contrast to 6 major leaks and 9 minor leaks found from the group that was sutured with a simple technique, the group with mattress suture had 1 major leak case (P value: 0.0348, statistically significant) and 2 minor leaks cases (P value 0.756), respectively. The three factors of the horizontal mattress suture may be responsible for the improved outcome: (1) enhanced closure strength (tension dispersion), (2) tension spread along wound edge, (3) wound edge eversion optimization [2]. An experimental study of rat esophageal anastomoses was done to see if interrupted horizontal mattress sutures would withstand the forces of tension better than interrupted simple sutures. It was found that interrupted simple suture anastomotic breaking strength was 3.22+/-0.56 and interrupted horizontal mattress group was 3.51+/-0.61 N (p=0.30) [8].

The incidence of anastomotic stricture after the esophageal anastomosis of EA ranging between 8% and 49%, which the type of anastomosis used is one of the many factors involved in the stricture formation. The technique described by Singh in 2001 can minimise the incidence of stricture formation, which the technique creates a wide anastomosis between the esophageal ends by making a horizontal incision on the hemi circumference and a corresponding vertical incision in the lower

esophageal pouch, so the suture line is not restricted to one plane [9].

5. Conclusions

Mattrass suture is significantly associated with a lower incidence of anastomotic leakage and sepsis. At Tarakan General Hospital, neonatal mortality with esophageal atresia was high, and sepsis was the most common cause of mortality. An esophageal anastomosis leak and suture type are two additional factors of mortality. However, further studies will be needed for long-term complications such as stricture occurring on the site of anastomosis, recurrence of tracheoesophageal fistula, GERD, and adenocarcinoma because in this study, the long-term complications are yet to be established. Limitation of this study is that there were few samples, which limited our analysis. Another limitation of the study include uneven numbers between the subgroups.

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7. Conflict of Interest

Not available

8. Financial Support

Not available

9. References

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