JCTEI
JOURNAL OF CLINICAL TRIALS AND EXPERIMENTAL INVESTIGATIONS
Year: 2023 Volume: 2 Issue: 2

ORIGINAL ARTICLE

10.5281/zenodo.8139814

Comparison of thoracotomy and thoracoscopy in patients with esophageal atresia - Tracheoesophageal fistula

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Received: 28 March 2023
Revised: 10 May 2023
Accepted: 12 May 2023
Published: 26 June 2023

Keywords
- Anastomosis
- Esophageal Atresia
- Esophageal Atresia Repair
- Thoracoscopy
- Thoracotomy
- Tracheoesophageal Atresia

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Abstract

Objective: The aim of this study was to compare the patients who underwent EA-TEF repair with both classical and thoracoscopic methods, and thus to reveal the advantages and disadvantages of both techniques.

Materials and methods: In this study, the files of 45 patients who underwent surgery for EA-TEF at the Erciyes University Faculty of Medicine (EUFM) Pediatric Surgery Clinic between August 2005 and July 2012 were retrospectively examined. Patients were divided into two groups based on the surgical method applied.

Results: A total of 45 patients who presented with EA-TEF and underwent surgical procedures were evaluated. Thirty-one (70%) patients underwent thoracotomy (Group I), and 14 (30%) patients underwent surgery using the thoracoscopic method (Group II). The average gestational age was 37.5 weeks, and the birth weight was 2600 grams. Nineteen (42%) of the patients were female, and 26 (58%) were male. Group I was 39 weeks and 38 weeks in Group II. There was no significant difference in gestational age between the two groups ($p>0.05$). There was no significant difference between the groups regarding accompanying system anomalies ($p>0.05$). The time to surgery for patients in both groups was 2 days ($p>0.05$). The operation time in Group I (95 minutes) was shorter than in Group II (105 minutes) ($p<0.05$). The time to start gavage feeding after surgery in Group II was shorter compared to Group I ($p<0.05$). No difference was detected between the groups concerning the time to start oral feeding ($p>0.05$). No difference was detected between the groups concerning the length of hospital stay ($p>0.05$). There was no significant difference between the groups regarding the rate of complications ($p>0.05$). No patient died during surgery. Eleven (35%) of the 31 patients in Group I and 2 (14%) of the 14 patients in Group II died between postoperative days 1 and 25. There was no difference in mortality rates between the groups ($p>0.05$).

Conclusions: Postoperative complications were detected at similar rates in both groups.

Cite as: Aslan A, Turan C, Küçükaydın M, et al. Comparison of thoracotomy and thoracoscopy in patients with esophageal atresia - tracheoesophageal fistula. J Clin Trials Exp Investig 2023;2(2):92-99.

Introduction

Esophageal atresia (EA) is a congenital anomaly seen in one out of 2,500-4,500 live births (1-3). The most common type (85-88%) is proximal esophageal atresia with distal tracheoesophageal fistula (TEF) (4-6). The first surgical intervention was performed in 1936 by Simpson-Smith (7). The basic principle in surgical procedures is to anastomose the ends of the esophagus after the TEF has been ligated (4). In recent years, with the advancements in minimally invasive intervention techniques, EA-TEF operations have become possible using these methods. The primary repair of thoracoscopic EA-TEF was first performed in 2000 by Rothenberg (8). In our clinic, thoracoscopic EA repair has also been performed in recent years.

In this study, our aim was to compare the patients who underwent EA-TEF repair with both classical and thoracoscopic methods, and thus to reveal the advantages and disadvantages of both techniques.

Materials and methods

In this study, the files of 45 patients who underwent surgery for EA-TEF at the Erciyes University Faculty of Medicine (EUFM) Pediatric Surgery Clinic between August 2005 and July 2012 were retrospectively examined. The EUFM Ethics Committee approved the study as ethically appropriate with its decision numbered 2011/80 and dated 01.11.2011.

Patients

Patients were divided into two groups based on the surgical method applied. Patients who underwent repair with thoracotomy formed Group I, and patients who underwent thoracoscopic repair formed Group II. The choice of surgical methods was made based on the personal preferences and experiences of different surgeons.

The name, surname, gender, file number, date of birth, birth weight, presence of prenatal polyhydramnios, and time of presentation of the patients were recorded. Accompanying anomalies with EA-TEF were examined. The time of patients being taken to surgery, surgery duration, postoperative nasogastric (NG) and oral feeding time, mechanical ventilator support, length of hospital stay, and postoperative complications were examined. The data of patients who were regularly examined postoperatively were examined from the files. The families of patients who did not come for follow-up were contacted by phone to inquire about their situation and complications. The groups were compared with the existing data. In our study, patients who underwent surgery with a diagnosis of EA-distal TEF were examined. Pure EA, isolated TEF, and patients with EA-proximal TEF were not included in the study.

Thoracotomy tecnique

In EA-TEF repair with thoracotomy, the patient was placed in the right lateral decubitus position. The right hemithorax was explored with a posterolateral muscle-protective incision made in the fourth or fifth intercostal space. The azygos vein was reached with an extrapleural approach and was ligated and cut. The TEF was ligated at the point closest to the trachea with 5/0 Polydioxanone and cut. The proximal end was identified and released with the help of a probe advanced by the anesthesiologist. The anastomosis was performed with 5/0 Polyglactin, placing seven or eight single sutures over a probe advanced to the stomach. A chest tube was placed through a separate incision.

Thoracoscopy technique

In thoracoscopic EA-TEF repair, the patient was placed in a modified prone position with the right side elevated 30-45 degrees. One 4 mm and two 3 mm trocars were used in the surgery. The first trocar (4 mm) for the camera was placed in the fifth intercostal space at the posterior axillary line. The other two trocars were placed two intercostal spaces above and below the camera entry in the mid-axillary line. The hemithorax was insufflated with CO2, and after achieving lung collapse, the azygos vein was cut with a monopolar cautery. The TEF was identified and ligated with 5/0 Polydioxanone. The upper pouch was identified and released. The anastomosis between the two ends was performed with 5/0 Polydioxanone, placing seven or eight single sutures. A chest tube was placed through the lower trocar entry and the procedure was completed. After surgery, patients were sedated and kept on mechanical ventilator support. On the 7th postoperative day, methylene blue was administered orally to determine anastomotic leakage and drainage from the chest tube was monitored. In patients without anastomotic leakage and in good general condition, the NG was removed and oral feeding was started

Statical analysis

The analysis of the data was performed using the SPSS 15.0 software package, and the normal distribution suitability test was conducted using the Shapiro-Wilk test. For categorical variables, group comparisons were performed using the Chi-Square test, while for continuous variables, group comparisons were conducted using the Mann-Whitney U test. A p-value less than 0.05 was considered statistically significant.

Results

A total of 45 patients who presented with EA-TEF

and underwent surgical procedures were evaluated. Thirty-one (70%) patients underwent thoracotomy (Group I), and 14 (30%) patients underwent surgery using the thoracoscopic method (Group II). Thirty-eight (84%) of the cases were born at external centers, and 7 (16%) were born at our hospital. The average gestational age was 37.5 weeks, and the birth weight was 2600 grams. Nineteen (42%) of the patients were female, and 26 (58%) were male. Twenty-one (47%) patients presented on the day they were born, 17 (38%) on the second day, 4 (9%) on the third day, 2 (4%) on the fourth day, and 1 (2%) on the sixth day. The median gestational age of patients in Group I was 39 weeks and 38 weeks in Group II. There was no significant difference in gestational age between the two groups ($p>0.05$).

In Group I, 21 (68%) patients had one or more accompanying anomalies, while in Group II, 5 (36%) patients had accompanying anomalies. There was no significant difference between the groups regarding accompanying system anomalies ($p>0.05$). The time to surgery for patients in both groups was 2 days ($p>0.05$). The operation time in Group I (95 minutes) was shorter than in Group II (105 minutes) ($p<0.05$).

When comparing the postoperative NG and oral feeding times of the groups; patients in Group I started NG feeding on postoperative day 4 (1-7) and oral feeding on day 10 (7-36), while patients in Group II started NG feeding on postoperative day 2 (1-8) and oral feeding on day 10 (7-22). The time to start gavage feeding after surgery in Group II was shorter compared to Group I ($p<0.05$). No difference was detected between the groups concerning the time to start oral feeding ($p>0.05$). All patients were sedated and monitored with mechanical ventilator support after surgery. This period was 8 days in both groups ($p>0.05$). The hospital stay duration for patients in Group I was 17 (12-43) days, while it was 19 (13-47) days for patients in Group II. No difference was detected between the groups concerning the length of hospital stay ($p>0.05$).

No patient died during surgery. Eleven (35%) of the 31 patients in Group I and 2 (14%) of the 14 patients in Group II died between postoperative days 1 and 25. There was no difference in mortality rates between the groups ($p>0.05$).

Of the 13 deceased patients, 6 (46%) had accompanying heart anomalies, 2 (15%) had gastrointestinal system anomalies, 2 (15%) had heart anomalies along with gastrointestinal and genitourinary system anomalies, 1 (8%) had major heart anomalies with trisomy 18, and 2 (15%) had no accompanying anomalies. It was learned that a patient with Tetralogy of Fallot died at the age of 2 after cardiac surgery.

Patients were compared for complications such as postoperative anastomotic leakage, anastomotic stricture, fistula recurrence, tracheomalacia, GER, and chest wall anomalies. Postoperative complications developed in 9 (45%) patients in Group I and 6 (50%) patients in Group II. There was no significant difference between the groups regarding the rate of complications ($p>0.05$)

On postoperative day 7, all patients were given methylene blue orally to detect anastomotic leakage, and drainage from the tube thoracostomy was monitored. Minor anastomotic leakage was detected in one patient in both groups. Patients with anastomotic leakage recovered with conservative management ($p>0.05$).

In follow-up, anastomotic stricture developed in 6 (30%) patients in Group I and 4 (33%) patients in Group II. No difference was detected concerning anastomotic stricture ($p>0.05$). Balloon dilatation was applied at least once to all patients with anastomotic stricture. There was no significant difference between the groups in terms of the number of dilatations applied to patients with stricture ($p>0.05$). No patient required anastomotic revision due to this.

Fistula recurrence occurred in one patient in both groups. These patients were re-operated. The second surgery for the patient in Group II was again performed thoracoscopically. There was no significant difference between the groups ($p>0.05$).

In the follow-up, severe tracheomalacia was not observed in Group I patients but was detected in one patient in Group II. Aortopexy was performed on the patient. There was no significant difference between the groups concerning tracheomalacia ($p>0.05$).

During patient follow-up, clinical findings regarding GER were assessed using contrast media administered orally and serial films taken under fluoroscopy. GER was detected in 4 (20%) patients in Group I and 3 (25%) patients in Group II. Medical treatment was initially applied to the patients. Fundoplication was performed on patients who did not improve with medical treatment. Fundoplication was performed on two patients in both groups. There was no difference between the groups concerning the incidence of GER and fundoplication ($p>0.05$) (**Table 1 and 2**).

Table 1: Demographic characteristics of patients

	Group I	Group II	p-value
Gestational age (weeks)*	39 (30-42)	38 (35-40)	>0.05
Male	17/26	9/26	>0.05
Female	14/19	5/19	
Birth weight (gr.)*	2820 (1065-3800)	2675 (1900-3700)	>0.05
Additional anomaly	21/26	5/26	
Time to surgery (days)*	2 (0-10)	2 (1-6)	>0.05
Operation time (min)*	95 (85-130)	105 (85-155)	**<0.05**
Nutrition from NG (days)*	4 (1-7)	2 (1-8)	**<0.05**
Oral feeding (days)*	10 (7-36)	10 (7-22)	>0.05
Length of stay on the ventilator (days)*	8 (4-15)	8 (3-20)	>0.05
Length of stay in hospital (days)*	17 (12-43)	19 (13-47)	>0.05
Exitus patient	11 (35)	2 (14)	>0.05
Mortality	9 (45)	6 (50)	>0.05

* Median (min-max), Mann-Whitney Test, others Chi-square test

Table 2: Comparison of the groups

Complication	Group I (n: 20)	Group II (n: 12)	p-value
Anastomotic leak	1 (%5)	1 (%8)	>0.05
Anastomotic stenosis	6 (%30)	4 (%33)	>0.05
Dilation ≥ 1	6 (%30)	4 (%33)	>0.05
Anastomosis revision	-	-	
Fistula recurrence	1 (%5)	1 (%8)	>0.05
Tracheomalacia	0	1 (%8)	>0.05
Gastroesophageal reflux	4 (%20)	3 (%25)	>0.05
Fundoplication	2 (%10)	2 (%17)	>0.05
Chest wall deformity	-	-	

Discussion

The first successful surgery for esophageal atresia (EA) and tracheoesophageal fistula (TEF) repair was performed in 1941 by Cameron Haight. Since then, surgery has made significant progress, and minimally invasive techniques have been developed and applied for various diseases, including congenital anomalies (7-10).

In a study comparing open and thoracoscopic methods, the records of 104 patients who underwent thoracoscopic EA-TEF repair in 6 different clinics were examined and compared with the results of patients who underwent open repair. As a result, thoracoscopic EA-TEF repair was found to be safe and effective (11). In another study comparing EA-TEF patients who underwent thoracoscopic repair and those who underwent open repair, it was found that musculoskeletal deformities frequently seen in patients repaired with thoracotomy were less common and did not provide an advantage for thoracoscopic repair (12). In our study, the fact that all patients' surgeries and postoperative follow-ups were performed in the same clinic and within the same time frame is an advantage for a more objective evaluation of the results.

It is known that congenital anomalies often accompany EA. The most critical anomaly affecting prognosis among accompanying anomalies is congenital heart anomalies, and echocardiography should be performed to identify them (4,13). In addition to echocardiography, urinary system ultrasound is recommended (5,13). In a study conducted by

Chittmitrappap et al. (14), 253 infants with EA-TEF were examined, and 213 accompanying anomalies were detected in 122 (48%) infants. The most common accompanying anomalies were cardiovascular system-related, detected in 29% of patients (14). In our study, additional anomalies were detected in 21 (68%) patients in Group I and 5 (36%) patients in Group II. The most common accompanying anomaly in Group I was cardiovascular system anomalies detected in 14 (45%) patients, while in Group II, gastrointestinal system anomalies were detected in 3 (21%) patients.

In patients with EA-TEF who do not have severe respiratory distress, the surgery should be performed as soon as possible after the baby is stabilized to prevent aspiration (15). In a study by Burford et al. (16), the average surgery age for patients undergoing EA-TEF repair with thoracotomy is 3.7 days. In our study, patients who underwent repair with thoracotomy were operated on a median of 2 (0-10) days. In a study by Holcomb et al. (17), reporting the results of patients with EA-TEF undergoing thoracoscopic repair, the average surgery age is 1.2 days. In our study, the median surgery age for patients undergoing thoracoscopic repair was 2 (1-6) days. The timing of surgery for patients in both groups was found to be consistent with the literature.

Comparing the surgery durations between the groups, it was seen that the duration in Group I was 95 minutes (85-130), while in Group II, it was 105 minutes (85-155). In our study, the initially longer surgery durations of EA-TEF patients undergoing thoracoscopic repair shortened as the surgeon's experience increased, and the last cases were performed in the same duration as patients undergoing open repair.

In EA-TEF repair, it is possible to start feeding the next day with the nasogastric (NG) tube placed while performing primary anastomosis between the proximal and distal ends (18). In our study, when the postoperative NG feeding times were examined, the median was 4 (1-7) days in Group I and 2 (1-8) days in Group II. The reason for the later NG feeding in Group I patients compared to Group II is the surgeon's personal preference, thinking that the anastomosis would be safer in this way. The postoperative oral feeding times are 10 (7-36) days in Group I and 10 (7-22) days in Group II.

In a study by Manning et al. (19), the average hospital stay for 63 patients undergoing thoracotomy due to EA-TEF is 24 (9-174) days. In another study, the average hospital stay for 104 patients treated with thoracoscopy is 18.1 (6-120) days (17). In our study, the median hospital stay for patients treated with thoracotomy was 17 (12-43) days, and for patients who underwent thoracoscopy, it was 19 (13-47) days, consistent with the literature.

In our study, when the groups were compared in terms of mortality rates, the mortality rate in Group I was found to be higher than in Group II. The reason for this is attributed to the higher incidence of heart anomalies in Group I compared to Group II (45% vs. 14%). In all patients in the series, mortality rates were found to be higher when compared with the literature.

Postoperative complications can occur in the early or late period. Early complications may be related to patient-specific factors, surgical technique, or a combination of both. These complications include anastomotic leaks (radiological or incidental, minor and major leaks), anastomotic strictures, TEF recurrence, and esophageal dysmotility accompanied by aspiration risk.

Minor anastomotic leaks are seen in 6-17% of cases (20,21). These leaks can usually be detected by the presence of saliva in the chest tube and can be treated as previously mentioned. Anastomotic leakage may be due to too few or too many sutures or poor suture technique. It has also been suggested that knots being too tight or not including the mucosa during anastomosis can lead to poor anastomotic healing (22). Tension on the suture line is a factor that contributes to the possibility of leakage and subsequent stricture formation. Mobilizing both the proximal and distal esophageal pouches will be helpful in reducing tension on the anastomotic line (22). While doing this, excessive mobilization of the distal esophageal pouch should be avoided to prevent impaired blood supply (23). In these infants, the postoperative intensive care process is at least as important as the surgical correction of the anatomical anomaly. If the neck is excessively extended or the NG tube is carelessly inserted during re-intubation, the anastomosis may partially or completely separate during these procedures. In our study, minor anastomotic leakage was detected in one patient (5%) in Group I and one patient (8.5%) in Group II. This data was found to be consistent with the literature.

Major leaks are usually seen in the early postoperative period (within 48-72 hours) at a rate of 3-5% (14). Mediastinitis may occur in these infants. A life-threatening situation is the development of tension pneumothorax, which requires urgent needle

decompression followed by tube thoracostomy (7). Another option is cervical esophagostomy and gastrostomy. The incidence of esophageal stricture is quite high after a major anastomotic leak. No major anastomotic leaks were detected in the patients in this series.

After esophageal atresia (EA) repairs, anastomotic stricture occurs in 6-40% of cases (25). The most well-known cause of anastomotic stricture is the tension that creates a low-grade ischemia at the anastomosis site (25). Another contributing factor to stricture formation is the suture technique used. A double-layer anastomosis is reassuring, but it increases the amount of tension in the remaining esophageal segments and may have a negative impact on intramural vascularization in the long term (23-25). In a study by Engum et al. (25), which treated 174 patients with thoracotomy, the anastomotic stricture rate was 32.7%. In a series of 104 patients treated by Holcomb et al. (11) with thoracoscopy, this rate was 31.7%. In our study, a stricture rate of 30% in group I and 33% in group II was identified, with no statistically significant difference between the groups. The rate of anastomotic stricture development in this series is consistent with the data in the literature.

In patients with EA, tracheoesophageal fistula (TEF) recurrence occurs in 2-15% of cases and is usually at the original location of the fistula. If an anastomotic leak has occurred or the anastomosis is tense, the risk of fistula recurrence is higher (29-31). In our study, fistula recurrence was observed in one patient (5%) in group I and one patient (8%) in group II. These rates are consistent with the data in the literature. Both patients underwent surgical repair of the fistula. The patient in group I was lost due to mediastinitis. The fistula repair of the patient who had previously undergone thoracoscopic repair was again performed thoracoscopically, and the patient recovered.

In surgeries performed with thoracotomy, musculoskeletal sequelae occur at a higher rate compared to thoracoscopy. Scoliosis is more common in patients who have had multiple thoracotomies or in whom the serratus anterior or latissimus dorsi muscle groups or their innervation have been damaged. Some women have developed breast asymmetry (32-35). In our study, all patients who underwent open surgery received muscle-sparing surgery. No musculoskeletal sequelae were observed in the follow-up of patients in both groups. It is interpreted that this may be related to musculoskeletal sequelae being observed in longer-term follow-ups.

In our study comparing the results of open and thoracoscopic methods in EA-TEF repair, no differences were detected between the two groups in terms of patient characteristics and postoperative complication rates. More definitive data can be obtained in comparing the two methods if a larger number of patients are studied with long-term follow-ups, and patients are ensured to attend regular follow-up visits.

Conclusions

In the group where thoracotomy was performed, the surgery duration was found to be shorter. In the group with thoracoscopy, patients started gavage feeding earlier in the postoperative period. In both groups, postoperative mechanical ventilator support and hospital stay durations were found to be similar. Postoperative complications were detected at similar rates in both groups.

Conflict of interest:

The authors report no conflict of interest.

Funding source:

No.

Ethical approval:

The EUFM Ethics Committee approved the study as ethically appropriate with its decision numbered 2011/80 and dated 01.11.2011.

Acknowledgment:

No

Peer-review:

Externally. Evaluated by independent reviewers working in at least two different institutions appointed by the field editor.

Contributions

Research concept and design: AA, CT, ABD, MED
Data analysis and interpretation: AA, CT, MK, SA
Collection and/or assembly of data: AA, CT, MK, SA, ABD, MED
Writing the article: AA, CT, SA
Critical revision of the article: AA, MED
Final approval of the article: AA, CT, MK, SA, ABD

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