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A COMPARATIVE STUDY OF AZYGOS VEIN LIGATION AND PRESERVATION IN ESOPHAGEAL ATRESIA SURGERY: TECHNICAL AND CLINICAL IMPLICATIONS

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ABSTRACT

Esophageal atresia (EA) and tracheoesophageal fistula (TEF) were regarded as fatal defects, but nowadays, more than 90% of such cases survive because surgeons' techniques have been invented. Since the first surgery attempt in 1888, it has gone through numerous improvements; hence, the outcome is improved with minimal complications. In the routine case the azygos vein will be ligated and cut high up to permit of more easy access to the atretic ends of the esophagus and the fistula, in order that anastomosis may be facilitated. Azygos vein also plays a significant role in the mediastinal venous drainage which is identified to prevent postoperative complications such as pneumonitis and anastomotic leaks as demonstrated in the previous studies. Esophageal anastomosis can be performed to the median or lateral of the preserved azygos vein, but lateral technique is more commonly used due to the simplicity of the procedure. The purpose of this prospective comparative study was to evaluate the practicability and potential advantages of performing esophageal anastomosis mediately to the preserved azygos vein. Three groups of 200 patients each were randomized, Group A (azygos vein ligated), Group B (azygos vein preserved and anastomosed laterally), and Group C (azygos vein preserved and anastomosed medially). The results confirmed that there were no considerable discrepancies between the groups in respect of the operative time and the nature of the patients. The development of postoperative complications, pneumonitis, anastomotic leak and mortality were not different in all the groups with the highest rate of complications and mortality in Group A. Although there was no reported difference in post-operative outcome compared to medial anastomosis to the preserved azygos vein, it permitted the restoration of normal anatomical relationships, and provided the most direct path to the neo-esophagus. Technically this operation was possible and it did not increase the operating time.

Keywords: Azygos Vein Preservation, Esophageal Atresia, Tracheoesophageal Fistula, Anastomosis Techniques, Postoperative Complications

INTRODUCTION

Esophageal atresia (EA) associated with tracheoesophageal fistula (TEF) is a congenital malformation, which was previously regarded as a malformation incompatible with life. Nevertheless, over the decades, the survival rates have drastically increased because of improvements in surgical methods, which are currently around over 90 percent [1]. Since then and since the first documented surgical attempt by Charles Steele in 1888, many improvements have been made, greatly improving the outcome of surgery and complications have been minimized [2]. The most common technique of EA/TEF repair is to ligate and cut azygos vein at the beginning of the operation. This maneuver helps to access the atretic esophageal stumps and the

tracheoesophageal fistula easily and the subsequent anastomosis becomes easier. Although this is a common practice, the azygos vein is critical regarding venous drainage of the mediastinal area, which results in hemodynamic stability and elimination of postoperative complications, including pneumonitis and anastomotic leaks [3-5]. The maintenance of azygos vein has been described to lessen tissue congestion and edema in the thorax, which finally leads to enhanced healing of the wound and fewer complications. The surgical junction of the esophageal pouches is called esophageal anastomosis and it could be made either in the midline or lateral to the preserved azygos vein. The latter is not used as frequently as the lateral approach because it is procedurally simpler and most surgeons are familiar with it [6]. Recent reports have, however, indicated that surgical anastomosis below the preserved azygos vein could have potential anatomical and physiological advantages including the restoration of normal anatomical relationships in the mediastinum and the fact that it does provide the shortest path of the neo-esophagus [7]. This prospective comparative study aim was to determine the technical possibility and the possible benefits of doing esophageal anastomosis mediad to the preserved azygos vein. The study was designed to assess that this method offered any considerable advantages as compared to the traditional lateral anastomosis or the ancient procedure of azygos vein ligation. Using operative time, postoperative complications, and mortality rates as the relevant data, the study aimed at discovering how using the medial approach affected the overall result of the surgery and whether it can be viewed as a valid alternative to the existing practices.

MATERIALS AND METHODOLOGY

The study was a prospective comparative study conducted to determine the feasibility and the potential benefits of doing esophageal anastomosis lateral to the preserved azygos vein in neonates with esophageal atresia (EA) and tracheoesophageal fistula (TEF). The study included all patients with EA/TEF who underwent primary surgical repair and fell within the inclusion criteria. Neonates having long-gap esophageal atresia with or without tracheoesophageal fistula, in whom primary esophageal anastomosis could not be performed were excluded in the study. Two-hundred neonates were recruited and they were randomly divided into three groups, Group A (azygos vein ligated), Group B (azygos vein preserved with lateral anastomosis), and Group C (azygos vein preserved with medial anastomosis). It was randomized using simple randomization technique in order to make the groups comparable. Experienced pediatric surgeons performed all the surgeries using the extra-pleural approach.

Demographics of the Patients: There was no difference among the three groups (A, B and C) in terms of the gestational age, age at presentation, sex, birth weight, associated anomalies and the distance between the esophageal pouches after their mobilization. A thorough demographic evaluation using variables, such as sex, gestational age, birth weight, presence of any associated anomalies and distance between the esophageal pouches following the mobilization, was done on each patient.

Surgical Technique: All were operated by means of a right posterolateral thoracotomy. The parietal pleura was easily freed of the endothoracic fascia with wet pledgets and the azygos vein was located as it crossed over to the left side of the right pleural cavity. The endothoracic fascia was incised just below the azygos arch and the fascia removed above the arch to form a tunnel through which a blunt, right-angled forceps was passed under the azygos arch. In case the lower esophageal pouch ended in a fistula beneath the azygos arch the fistula was spatulated and divided and its opening made tight with interrupted non-absorbable sutures or by transfixation. Then its lower end was pulled through the tunnel made below azygos arch and an end to end anastomosis was performed with the upper esophageal pouch after sufficient mobilization. In case the lower esophageal pouch terminated higher with a fistula to the trachea the pouch was re-formed above the azygos arch by merely pulling down on the azygos arch with a pull. The normal anatomical relations were re-established and the neo-esophagus was anastomosed in the middle to the preserved azygos vein.

Postoperative Management: Early enteral feeding was started with the insertion of 6 Fr trans-anastomotic feeding tube at the time of anastomosis. Twenty-four hours after surgery feeding was initiated. Retro pleural drain was inserted at the discretion of the surgeon, and all the patients were followed up closely in the post-operative period to detect any complications in the form of pneumonitis and anastomotic leaks. On the 6 th postoperative day, a water-soluble contrast esophagogram was carried out and then oral feeding was started. The data, obtained in the three groups was analyzed by standard statistical methods. Operative time, postoperative complications (such as pneumonitis, anastomotic leaks and mortality), and other variables were compared using chi-square tests and analysis of variance (ANOVA). The statistically significant P-value was set to be less than 0.05. The results were reported in the form of percentages, means and standard deviations where necessary [1-7].

RESULT

The patients who were used in the study were 200, 67 patients in Group A, 67 in Group B and 66 in Group C. No significant differences in the justifiable patient features, such as sex, mean age at admission, mean weight, prematurity, associated anomalies, and distance between the esophageal pouches following the mobilization were present amongst the three groups (Table 1). Meaning of average operative time was similar in all the groups; 60 minutes in Group A, 62 minutes in Group B and 64 minutes in Group C. There was no significant difference between the groups in terms of the time of procedure and it means that either preservation of the azygos vein or the location of anastomosis did not influence the time of operation. All the groups experienced the postoperative complications with the pneumonitis as the most frequent complication. Group A (28%), Group B (13.95%) and Group C (11.62) had the highest incidence of pneumonitis. However, the difference between the groups was not found to be significant ($p > 0.005$), and it showed that anastomosis technique either towards the median or lateral to azygos vein did not affect the occurrence of pneumonitis significantly. Anastomotic leaks were the other significant complication in the study. Group A (20%), Group B (13.95%) and Group C (10.52%) recorded the highest incidence of anastomotic leaks. Group A has also given the highest occurrence of major leaks (11.42%) and the least occurrence of major leaks was observed in Group C (7.89). Group A recorded the highest percentages of minor leaks (8.57%) and Group C recorded the lowest (2.63%). Again, the differences between the groups were not found to be significant ($p > 0.005$) and this fact indicated that location of anastomosis medial or lateral did not affect the rates of leakage significantly. Group A (22.85%), Group B (11.62%) and Group C (10.52%) showed the highest mortality rates. Major related anomalies were associated with severe pneumonitis and septicemia, significant anastomotic leaks and complications that were attributed to be associated with mortality. Though the study found the differences in postoperative complications such as pneumonitis, anastomotic leaks, mortality, no statistically significant advantages could be found between the groups basing on the technicality of conducting esophageal anastomosis, either mediated or lateral to the preserved azygos vein.

Table 1: Patient Characteristics by Group

Patient Characteristic	Group A (n=67)	Group B (n=67)	Group C (n=66)
Male	22	26	23
Female	13	17	15
Mean age at admission (hrs)	37.93	41.87	40.16
Mean weight (kg)	2.48	2.72	2.59
Premature	9	14	12
Associated anomalies	13	14	10
Mean gap (cm)	1.43	1.29	1.37

Table 2: Postoperative Complications by Group

Parameter	Group A (n=67)	Group B (n=67)	Group C (n=66)
Average operative time (min)	60	62	64
Pneumonitis	19 (28%)	9 (13.95%)	7 (11.62%)
Anastomotic leaks (Total)	14 (20%)	9 (13.95%)	7 (10.52%)
Anastomotic leaks (Major)	8 (11.42%)	6 (9.30%)	5 (7.89%)
Anastomotic leaks (Minor)	6 (8.57%)	3 (4.65%)	2 (2.63%)
Mortality	15 (22.85%)	8 (11.62%)	7 (10.52%)

Figure1: Patient Characteristics by Group

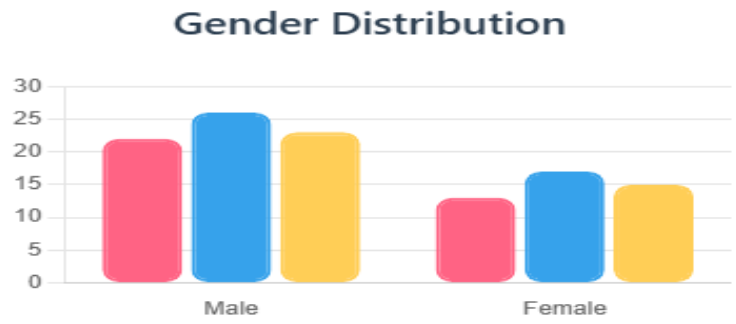
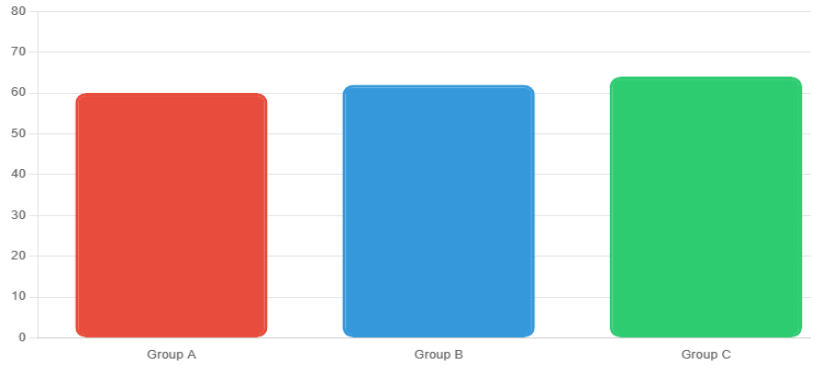


Figure 2: Postoperative Complications Analysis



DISCUSSION

Esophageal atresia (EA) and tracheoesophageal fistula (TEF) used to be regarded as a fatal malformation. However, with the creation of more effective surgical operations, the survival chances have radically shifted and today, the outcomes are more than 90 per cent. Since the first surgery was conducted by Charles Steele on a patient with EA without TEF in 1888, refinements of the operative procedures have been made numerous times, leading to improvements in the surgical outcome, reduction of the mortality and reduction of the complications. Azygos vein ligation and division early in the operation to facilitate access to the atretic esophageal ends and fistula is now the most popular and anastomosis is easier. Azygos vein is said to play a crucial role in the venous return as it has the potential to provide alternative routes to the blood and it also provides the shortest route between the tissue source and the great veins. The superior right intercostal vein drains into the azygos arch, with the 2nd, 3rd and 4th posterior intercostal veins. The azygos vein then crosses over the hilum of the right lung at the 4 th thoracic vertebra level and enters the superior vena cava, with the esophagus located medial to the azygos vein in the posterior mediastinum [1-4]. It has been shown that preservation of the azygos vein during surgery can permit preservation of the mediastinal venous drainage which helps to relieve postoperative chest congestion and tissue edema. This, in its turn reduces the risks of getting such complications as

pneumonitis and anastomotic leaks, and enables the wounds to heal better. Esophageal anastomosis can be performed lateral or medial to the intact azygos arch but lateral approach is more common due to the ease of the procedure. We have done the anastomosis between the preserved azygos arch and meditation in our series without any significant technical difficulty and this does not add operative time. In accordance with other studies, though the groups where the azygos vein was intact (Groups B and C) experienced less complications and lower mortality rates as compared to Group A where the azygos vein was ligated, the study outcomes were not determined to be statistically significant [5-7]. Our procedure of preferred anastomosis in the median to the preserved azygos arch, not only restores the normal anatomical relations, but it also gives the neo-esophagus the shortest path along which to pass.

CONCLUSION

The management of esophageal atresia (EA) and tracheoesophageal fistula (TEF) has been a revolution since it has been possible to repair it continuously and the conditions that were originally fatal are now curable since the survival rate is over 90%. These inventions have significantly reduced complications and mortality rates over the years. Traditionally, once the surgery is initiated, the surgical procedure commences with ligation and division of the azygos vein that helps in exposing the atretic ends of the esophagus and the fistula that helps in making the anastomosis easier to achieve. However, the surgical significance of the azygos vein preservation has proved to carry important physiological benefits, in particular, the drainage of the mediastinal venous system, which will compensate the postoperative complications, in particular, chest congestion, tissue edema, pneumonitis, and anastomotic leaks. This prospective comparative study had an objective of establishing the benefits of esophageal anastomosis mediastinal to the preserved azygos vein when compared to the standard lateral anastomosis and the traditional azygos vein ligation. Two hundred neonates with EA/TEF were randomly assorted into three groups Group A (azygos vein ligated), Group B (azygos vein preserved and lateral anastomosis), and Group C (azygos vein preserved and medial anastomosis). The groups did not differ in terms of patient characteristics, including sex, average age at admission, birth weight, prematurity, associated anomalies, and the distance between the esophageal pouches after mobilization. The operative time was not significantly different in the groups; Group A- 60 min,Group B- 62 min and Group C- 64 min. It suggests that preservation of the azygos vein and the site of anastomosis (medial or lateral) did not affect the total length of the procedure. The rates of postoperative complications including pneumonitis, anastomotic leaks and mortality were noticed in all the groups with the highest rates in Group A. Specifically, pneumonitis was more in Group A (28%) than Groups B (13.95%) and C (11.62%), anastomotic leaks were most in Group A (20%) and least in Group C (10.52%). Although no statistically significant differences were observed between the medial and lateral anastomosis groups, anatomical benefits of the medial approach to the preserved azygos vein were observed to provide a restoration of normal mediastinal relationships and provide the shortest path which the neo-esophagus could take. This technique did not require addition of operative time and was technically simple, thus it may be used as an alternative to more commonly used lateral anastomosis. The anatomical advantage of medial anastomosis and azygos vein preservation was seen to have no significant impact on the reduction of postoperative complication and mortality as compared to the standard methods hence, the medial technique provides a normal anatomical alignment and ideal path to the neo-esophagus and as such is a potential technique to be used in surgical management of EA/TEF. Longer-term benefits of this modality need to be establishes prospective studies of sufficient durations need to be carried out to establish longer term benefits of this modality.

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