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# PROGNOSTIC IMPLICATIONS OF GAP LENGTH IN TRACHEOESOPHAGEAL FISTULA WITH ESOPHAGEAL ATRESIA CASES

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**Abstract**

**Background and Objectives-** This study was aimed at identifying factors which may affect the gap length in cases of esophageal atresia with tracheoesophageal fistula (EA-TEF) and whether gap length plays any role in determining the outcome.

**Methods-** This was a prospective observational study conducted in a tertiary care hospital including all cases of gross type C EA-TEF from August 2021 to December 2023. In this study, the cases of pure EA were not included. The patient's age at operation, their sex, their gestational age, their birth weight, their parents' ages, the order of birth, any concomitant abnormalities, and the presence of polyhydraminos in the womb were all documented parameters. A total of 66 cases were studied. Epi-info 7 was used for analysis.

**Results-** A total of 66 patients were divided in three groups based on gap length. As the gap length progresses the age at surgery also increases but it was not significant similar with gestational age and birth weight increases with gap length which was significant ($p<0.05$). Most of the patients belonged between 2-2.5 kg weights. Among 66 patients 36 were females and 30 were males. Radiographic assessment shows tube arrest is more common at T2-T3 levels in group A while it was more common in T3-T4 levels are in group B and C and it was statistically significant.

**Conclusion-** The gap length and birth weight exhibited a direct reciprocal relationship. Intraoperative gap length was linked with radiographic evaluation. Poorer results and a greater demand for postoperative ventilation were linked to longer gaps.

**Keywords-** Esophageal atresia, gap length, tracheoesophageal fistula, pneumonitis.

## Introduction-

A century ago, Haight and Towsley successfully repaired the first case of esophageal atresia with tracheoesophageal fistula (EA-TEF), marking the victory of humanity over one of the most fatal diseases that affects neonates.[1]The survival rates have significantly changed as a result of improvements in patient treatment and a deeper comprehension of the illness. After a

dismal start, the western world's current survival rate is getting close to 100%. In underdeveloped nations like India, where the majority of EA-TEF kids come late with aspiration pneumonitis and a high prevalence of low birth weight, the situation is still not as positive. While a number of prognostic classifications have been presented, none of them are appropriate for predicting the result in these circumstances.[2,3] In cases of EA-TEF, the distance between the two esophageal pouches is thought to be a significant independent risk factor for both short- and long-term outcomes.[4] Little information is available about the potential variables that could influence the gap length in EA-TEF patients. Although they haven't been researched previously, preterm, low birth weight, and other related congenital abnormalities may have an impact on gap length in EA-TEF patients.[5]

The preoperative evaluation of gap length aids in the prognostication of the disease and helps the surgeon get ready for the procedure. In this work, we evaluated the impact of gap length on the result as well as the influence of other factors that may affect gap length in EA-TEF situations.

**Materials and Methods-**

This was a prospective observational study conducted in a tertiary care hospital including all cases of gross type C EA-TEF from August 2021 to December 2023. In this study, the cases of pure EA were not included. The patient's age at operation, their sex, their gestational age, their birth weight, their parents' ages, the order of birth, any concomitant abnormalities, and the presence of polyhydraminos in the womb were all documented parameters. A total of 66 cases were studied.

**Methodology-**

For every patient, a plain radiograph was obtained, showing the chest, belly, and upper esophagus with nasogastric tube 8 Fr in place. This was done to confirm the diagnosis and check for any obvious abnormalities. The distal end of the nasogastric tube was arrested at the thoracic vertebral level. This is equivalent to the upper esophageal pouch's lower end. A putative evaluation was performed at the level of upper pouch in respect to the thoracic vertebra at the level of clavicle, which represents the first thoracic vertebrae. The radiographic findings were grouped into four groups as T1-T2; T2-T3; T3-T4; and T4 depending on the thoracic vertebral level of arrest of the lower end of the nasogastric tube. Before the fistula ligation and upper pouch mobilization, the gap length between the two esophageal pouches was measured intraoperatively in cm using a Vernier caliper in all of these instances that underwent right posterolateral thoracotomy.

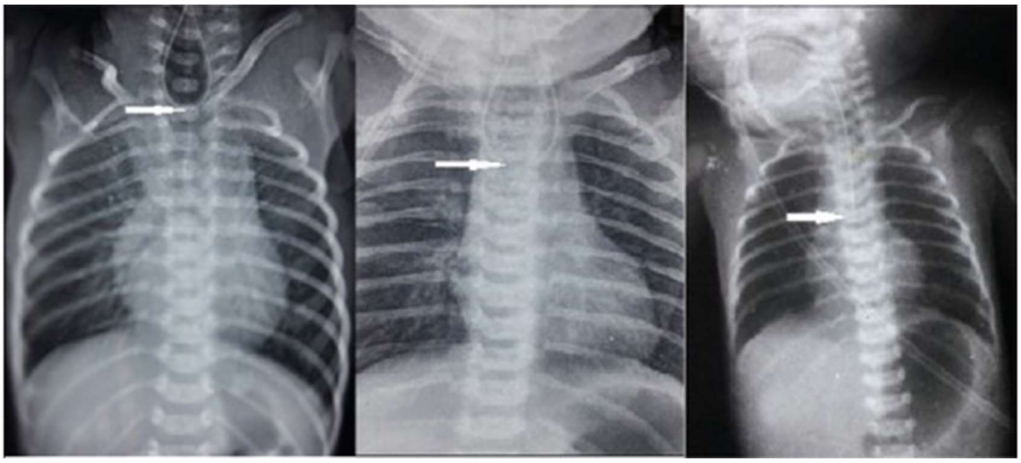
The patients were divided into three groups according to the measured gap length as Group A gap length >2.1 cm (long), Group B gap length >1-≤2 cm (intermediate), and Group C gap length ≤1 cm or less (short). Analysis was done on how different parameters affected the gap length in each of the three groups. Following surgery, the measured gap length was compared to the radiography groups that had previously been recorded. The three groups' requirements for postoperative ventilation were contrasted. The percentage of survivors in each of the three gap length groups at the time of hospital discharge was the end result.

**Statistical Analysis-**

Epi-info 7 was used for analysis. The means were used to express all descriptive data and (SD) as well as frequency (%). Fischer's exact test and the chi-square test were used to evaluate how the two groups' primary and secondary outcome measures differed from one another. In terms of statistics, a p value less than 0.05 was deemed significant.

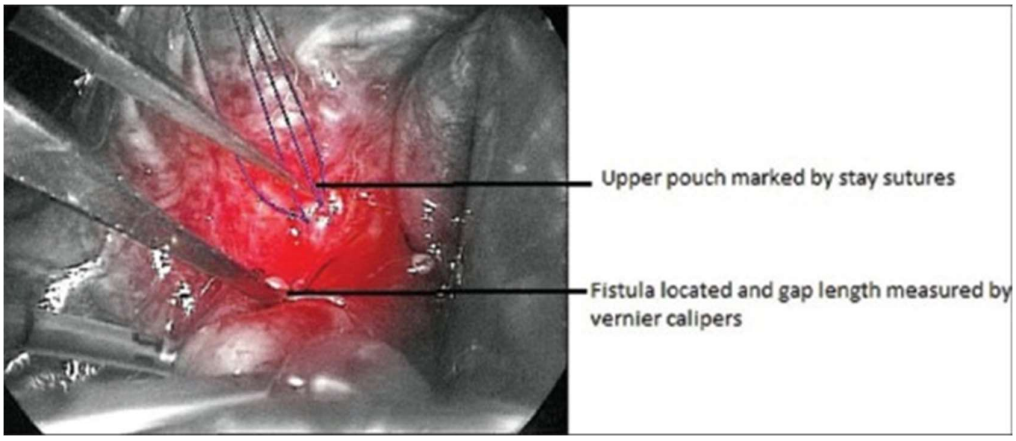
**Results-**

**Figure 1- Gap length A, B, C Group**



Chest X-ray showing different levels of arrest of the nasogastric tube (white arrow) (a) arrest at T1-T2 level (gap length = 2.2 cm), (b) arrest at T3–T4 level (gap length = 1.2 cm), (c) arrest at T4 level (gap length = nil)

**Figure 2- Measurement of intra operative gap length**




As per figure 2 the measurements of intra-operative gap length was shown, gap is measured by Vernier calipers and upper pouch is marked by stay sutures.

**Table 1- Demographic presentation of study participants based on Gap length**

| **Variables** | **Gap length** | | | **P-value** |
|---|---|---|---|---|
| | **A (22)** | **B (24)** | **C (20)** | |
| Age at surgery | 1.72±0.88 | 1.84±1.01 | 2.52±1.52 | 0.08 |
| 1-2 days | 18 | 22 | 17 | |
| 3-4 days | 2 | 2 | 1 | |
| 5-6 days | 2 | 0 | 2 | |
| Gestational age (weeks) | 35.42±1.58 | 36.44±1.82 | 36.62±1.42 | 0.09 |
| Birth weight (kg) | 2.12±0.36 | 2.36±0.42 | 2.48±0.40 | 0.01* |
| <1.5 | 0 | 0 | 1 | |
| 1.5-2 | 11 | 4 | 0 | |
| 2-2.5 | 11 | 10 | 11 | |
| >2.5 | 0 | 10 | 8 | |
| Order of birth | 1.48±0.86 | 1.18±0.48 | 1.56±0.16 | 0.21 |

As per table 1 patient characteristics based on gap length was studied. A total of 66 patients were divided in three groups based on gap length. As the gap length progresses the age at surgery also increases but it was not significant similar with gestational age and birth weight increases with gap length which was significant ($p<0.05$). Most of the patients belonged between 2-2.5 kg weights. Among 66 patients 36 were females and 30 were males.

**Table 2- Intra operative gap length groups v/s Pre-operative radiological assessment groups, need for post-operative ventilation and mortality**

| **Variables** | **Gap length** | | | **P-value** |
|---|---|---|---|---|
| | **A (22)** | **B (24)** | **C (20)** | |
| **Radiographic assessment** | | | | 0.001* |
| T1-T2 | 2 | 0 | 0 | |
| T2-T3 | 19 | 7 | 2 | |
| T3-T4 | 1 | 17 | 17 | |

| | | | | |
|---|---|---|---|---|
| T4 | 0 | 0 | 1 | |
| **Post-operative ventilation** | | | | 0.01* |
| No | 6 | 14 | 12 | |
| Yes | 16 | 10 | 8 | |
| **Post-operative outcome** | | | | 0.001* |
| Death | 7 | 4 | 1 | |
| Discharge | 15 | 20 | 19 | |

As per table 2 radiographic assessment shows tube arrest is more common at T2-T3 levels in group A while it was more common in T3-T4 levels are in group B and C and it was statistically significant. Nearly 80% patients of group A required ventilation while compare to group B And C. Since due to higher ventilation the post-op outcome of mortality was higher in group A and least in Group C and it was significant ($p<0.05$).

**Discussion-**

With or without TEF, the prognosis in EA is significantly predicted by Waterston's risk categorization[1], which takes into account three factors: birth weight, the severity of the pneumonia, and the severity of related irregularities. The impact of Waterston's risk factors has been largely mitigated by early identification, better surgical techniques, newborn anesthetic, sophisticated ventilator support, advanced critical care management, and early treatment of related congenital defects. Enhanced survival rates were seen, regardless of Waterston's classifications.[6]

From a surgeon's standpoint, the goal in EA-TEF instances is to accomplish a main anastomosis, for which the gap length is crucial. The gap length has also been shown to be a significant outcome predictor in certain investigations.[7,8] The gap length is preoperatively assessed to aid in the surgeon's operational readiness. We attempted to evaluate the influence of various factors on the gap length as well as the impact of gap length on the outcome because there is a dearth of information in the literature addressing the potential factors determining the gap length in cases of EA.

According to WHO standards, the majority of newborns born in impoverished nations like India have low birth weights, and most deliveries are made by unskilled staff, which delays the detection of these instances.[9] We have chosen gap length as a new approach for prognosticating such patients because the majority of TEF with EA kids that reported at our center were low birth weight, had pneumonitis, and had sepsis-like symptoms.

During surgery, it is convenient to measure the gap length in centimeters. As an alternative, it can be said to be comparable to the vertebral bodies. In this investigation, we used Vernier

calipers to quantify it in centimeters while performing a thoracotomy. Our analysis did not include pure EA since their care does not involve early thoracotomy. Based on the intraoperative measurement of gap length, the patients were categorized into three groups for comparison: A 22 (33%), B 24 (36%), and C20 (31%).

Our research revealed a clear correlation between the gap length and the birth weight. Anastomosis becomes more practical and tension-free as birth weight grows since the gap length decreases. More gap length was seen in our low birth weight patients, and this discovery has not been previously published. The idea that a large infant should have a larger anatomical gap than a baby of proportionately smaller size is contradicted by this observation. This might be explained by the esophagus growing more proportionately in a baby with a larger body weight.

Similar to the findings in few studies patients with lengthy gap lengths had considerably increased mortality in this study[9] In a group of 66 neonates, they also found that the incidence of all problems rose with increasing gap length. They suggested that a classification based on gap length was more appropriate in the current day.[9] Our long gap patients also required substantially more postoperative breathing, which is consistent with study results.[10] Upadhyaya et al.[11] and Mansur et al.[12] have both highlighted the significance of gap length on the ultimate result in EA patients. Nevertheless, a recent study by Thakkar et al.[13] disproved the notion that gap length is a significant predictor of outcome.

Over the past century, a great deal of research has been done on the variables influencing the survival in EA. The patient's overall health and the severity of their esophageal disease are the two main elements that determine their prognosis.[14] Survival rates above 90% have been documented in the western world with early diagnosis, comprehensive neonatal care, and postoperative ventilation, regardless of birth weight and related abnormalities.[14] In the present situation, the earlier classifications have consequently been called into question.

In 2/24 (20.8%) patients the tube arrest occurs at the T1-T2 level, corresponding to gap length Group A. In 19/24 (75%) patients, the tube arrest occurs at the T2-T3 level. In 17/20 (89.47%) of the patients in gap length group C, the tube was found to have arrested at the T3-T4 level. It was determined that this link was statistically significant ($P < 0.001$). A linkage like this has never been documented before. This finding avoids the need—as recommended by some authors—for a preoperative computed tomography scan to measure the gap length and shields a newborn from needless radiation exposure.

According to this study, risk factors (such as low birth weight, prematurity, age at presentation, severe pneumonitis, and other associated congenital abnormalities) that were used in the previous classifications of these patients were found to predict their outcome, but they were not significant factors for developing nations like India. The majority of the patients in this series had low birth weights, a significant incidence of concomitant abnormalities, pneumonia, sepsis, past feeding attempts, and late hospital admissions. We believe that both short- and long-term effects can be predicted by the distance between the two esophageal pouches.

**Conclusion-**

It was discovered that the gap length and birth weight were directly correlated, with a lower weight corresponding to a larger gap. The thoracic vertebral level of the tube's arrest (T1–T4), as revealed by radiography used for preoperative gap length measurement with a feeding tube in the upper esophagus, corresponds with the gap's intraoperative finding. Higher gap lengths result in worse outcomes and a greater demand for postoperative breathing. With TEF surgery, this classification—which is based on readily quantifiable criteria—offers a helpful way to forecast the morbidity, long-term prognosis, and mortality of EA.

**Conflict of Interest**- None declared

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