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JSM Cardiothoracic Surgery

Short Communication

Is there an Increased Risk of Thoracoscopic Esophageal Leaks due to Intra-Pleural Pressures in Neonates

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Submitted: 23 June 2017

Accepted: 16 August 2017

Published: 19 August 2017

ISSN: 2378-9565

ISSN: 2573-1297

OPEN ACCESS

Abstract

Trans-pleural thoracoscopic repair of esophageal atresia was first performed in 1999. Esophageal leak rates are twice higher when compared to the open approach. Two-dimensional view and difficulty in suturing within the small neonatal chest cavity as well as the loss of tactile sensation may explain this higher leak rate. We propose that a sustained negative pleural pressure by trans-pleural approach may contribute to this leak rate. Over a 3-year period, 11 neonates undergoing patent ductus arteriosus ligation via extra- or trans-pleural approach were selected. After ligation, an intercostal drain was placed and a non-invasive manometer was connected to it. Continuous pressure measurement was carried out for 24 hours. In cases with extra-pleural approach; an initial negative pressure rapidly reached zero whereas in trans-pleural cases, pressures remained negative over 24 hours. It is therefore possible that increased esophageal leak may be as the result of sustained negative trans-pleural pressures.

INTRODUCTION

Anastomotic leakage after esophageal atresia (EA) repair is an unusual but serious complication of the surgery. This may occur due to technical errors during the anastomosis; (a) incorrect placement of suturese.g. by not including submucosa; (b) ischaemia of the oesophagus due to excessive mobilization; (c) undue tension on the oesophagus anastomosis [1-4]. Open extra-pleural (EP) approach has been the gold standard for 5 decades mainly to contain such leaks if they should occur. The reported incidence rate by this approach is approximately 5%-8% [5,6]. However, with the introduction of thoracoscopic EA surgery, the approach by most surgeons is that of a trans-pleural (TP) approach. Leak rate with this approach has doubled to 11%-19% in 2 large recent series [7,8]. The aim of study is to ascertain whether pleural pressures have a role in this complication, utilizing patients undergoing patent ductus arteriosus (PDA) ligation.

MATERIALS AND METHODS

Over a 3-year period (Jan 2012- Jan 2015), 49 neonates underwent PDA ligation either by EP or TP approach via a left 3rd rib space. A chest tube was inserted in all cases after closure of the thoracotomy wound.

Patients who were on high frequency oscillation (23 cases) or positive pressure ventilation (15 cases) were excluded because, these neonates would all have had positive pleural pressures. Majority of PDA patients were on these modalities of ventilation due to altered cardiac circulation or lung prematurity.

11 remaining patients, who were on spontaneous ventilation mode (SIMV), were selected for this study. SIMV is physiologically similar to spontaneously breathing in infants and therefore suitable for pleural pressure measurement. There were 5 EP and 6 TP cases.

After completion of surgery and insertion of an intercostal drain, a standard non-invasive manometer was connected to it via a 3-way stop cock and continuous pressure measurement was carried out for 24 hours (Figures 1,2). Drains were removed after 24 hours as per standard protocol for PDA ligation.

Ethics was obtained from local advisory bodies and included in a written consent form.

Student *t*-test was used for statistical purpose and p values <0.05 were considered to be significant.

RESULTS

There were8 males and 3 females, the two groups were similar in gender, gestational age, age at surgery and weight (Table 1).

The intra- and extra-pleural pressures were similar in both groups at the start of the measurement. Patients who had EP approach had negative pressure at the beginning but rapidly approached zero whereas in TP cases, intra-pleural pressures were negative and remained negative over 24 hours.

Mean pressure changes were plotted on a scatter gram (Figure 3). The difference between two groups was statically significant (p<0.005).

Table 1: Patient information for extra- and trans-pleural groups.

	Gender (Female: Male)	Weight * (kg)	Age* at surgery (days)	Gestation* (weeks)	Complications
TP	2:4	2.1 +/- 0.2	22 +/- 2	28 +/-1	0
EP	1:4	1.9 +/- 0.3	19 +/- 3	27 +/-1	0
P value	0.1	0.15	0.2	0.2	-

*Average age +/- 2 standard deviation

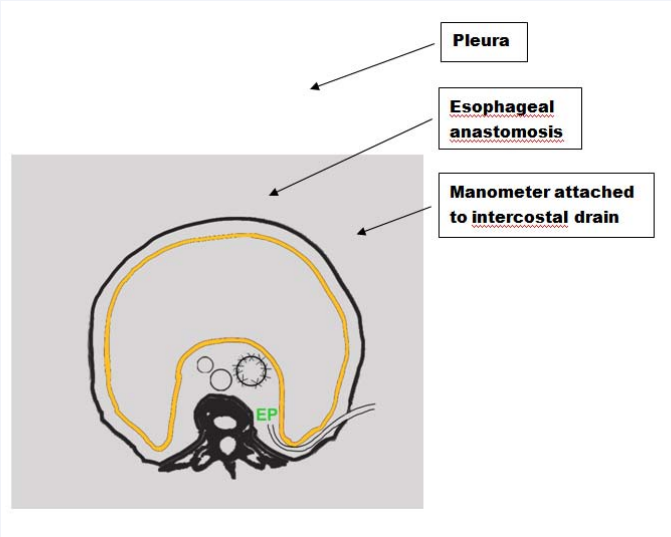

Figure 1 Extra-pleural approach to esophageal atresia and "pressure measurement."

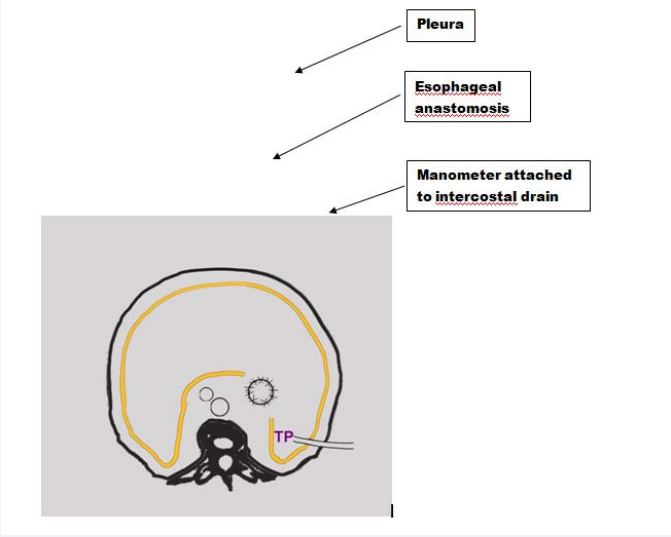

Figure 2 Trans-pleural approach to esophageal atresia & "pressure measurement."

There was no complication either from PDA surgery or from chest drain usage.

DISCUSSION

Successful primary esophageal anastomosis for EA +TEF was first described by Haight in 1941. In his detailed description, and subsequent publication, he emphasised the role of an extra-pleural approach, in order to reduce the risk of trans-pleural leak and its resultant empyema (Figure 4) [9]. It has been shown that patients with an extra-pleural anastomotic leak had better survival rate and an esophago-cutaneous fistula closed spontaneously (Figure 5) [10]. Techniques in reducing

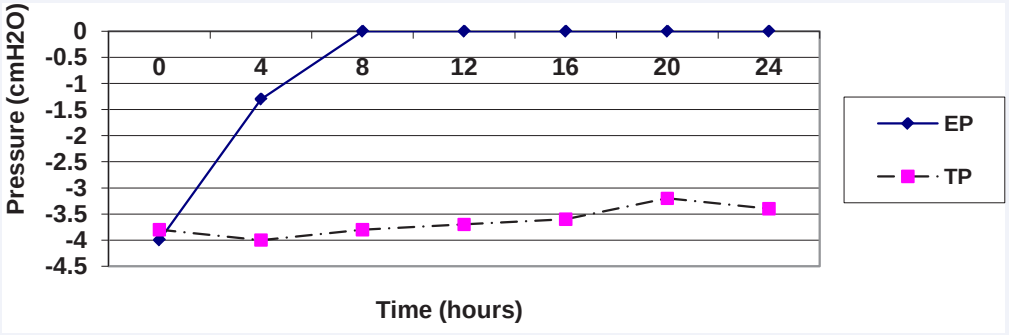

Figure 3 Mean pressures for the trans- and extra-pleural groups, plotted over time.

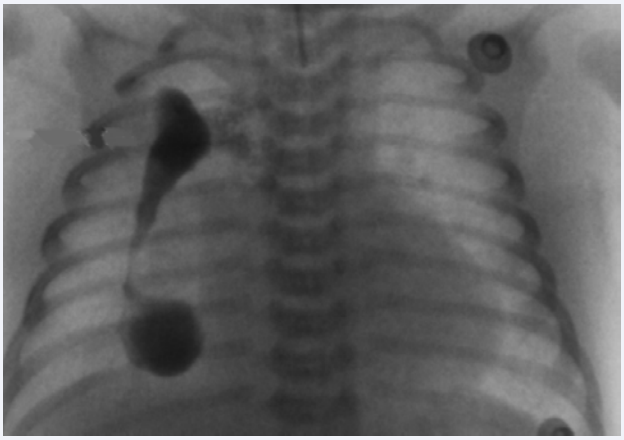

Figure 4 Extra-pleural anastomotic leak.

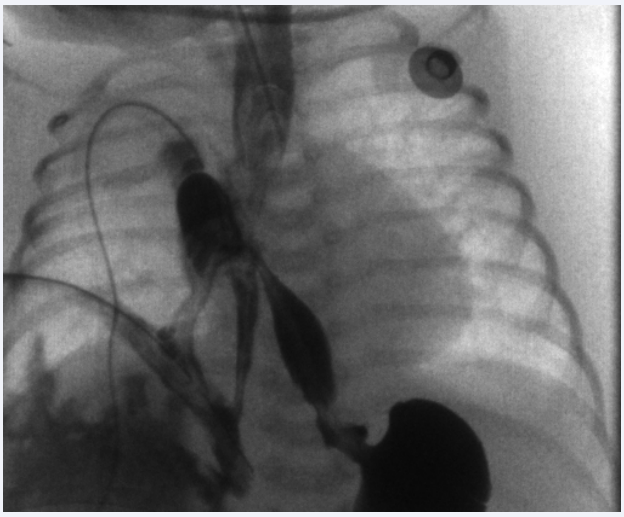

Figure 5 Trans-pleural anastomotic leak.

anastomotic leak include utilizing optical magnification to catch and suture submucosal layer, avoiding excessive mobilisation of mid oesophagus due to its multiple direct supply form aorta and instead rely on mobilised upper pouch to reduce anastomotic tension (with its blood supply from inferior thyroid vessels).

Successful thoracoscopic repair of EA +TEF was first reported about 15 years ago [11,12]. Its main advantage appears to be a decrease in the incidence of musculoskeletal complications seen with thoracotomy e.g. scoliosis, rib fusion and chest wall deformities [13]. With advances in minimally invasive surgery, the thoracoscopic approach is considered to be equivalent to the open approach in first world environment, however the leak rate has doubled in this approach [7,8,14-16].

The higher leak rate is most likely due to operating and

suturing in small chest cavity of a neonate. Two-dimensional view and loss of tactile sensation are also stated as a reason for higher leak rate [17]. In our small study, we have suggested that there might be a further reason; sustained negative pleural pressure noted in trans-pleural approach.

This small study shows that in a sample cohort of neonates, undergoing thoracotomy, either via an extra- or trans-pleural approach, there is a different negative pressure impact on the anastomosis. This is not due to the presence of a barrier (i.e. pleura) but to the fact that extra-pleural pressure returns to normal tissue pressure within an hour whereas trans-pleural pressure remains negative for many hours after surgery. This is after all, normal physiology of the thoracic space where trans-pleural pressures need to stay negative to allow for lung expansion. When EA+TEF is repaired thoracoscopically via TP approach, the anastomosis is subjected to sustained negative pressures than during a EP approach which may explain the higher leak rate [7,8,18].

With the advent of new antibiotics, aggressive surgical drainage strategy and major improvements in neonatal care, esophageal leaks and empyema is not a potentially fatal condition that it used to be decades ago. Two recent thoracoscopic series have shown that the incidence of mediastinitis is low [6,12].

Although, low fatal leaks is true in the first world environment, the same does not apply to the developing countries where [5] there is a lack of experienced neonatologists that result in delayed diagnosis and prompt drainage of intra-pleural empyema/ saliva collections [6], shortage of trained neonatal nursing staff which reduces intensive care needed for these neonates and [7] unavailability of certain newer broad-spectrum antibiotics (due to cost constraints) where correct antibiotics are not given.

Under these adverse circumstances, extra-pleural approach with its lower leak rate should remain the gold standard to repair of TEF & EA in developing countries.

The main disadvantage to this study is its small sample size, this is unavoidable because a near normal respiratory physiology is not often seen in neonates with PDA. Another confounding feature is that the surgical techniques are different in PDA ligation compared with TEF surgery, but since we were only interested in pleural pressures, these differences in surgical technique would not alter our results.

In conclusion, it is not known why there is an increased leak after thoracoscopic repair of EA +TEF but pleural pressure may play a role.

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Cite this article

Fourie N, Banieghbal B (2017) Is there an Increased Risk of Thoracoscopic Esophageal Leaks due to Intra-Pleural Pressures in Neonates. JSM Cardiothorac Surg 2(2): 1012.