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Safety Of Thoracoscopic Repair Of Congenital Diaphragmatic Hernia

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Abstract

Background: Congenital Diaphragmatic hernia (CDH) is a defect in the diaphragm leading to protrusion of contents of abdomen into the thoracic cavity affecting the development of the lungs, although advances in the management of CDH, the mortality and recurrence still high , this study to evaluate the safety of thoracoscopic repair of congenital diaphragmatic hernia.

Methods: this study is prospective study of 60 patients with unilateral Congenital diaphragmatic hernia In the period between August 2018 and April 2021, a sheet was filled for every patient which include preoperative data including full history ,examination and investigations , intraoperative data including operative time, and any intraoperative complications and post-operative data including mortality, recurrence and post-operative arterial blood gases.

Results: The infants age range from 4 days to 4 years, males were 36(60%) cases, The left side defect in 45(75%) cases while 15(25%) cases were right side, The mean of the operative time was 90.75 minutes, , no clinically significant difference in pH and $paCO_2$ levels pre and post-operative, We converted to open (laparotomy) in 6(10%), The mortality was 12 (20%) cases, The recurrence was 3(5%) cases.

Conclusion: thoracoscopy is a safe approach to repair CDH in stable patients, no clinically significant difference in pH and $paCO_2$ levels pre and post-operative, a thoracoscopic approach was associated with decreased mortality rate.

key words: thoracoscopy ,congenital diaphragmatic hernia, pH and $paCO_2$ levels pre and post-operative, recurrence , mortality.

Introduction:

congenital Diaphragmatic hernia (CDH) is a defect in the diaphragm which leads to pushing of abdominal contents into the thoracic cavity leading to lungs hypoplasia, This anomaly may present as an isolated anomaly or as part of a syndrome, The incidence of CDH nearly 5/10,000 births and varies across the population with male slightly predominance ,the mortality and morbidity remain high in spite of advances in the management of CDH[1].

Most of the cases have an isolated anomaly and presenting with pulmonary hypoplasia and persistent pulmonary hypertension of newborn (PPHN), CDH can be associated with cardiac, genitourinary anomalies, gastrointestinal, or chromosomal anomalies such as trisomies [2].

The Posteriolateral hernias (Bochdalek hernias) are the most common type (75%) ,more common on the left side (85%) and less frequently on the right side (13%) and bilateral (2%), the other types are anterior defects or Morgagni hernias (23), central hernias, congenital eventration and congenital hiatus hernia[3].

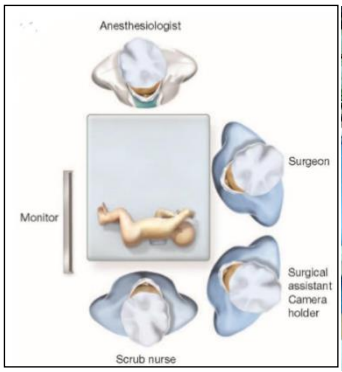
Thoracoscopic repair has been suggested to have advantages over the open methods in CDH. However, many studies also indicated that the procedures involved in thoracoscopic repair for CDH were difficult and that the recurrence and mortality rates were high[4].

Patient and methods :

This study is prospective cross sectional study of 60 patients with unilateral Congenital diaphragmatic hernia presented to Minia University Pediatric Hospital and Cairo university specialized pediatric hospital, and operated by thoracoscopic repair, In the period between August 2018 and April 2021, a written informed consent was obtained from all parents to allow their babies to share in the study, the study included patients **from** day one till 14 years with unilateral Congenital diaphragmatic hernia and hemodynamic and pulmonary stabilization and excluded patients with bilateral or acquired Diaphragmatic hernias or hiatus hernia or Hemodynamic and pulmonary unstability or Patients with associated major congenital anomalies like major cardiac anomalies (except PDA, PFO, small ASD and small VSD), malrotation and neurological disorders or Patients were on ECMO support pre-operative.

Preoperative assessment of all patients was done by careful history taking, clinical examination and investigations(chest x ray and ECHO), Thoracoscopic repair of the diaphragmatic defect was undertaken following physiologic stabilization, Therapeutic goals included oxygen saturation more than 85% and pH 7.2–7.4 with FiO 2 ≤ 50 %, normalization of blood pressure, UOP1-2 mL/kg/h, and resolution of pHTN. This process usually takes between 2 and 10 days.

The thoracoscopic approach required a general anesthesia A nasogastric tube was necessary to reduce the size of the stomach ,prophylactic antibiotics were given. The infant was placed in a near-lateral decubitus position with a small raised support placed beneath, Anesthesia positioned at the side of the operative table, the scrub nurse was on the other side and the operating surgeon and his assistant were near the patient's head, a monitor at the patient's feet.(fig 1,2)



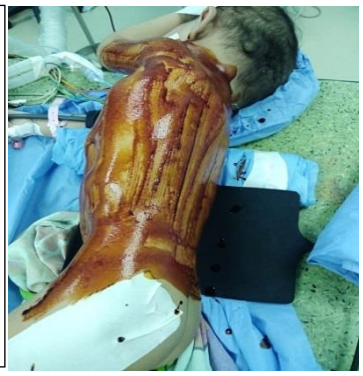


Fig. (1): Operating room setup . **Fig. (2):** Position of the patient.

5- and 3 mm instrumentations were of adequate size , 2/0 or 3/0 non absorbable coated polyester or silk sutures were used for the repair, Instruments for a possible conversion to open surgery, as well as double face mesh should be at hand if needed**,** The first trocar was introduced under the scapula for camera placement, two more working trocars were introduced: one in the fifth intercostal space on the anterior axillary line and the other one in the fourth intercostal space between the spine and the camera trocar, the CO2 was insufflated at a flow rate of 1L per minute with pressure from 4 to 8 mm Hg. the reduction of the hernia contents was the first part of the procedure, fig 3

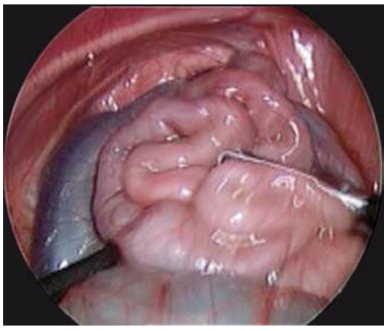


Fig (3) : Reduction of the contents

In presence of a hernia sac, the sac was not resected , the edge of the defect coagulated carefully (fig 4). the posterior flap of the diaphragm was identified to access the possibility of primary repair (fig 5).

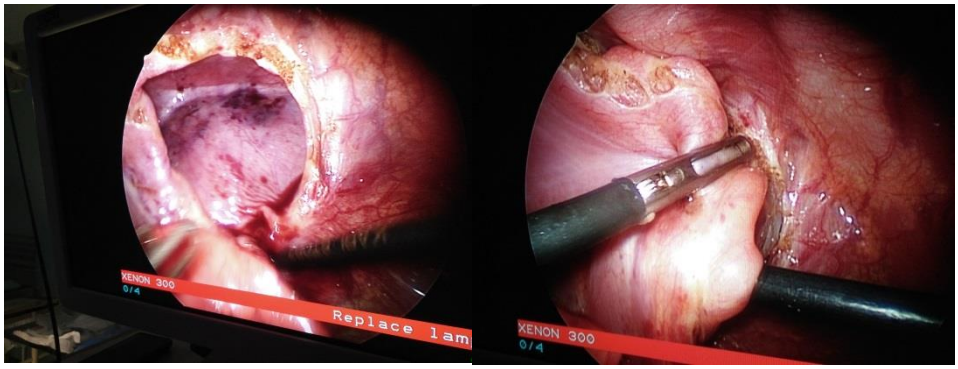
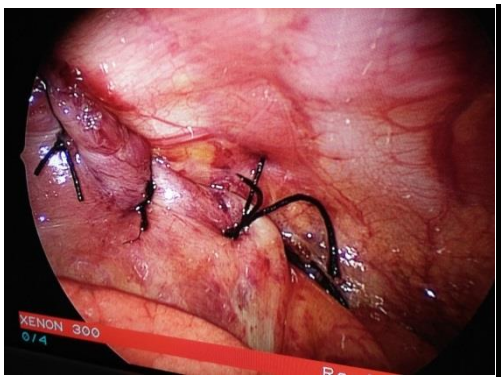


Fig. (42): Coagulation the edge of the defect. Fig(5):the possibility of primary repair

The defect The diaphragmatic was closed with interrupted non absorbable sutures, If the defect was too big to be closed by primary sutures ,double face mesh had been applied, it was introduced throw one of the ports and edges were adjusted to the size of the defect (fig6, 7). At the end of the procedure, CO2 was suctioned out through one of the ports, chest tube was usually not required.. Trocars were removed and skin was closed.



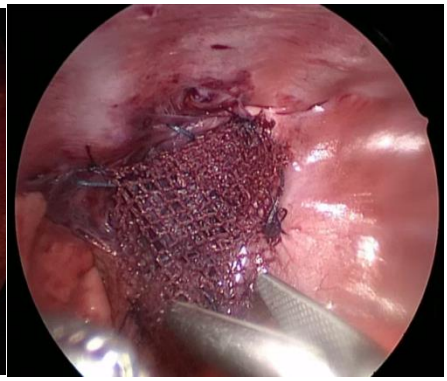


Fig 6: primary repair . fig7: Repair with mesh.

Post-operative Pain control was very importance via intravenous paracetamol, Post-operative arterial blood gases (1 hour post-operative and daily till discharge) and follow up x ray (12 hour post-operative and daily till discharge) were essential , The chest tube removed the next day if there was no indication for it, The patient was allowed to eat within 24 hours ,if the patient ventilated, gradually weaning occurred. A sheet was filled for every patient which include preoperative data including full history ,examination and investigations , intraoperative data including operative time, characters of the defect and any intra operative complications and post-operative data including days in ventilator, days in NICU or PICU, total hospital stay, duration till full enteral feeding, post-operative arterial blood gases, and the follow up visits.

Results

The infants age in this study range from 4 days to 4 years, 42(70%) cases were neonates < 30 days and 18 (30%)cases were ≥ 30 days, the mean age of all cases was 176 days as shows in table 1, males cases were 36(60%) cases and females were 24(40%) cases shows in fig 8.

Table (1): Age of the patients

Variable	Descriptive statistics
Age (days): <30 days n(%) ≥ 30 days n(%)	 42 (70%) 18 (30%)
Mean ±SD (range)	176±333.7 (4-1440)

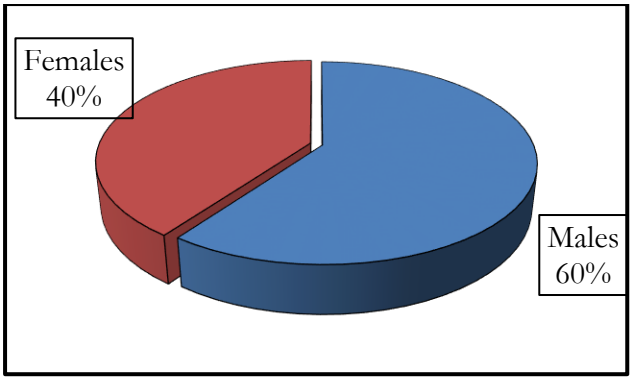


Fig 8 : sex of cases. .

The side of the defect was left side in 45(75%) cases while 15(25%) cases were right side as shows in figure 9.

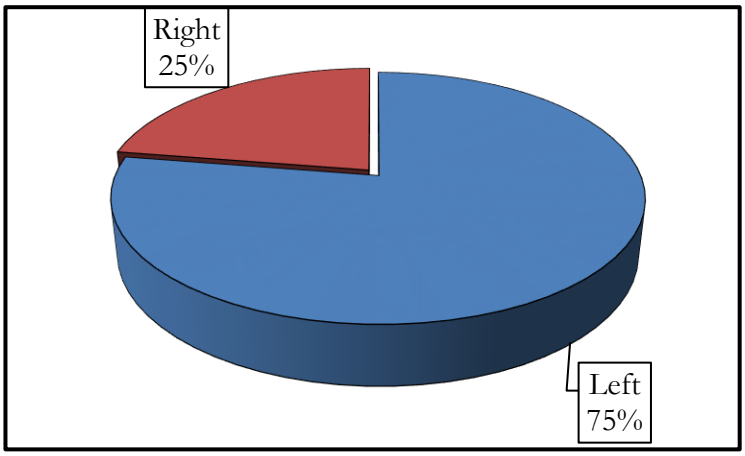


Fig. (9): Side of the defect.

The site of the defect was Post-lateral in 51(85%) cases, and anterolateral in 9 (15%) cases as shows in table 2.

Table (2): Site of the defect

Site: n (%)	Descriptive statistics
Anterolateral	9(15%)
Post-lateral	51(85%)

Iatrogenic injury was 0(0%), mesh used in 5(8.3%) cases which were with large defect ,Chest tube was inserted in 5(8.3%) cases, two cases of intestinal obstruction for drainage and three cases desaturated intraoperative, The mean of the operative time was 90.75 minutes, with range from 60 to120 minutes, the operative time is the time from the start of sterilization of the patient till last stitch in trocars sites as shows in table 3, The mean of the post-operative days on ventilator was 1.5 days with range from 0 to 15 days, The mean of the post-operative days on ICU was 5 days with range from 2 to 20 days as shows in table 4.

Table (3): Operative data

Variable	Descriptive statistics
Iatrogenic injury: n (%)	0 (0%)
Mesh: n (%)	5 (8.3%)
Chest tube: n (%)	5 (8.3%)
Operative time: Mean ±SD (range)	90.75±19.66 (60-120)

Table (4): Post-operative data of studied sample

Variable	Descriptive statistics
Days on vent: mean ±SD (range)	1.5±3.52 (0-15)
Days on ICU: mean ±SD (range)	5±3.82 (2-20)

pH and $paCO_2$ levels are detected pre and post-operative to evaluate the effect of CO_2 insufflation, there was no clinically significant in the mean of pH and $paCO_2$ preoperative and postoperative. as shows in table 5.

Table (5): Laboratory data of studied sample

Variable	Preoperative N=60	Postoperative N=60	p-value
	Mean ±SD Range	Mean ±SD Range	
pH	7.36±0.06 7.26-7.59	7.35±0.05 7.25-7.42	0.327
$paCO_2$	37.89±5.98 22-50	39.25±5.79 30-50	0.127

We converted to open (laparotomy) in 6 (10%) cases, The mortality was 12 (20%) cases, The recurrence was 3(5%) cases as shows in figure 10.

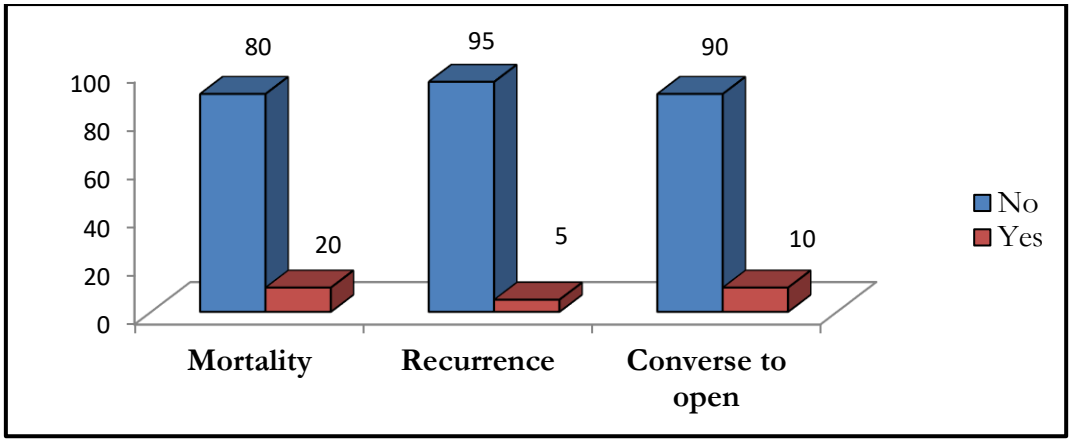


Fig. (10): Outcome of the repair.

Discussion

congenital Diaphragmatic hernia (CDH) is a defect in the diaphragm leading to pushing of abdominal contents into the thoracic cavity resulting in lung hypoplasia and Persistent pulmonary hypertention of newborn,some studies have demonstrated the advantages of the thoracoscopic repair of CDH such as significant reduction in hospital stay, reduced tissue trauma , pain, and cosmetic deformity ,shorter time to goal feeds, and lower mortality but others studies also indicated that the technique was difficult and that the recurrence and mortality rates were high[**5**].

Our study is to evaluate the safety of thoracoscopic repair of congenital diaphragmatic hernia including mortality ,recurrence rates and arterial blood gases changes pre and post-operative , we operated 60 cases which presented to Minia University Pediatric Hospital and Cairo university specialized pediatric hospital compatible with the inclusion criteria in the period between August 2018 and April 2021.

As regarding the age in our study ranged from 4 days to 4 years, 42(70%) cases were <30 days, while 18 (30%)cases were ≥ 30 days, the mean age of all cases was 176 days. The incidence of late-presenting CDH among all CDH cases varies from 5% to 25% [**6**],and our results were close from this incidence with relative increase may be due to the fact that the inclusion criteria required cardiorespiratory stability, Another explanation is delayed diagnosis of CDH cases who were born asymptomatic and were diagnosed later on. In the study of **Osama et al.[7],**the number of cases was 30, the range of age from 3 day to 5 years, 11(36, 7%) cases were neonates < 30 days and 19 (63%)cases were ≥ 30 days, , the mean age of all cases was 313, 8 days, while in the study of **Huang et al [8],**the number of cases was 60, the range of age from 1 day to 10 months, 53(80%) cases were neonates < 30 days and 7 (11.7%)cases were ≥ 30 days.

In our study The sex distribution of the cases showed male predominance, 24(40%) cases were females and 36 (60%) cases were males, and this agree with the international consensus[9].In the study of **Costerus et al.**[10],there were 41 (54.5%) male and 34 (45.5%) female**.** While in the study of **Yuan et al.[11],**there were 31(52.5%) male and 28 (47.5%) female.

In our study defect side is left in 45(75%) cases and 15 (25%) cases are right side. And this agree with the international consensus which reported left side more common than right side.[9]. In the study of **Yuan et al.[11],**46 (77.9 %) cases were left side and 13 (22.1%) cases were right side. While in the study of **Crisset al.[12],**31 (88.6) cases were left sideand4 (11.4%) cases were right side.

In our study The site of the defect was Post-lateral in 51(85%) cases, and anterolateral in 9 (15%) cases. which are similar results to those published by **Osama et al.[7]** which reported that The site of the defect was Post-lateral in 26(86.7%) cases, and anterolateral in 4 (13.3%) cases.

In our study there is no any iatrogenic injury during the thoracoscopic repair, as the study of **Inoue et al.[13],**which estimated no iatrogenic injury.

In our study we needed to use mesh in 5(8.3%) cases which were with large defect, while in the study of **Costerus et al.[10]** ,mesh were used in 44 (58.7%) cases. and in the study of **Criss et al.[12],**mesh were used in 9 (25%) cases, while in the study of **Inoue et al.[13],**4 (50%) cases needed mesh.

In our study Chest tube was inserted in 5 (8.3 %) cases, in the study of **Yuan et al.[11],**chest tube used in 49 (83 %) cases, in the study of **Criss et al.[12],**chest tube used in 16 (46 %) cases. While in the study of **Okazaki et al.[14]**, there was no chest tube.

In our study the mean of the operative time was 90.75 minutes, with range from 60 to120 minutes. In study of **Okazaki et al.[14],**the mean of the operative time was 178 minutes, with range from 105 to 260 minutes**,** and in study of **Inoue et al.[13],**the mean of the operative time was 217 minutes, with range from 172 to 258 minutes**,** while in study of **Yuan et al**[11]the mean of the operative time was 55 minutes with range from 30 to 100 minutes.

In our study the mean of the post-operative days on ventilator was 1.5 days with range from 0 to 15 days. In the study of **Inoue et al.[13],**the mean of the post-operative days on ventilator was 6.5 days with range from 0 to 19 days**,** while in the study of **Huang et al.[8]** the range of postoperative days on ventilator was from 0 to 6 days with mean 3.24 days.

In our study the mean of the post-operative days on ICU was 5days with range from 2 to 20 days, while in the study of **Huang et al.[8],**The mean of the post-operative days on ICU was 7.13 days with range from 3 to 16 days.

In our study the mean of pH preoperative was 7.36 with range from 7.26 to 7, 59 while mean of pH postoperative was 7.35 with range from 7.25 to 7, 42 with p-value 0, 327 which is not clinically significant, the mean of $paCO_2$ pre-operative was 37.89mmHg with range from 22mmHg to 50mmHg, while the mean of $paCO_2$ post-operative was 39.25mmHg with range from 30mmHg to 50mmHg with p-value 0.127 which is not clinically significant. In study of **Okazaki et al.[14],**the mean of pH preoperative was 7.44 with range from 7.29 to 7, 61 while the mean of pH postoperative was 7.41 with range from 7.15 to 7, 59 which is not clinically significant, and the mean of $paCO_2$ pre-operative was 38.88mmHg with range from

22.8mmHg to 59.9mmHg, while the mean of $paCO_2$ post-operative was 37.7 mmHg with range from 23.8mmHg to 65.8 mmHg with no clinically significant difference, while in the study of **Costerus et al.[10],**the median pH decreased from 7.37 to 7.31; the median of the pCO2 increased from 5.54 to 5.93 preoperative values for the pH and pCO2 were significantly different from the corresponding postoperative values).

In our study there is no difference in pH and pCO2 pre and postoperative may be due to the fact that the inclusion criteria required cardiorespiratory stability and excluded cases which needed ECMO.

In our study we converted to open (laparotomy) in 6 (10%) cases, in the study of **Costerus et al.[10]**converted to open in 15 (20.3%) cases, and In study of **Okazaki et al.[14],**converted to open in 5 (25%) cases while in the study of **Criss et al,[12]**converted to open in 2 (5.7) cases.

In our study The mortality was 12 (20%) cases while in the study of **Costerus et al.[10],Criss et al.[12]and Okazaki et al.[14]** no mortality were reported. The mortality in our study is higher than other studies because we did not exclude right side congenital diaphragmatic hernia from the study and 3 cases died with right side, two cases were right side congenital diaphragmatic hernia with Hepato Pulmonary fusion and large defect, another case with right side congenital diaphragmatic hernia with large defect and desaturated intra operative and died while in the study of **Costerus et al.[10]**and study of **Okazaki et al.[14],**right side congenital diaphragmatic hernia was excluded from the study, ECMO is not available in our units and this is another cause for high mortality**.**

In our study The recurrence was 3(5%) cases, in the study of **Criss et al.[12[,**the recurrence was 6(17, 1%) cases, and in the study of **Costerus et al.[10],**The recurrence was 14(18.6%) cases**,** while In the study of **Okazaki et al.[14],**The recurrence was 1 (6.6%) case.

Conclusion: thoracoscopy can be safely used to repair CDH in stable patients, a thoracoscopic approach was associated with shorter mechanical ventilation days, with no clinically significant difference in pH and $paCO_2$ levels pre and post-operative and does not associated with high mortality or recurrence rates.

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