

# Thoracoscopic Congenital Diaphragmatic Hernia repair in neonate: The First Experience of Iranian Group

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## Abstract

**Background:** Congenital diaphragmatic hernia (CDH) occurs due to a failure in closing pleuroperitoneal membrane thus resulting in an incomplete diaphragm formation<sup>1</sup>, which allows passage of the abdominal viscera into the thorax.<sup>1,3</sup> Until 1995, the standard method for treatment of CDH was performed by open surgery through the abdomen or thoracic cavity. Minimally invasive approach via thoracoscopy or laparoscopy is applicable for treatment of CDH since 1995.<sup>4</sup> Now a day's thoracoscopic repair of CDH (T'Scopy CDH) is performed in many centers. In this paper, we present our experience of T'Scopy CDH repair from Iran.

**Patients and Methods:** From 2011 to 2015, 74 patients with CDH were admitted to Pediatric Surgery Department of Dr. Sheikh (Sarvar) Pediatric Hospital. Twenty one patients (28%) met our inclusion criteria and underwent T'Scopy CDH repair. The median age at the time of repair was 5 days (2-days-old to 4-years-old patients). Inclusion criteria were weight over 2 kg and stable hemodynamics and arterial blood gas. Fourteen cases were intubated before entering the operating room. The defect was in the left side except in two cases. In 8 cases, we used thoracic wall as part of repair. Also, mesh support was utilized in **8 cases even in** cases where primary repair of diaphragm was possible in order to reinforce the repair (5 cases). Of these 8 cases, in 3 patients, whole repair was accomplished by mesh due to presence of a large defect.

**Results:** The mean time of operation was 80 minutes (40-230 minutes). Intraoperative mortality was zero. In hospital, mortality occurred in two cases due to septicemia in one and respiratory and cardiac failure in another. Conversion to open surgery was required in 6 cases. Late recurrence was observed in 2 cases. The mean time of follow up was 14.6 months (3-36 months).

**Conclusion:** It seems that appropriate case selection and liberal use of thoracic wall and mesh as a part of repair may cause better results and decreased chance of early and late recurrence.

## keywords

- congenital diaphragmatic hernia
- thoracoscopy
- surgical repair

## Introduction

CDH happens between the 6<sup>th</sup> and 8<sup>th</sup> weeks of pregnancy.<sup>5</sup> Although the exact mechanism of the disease is not clear yet, it seems that a failure in closing pleuroperitoneal membrane could be the main cause.<sup>5</sup> The final result of this process is displacement of abdominal viscera into the thoracic cavity.<sup>3</sup> The incidence of this defect is approximately 1 in 2500 births.<sup>6</sup> First laparoscopic repair of CDH was reported by van der Zee and Bax in 1995.<sup>7</sup> Since 2001, which the first report describing T'Scopy repair of CDH by Françoise Becmeur was published<sup>8</sup>, a new window has opened for treating CDH with minimally invasive surgery. Although the exact rate of recurrence and complication is still controversial, it seems that recurrence rate is higher than open surgery. It is likely that as time passes and our techniques and experience improve the recurrence rate will gradually decrease. We have repaired 21 cases of diaphragmatic hernia via thoracoscopy technique from 2011 to 2015. In these cases, we freely used both thoracic wall and mesh support as part of the repair. Accordingly, the success rate and the need for intraoperative conversion to open surgery, and in-hospital and late recurrence were evaluated.

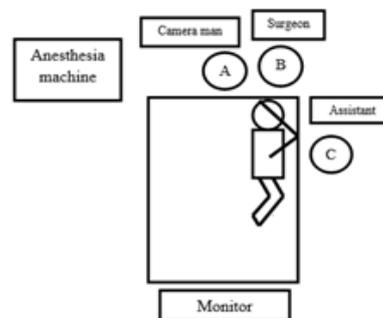
## Patients and Methods

Seventy four CDH patients were admitted to Dr. Sheikh (Sarvar) Pediatric Hospital Mashhad between 2011 and 2015. Twenty one of whom (28%) met inclusion criteria for T'Scopy CDH repair and underwent thoracoscopic operation. The group consisted of 6 females and 15 males presenting with 19 left-side and 2 right-side hernias. The median age at the time of repair was 5 days (2-days-old to 4-years-old patients). Inclusion criteria was weight over 2 kg and stable hemodynamics ( $P_{aO_2} > 40$  mmHg,  $P_{aCO_2} < 60$  mmHg under conventional mechanical ventilation or extubated) and arterial blood gas (PH greater than 7.3). Fourteen cases were intubated when they entered the operating room. The cases with major cardiac anomaly were excluded from the study. Two long ventilations were used in all cases during operation.

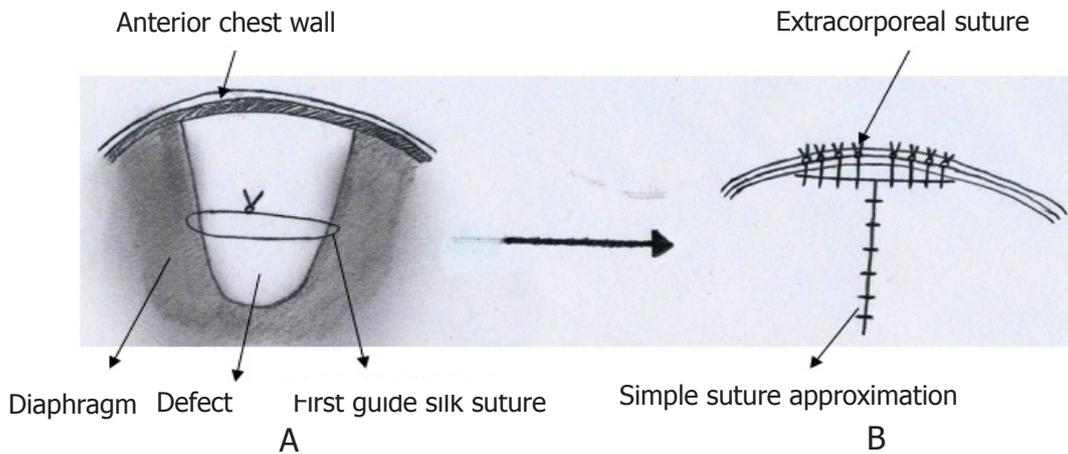
## Surgical consideration

The patient is placed in a lateral position in the left upper corner part of operating room table. The upper arm is fixed over the head. The position of surgeon and others is mentioned in (Fig1). The first five mm transparent port was inserted just below the tip of scapula. Two other 3 mm ports were inserted for instruments in the 5<sup>th</sup> intercostal space (anterior and posterior axillary line). Gas insufflation started with a 5-7 mmHg pressure and a flow rate of five L/min. After visualization of the thoracic cavity, we tried to reduce the hollow viscous and spleen toward the abdominal cavity. After that, we evaluated the diaphragmatic defect. Based on our previous experience in open CDH repair, simple closure of diaphragmatic repair

may be difficult or impossible in all cases and surgeon has to use the chest wall or prosthetic material in order to perform a tension free diaphragmatic repair and prevent untoward diaphragm tearing. Our trend is a combined method of simple closure, liberal use of chest wall and prosthetic material in diaphragmatic repair. So, we started the repair with silk stitch as a first guide in the mid portion of defect to approximate the diaphragm edges and evaluate the tension. Then, we started with simple closure of defect from the posterior wall (according to thoracoscopic view), up to the point where a tension free approximation was possible and then tried to close the remaining defect using the chest wall and reinforced it using prosthetic material in some cases; even if we were able to close the defect by simple closure. This approach may prevent unexpected tearing of the diaphragm especially while suturing the anterior part. In this approach we closed the remaining defect using extracorporeal stitches to the chest wall. Finally, a T-shaped tension free repair would be created (Fig 2). Diaphragm was repaired with 3-0 nylon or prolene suture. Even in cases that the primary repair of diaphragm was feasible, we used mersilene or prolene mesh for support (5 cases). In cases of eventration or CDH with hernia sac, mesh was inserted between hernia sac and the repair area of the diaphragm. The prosthesis was fixed with a few holding sutures. In all cases, chest tube was inserted at the end of operation. During surgery, gastric perforation was observed in one patient who had undergone tube thoracostomy in another center before referral to our hospital. Fortunately, stomach repair was done successfully by thoracoscopy. All patients were transferred to NICU with endotracheal tube. Extubation and weaning from the ventilator was carried out by our neonatal intensivist. Feeding was started based on general condition of patients. After surgery, the repair was evaluated by chest radiography in order to estimate the early success rate.



**Figure1:** Position of surgeon and others at the operating table



**Figure 2:** (A) The first guide suture was applied to evaluate how long of the defect could be repaired by simple suture approximation. (B) Anterior part of the defect was repaired using extracorporeal stitches that approximated the anterior part of defect to the anterior chest wall. This way, a T-shape repair would be created at the end.

## Results

There were 21 patients, including 15 boys and 6 girls. The patients' age ranged from 2 days to 4 years. In 15 cases, we were able to accomplish the procedure completely by thoracoscopic approach. The hernia was located on the left side in all patients except two. Mean operative time was 80 minutes. In eight patients, the defect was repaired by suturing the upper part of diaphragm to the thoracic wall. No intraoperative mortality was observed. However, there were two postoperative deaths due to septicemia in one case, and hypercapnia, leading to respiratory and cardiac failure in another case. Conversion to open repair was required in 6 patients. Recurrence was observed in 4 patients. Two of them occurred in hospital and the others had late recurrences. Mesh support was used in 8 cases. Of these, the whole defect was repaired by mesh in 3 patients due to the presence of a large defect and in 5 other patients the use of mesh was for reinforcing the repair. The mean time of hospitalization was 12.2 days. The mean time of intubation was 8.4 days after surgery. All 19 patients were discharged from the hospital and no mortality was seen during follow up in these cases. The results are summarized in **Table 1**.

**Table 1.** The result of T'Scopy repair of CDH

results	n	%
T'Scopy success rate	15	71.4%
Intraoperative conversion	6	28.5%
Recurrence rate	4	19%
In-hospital recurrence	2	9.5%
Late recurrence	2	9.5%
Mortality	2	9.5%
Intraoperative mortality	0	0
Mesh repair	8	38%
Chest wall	8	38%

## Discussion

Although it is still unclear whether T'Scopy repair has better outcomes than traditional open surgery and laparoscopic repair (LR), we are attempting to answer this question by comparing the results of T'Scopy in our study and other literatures. We describe our experience in T'Scopy CDH repair as a feasible and safe technique in selected children and newborns. In our study, conversion to open repair, as shown in **Table 1**, was approximately 28.5% which is almost similar to Liem's study<sup>2</sup> (27%) and completely different from the report of recent studies (3.4-20%).<sup>9</sup> The cause of conversion was inability to repair diaphragm thoracoscopically, impossibility of viscera reduction into the abdominal cavity, bleeding due to tearing of intestinal mesentery, and inability to overcome hypercapnia and hypoxemia during the procedure. Unfortunately, of three patients whose defect was large and totally repaired by mesh, two patients (66%) had in-hospital recurrence in our study which is precisely consistent with a meta-analysis performed by Emily Chan et al who found that the recurrence rate was higher after minimally invasive surgery with patch repair only.<sup>10</sup> On the other hand, there wasn't any mesh support in cases of late recurrences and simple closure was performed in order to repair the defect. Thereby, it is likely that if we use mesh as a support, it may prevent late recurrence. In a study conducted by Nam, the recurrence rate of thoracoscopic repair was between 5-25%<sup>11</sup> whereas this rate was reported 19% in our study (**Table 1**). Liberal use of thoracic wall and mesh support may be a reason for having an acceptable recurrence rate in our study. In a review article, use of thoracic wall has been mentioned in 3 studies.<sup>2,12,13</sup> Similar to our study, Keijzer et al showed a series of 17 cases and declared that liberal use of mesh prevents extensive tension and consequently decreases recurrence up to 12%.<sup>6,14</sup> Studies about liberal use of mesh are still controversial and recommend it only in cases of large defects or in situations where there is undue pressure on diaphragm's rims.<sup>15</sup> Tension can be a risk factor in open and/or minimally invasive surgery.<sup>15</sup> Although, there were some studies

which showed that mesh support increases the chance of recurrence in T'Scopy.<sup>16,17,18</sup> Only two postoperative mortalities happened in two 6-days-old infant. Nowadays, T'Scopy and mesh support are useful and considered as a first choice of treatment. Based on other reports, T'Scopy is associated with less surgical stress than open repair.<sup>4</sup> On the other hand, the benefits of T'Scopy include easy access to posterior lateral defect, minimal trauma, better cosmetic results, less chance of intestinal obstruction and quick improvement.<sup>19</sup> In addition, due to less trauma to the abdominal and thoracic muscles, respiratory function is impaired minimally after surgery.<sup>19</sup> In conclusion, although the recurrence rate in T'scopy (5-

25%) is more than open surgery (2.7%),<sup>4,8</sup> with improving surgical technique and surgeon's experience it is expected that these rates decline gradually. It should be noted that one of reasons for a low recurrence rate in our study like others,<sup>12,20</sup> is removing critically ill patients from the study and selecting stable ones.

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