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**Single transversus abdominis muscle flap: another possibility for large congenital diaphragmatic hernia repair.**

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## Introduction

Large defect congenital diaphragmatic hernias comprise a defect too large to be closed primarily and diaphragm agenesis. This condition remains a surgical and intensive care challenge<sup>1</sup>. Many different approaches have been described. Prosthetic patches are often used, but they face the major issue of high recurrence rate ranging from 27 to 50%<sup>2</sup>. Some reports in the literature describe muscle flap repair and though they are scarce and concern small series, they indicate that muscle flaps recur only in 0 to 4.3%<sup>3,4</sup>. For the last 20 years, our routine clinical practice has been to avoid patches by using a muscle flap to repair the defects that are too large for primary closure. We therefore present a simple novel technique using a single layer muscle flap based on the transversus abdominis muscle.

## Patients and methods

Between 1995 and 2015, all newborns presenting with large congenital diaphragmatic defect (i.e. a defect too big to be closed primarily and diaphragmatic agenesis) underwent a single layer transversus abdominis muscle flap repair. We reviewed the data from the medical files of these children. This study was approved by our institutional research ethics board. Data are given in median (range).

## Surgical technique

Under general anaesthesia, the newborn is placed in supine position, with a roll under the thoraco-lumbar junction.

The abdominal cavity is opened with a transversal incision 5mm above the umbilicus, extended to the side of the hernia (Figure 1-A). All layers are cut by monopolar diathermy. After reduction of the herniated organs, the anterior and posterior aspects of the diaphragm remnants are dissected. (Figure 1-B). The flap is fashioned. Using the tip of dissecting

scissors in the avascular plane, the transversus abdominis muscle is divided from the two other layers of the upper lateral quadrant of the abdominal wall, joining the lower edges of the ribs. Sagittal incision of the aponeurosis between transversus abdominis muscle and the rectus muscle frees the median edge of the flap in order to rotate it backward around the costal edge axis (Figure 1-A). After dissecting the edges of the diaphragmatic remnant (if present) all around the defect, the flap is sutured either to the muscle rim or to the ribs' periosteum using non-absorbable interrupted stitches (Figure 1-C and D). The abdominal muscle wall is then closed in two layers, i.e. superior sheet of external and internal obliques sewn to an inferior sheet of intact abdominal wall. In case of inadequate abdominal capacity, a staged closure of the abdominal wall is performed using a silo.

## Results

16 newborns underwent the single muscle flap repair. All patients but one had a left hernia. Gestational age at birth was 37.6 weeks (34-38.7) and birth weight was 2.875 kg (1.78-3.2). Surgery was performed at 29 hours of life (4-96), all neonates being ventilated on high frequency oscillation. Procedure length was 2.5 hours (1.5-3). Surgery was performed in neonatal intensive care unit (NICU) or in theatre in 14 and 2 cases respectively. Abdominal wall was primarily closed in all but two patients who required a staged closure. Twelve infants were discharged from NICU. Length of stay was 34 days (20; 483) in intensive care unit and 67 days (32; 483) in hospital. Four patients died in NICU: 3 due to refractory pulmonary hypertension (2 at day1, 1 at day228) and 1 as a result of staphylococcus pneumonia at day9.

**Discussion**

Large congenital defect of the diaphragm, i.e. not primarily closable, remains a surgical challenge. Many techniques have been proposed. The abdominal muscle flap repair for diaphragmatic defect was first described in 1962 mobilizing the three layers of the abdominal wall and was then modified by Simpson and Gossage in 1971<sup>5</sup>. They described a two-muscles flap using transversus abdominis and internal oblique, swung posteriorly and stitched to the posterior muscle rim. In our technique, we also use an abdominal muscle flap, but we dissect only the transversus abdominis. The dissection plane allows for a high quality, well-vascularized and innervated flap. The transverse incision at the umbilicus level gives a good exposure to the medial and posterolateral part of the defect compared to medial incision. This incision also facilitates the tailoring of a large muscle flap. Indeed, this technique has always produced a flap large enough to complete the defect closure without requiring prosthetic patch addition.

In conclusion, considering the ease of the flap elevation and the large amount of well-vascularized tissue available, we believe that the transversus abdominis muscle flap repair is a safe, simple and suitable technique for large congenital diaphragmatic defect.

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ACCEPTED MANUSCRIPT

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Figure 1 : Surgical technique

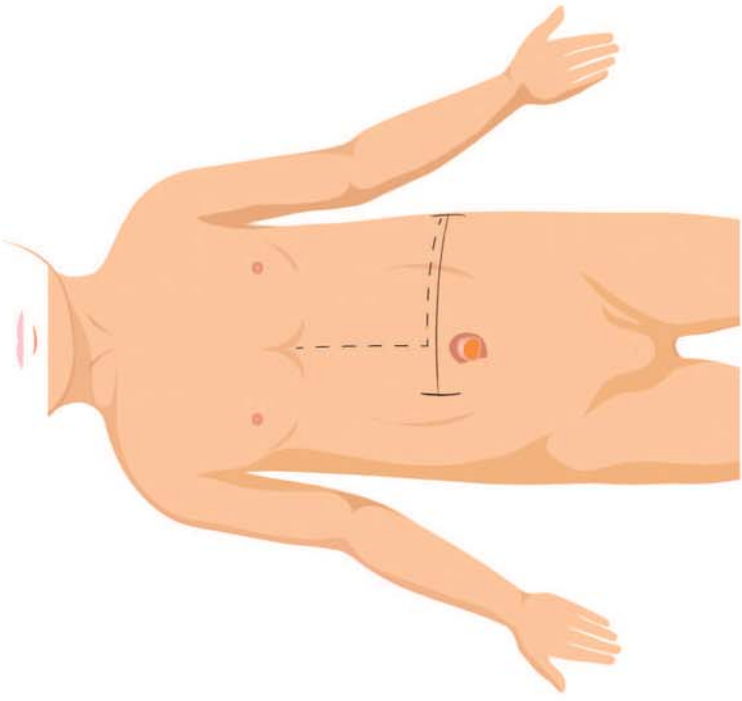
A- Newborn is placed in supine position. A transversal cutaneous incision is performed 5mm above the umbilicus (continuous line). Muscle flap will be divided along the rectus (dotted line).

B- View of a large congenital left diaphragmatic defect. Anterolateral abdominal wall consists of 3 muscle layers : transversus abdominis (TA), internal oblique (IO) and external oblique EO).

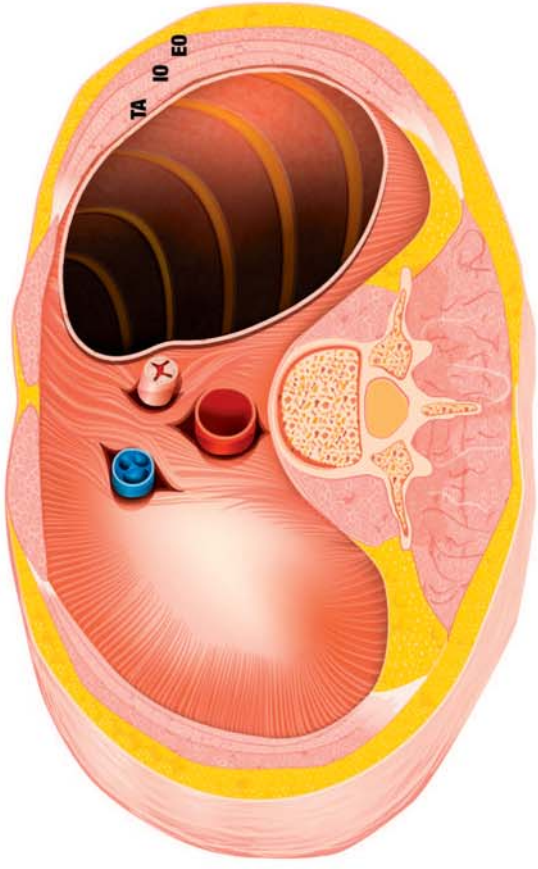
C- After division of the avascular plan between the transversus abdominis (TA) and the internal oblique (IO) muscles, the flap (TA) is rotated backward and sutured to the diaphragmatic edges.

D-Suture of the transversus abdominis single muscle flap (TA) to the edges of the diaphragmatic remnant is completed. Two muscles, internal oblique (IO) and external oblique (EO), stay in place in the anterolateral abdominal wall.

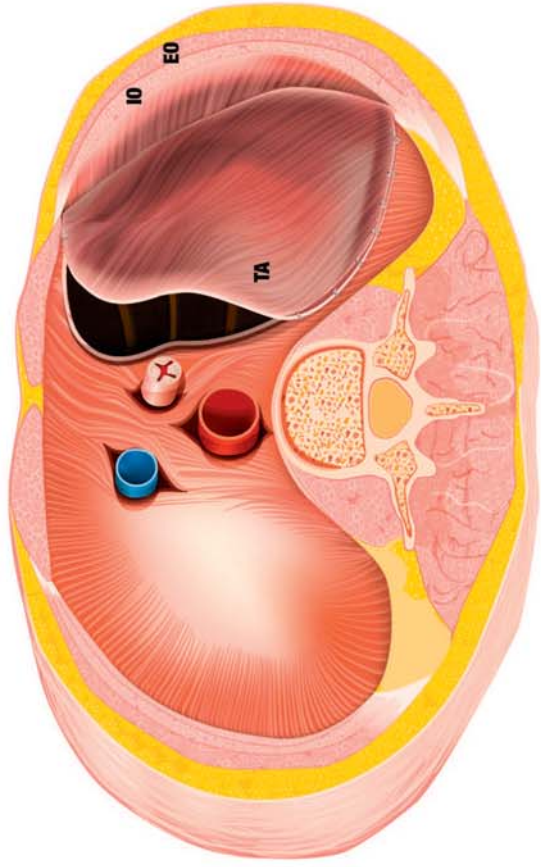




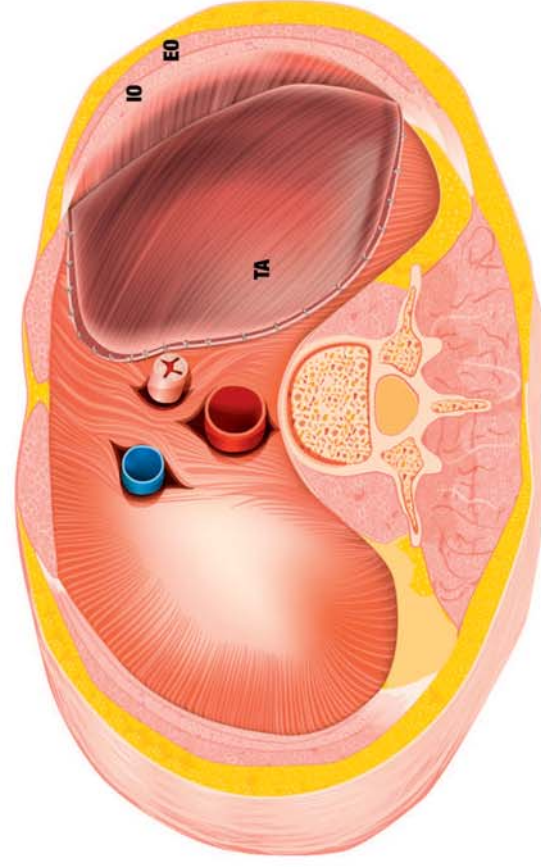
**A**



**B**



**C**



**D**

