Case report

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DOME-SHAPED PATCH OFFERS OPTIMAL BIOMECHANICS FOR REPAIR OF LARGE DEFECTS IN CONGENITAL DIAPHRAGMATIC HERNIA

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The surgical management of congenital diaphragmatic hernia (CDH) using biomaterials is still not clearly understood. A neonate with a large left-sided CDH and severe pulmonary hypoplasia was offered surgical closure of the defect using a polytetrafluoroethylene (PTFE) patch on the 12th day after birth. The infant presented with a recurrence 2.5 months later as an emergency with intestinal herniation in the thorax manifesting in the form of a mechanical ileus. The recurrence was managed using a cone-shaped PTFE patch with tension-free approximation to the residual diaphragm and ribs. Six months after the second repair, the infant presented a second recurrence detected during a regular follow-up examination. The second recurrence was managed with a dome-shaped PTFE and polypropylene (PP) patch (composite prosthetic) which offered the advantage of providing a larger volume for the accommodation of the intestinal viscera. The follow-up examinations over the past 12 months have been uneventful. *Acta Medica Medianae 2014;53(4):42-45.*

Key words: *congenital diaphragmatic hernia, recurrence, dome-shaped patch, polytetrafluoroethylene, polypropylene*

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Introduction

Congenital diaphragmatic hernia (CDH) presenting with large defects in the diaphragm requires surgical repairs using biomaterials. About half of all prosthetic patches used for repair of CDH shows evidence of reherniation and requires revision (1). Polytetrafluoroethylene (PTFE) (Gore-Tex® Surgical Membrane; W. L. Gore & Associates, Inc., Flagstaff, AZ) is the most commonly employed non-degradable synthetic material for repair; however, the role of such material in large defects with regards to integration in a growing hemi-thorax is not well understood with regards to biomaterial-suture interface, type of replacement tissue and its functional assessment. The case of a neonate with two recurrences after closure of a large left-sided CDH with PTFE, finally successfully managed with a dome-shaped composite prosthetic patch/mesh using PTFE and Polypropylene (PP) (Prolene Polypropylene Mesh®; Johnson & Johnson Medical Products GmbH, Vienna, Austria), is reported.

Case report

A newborn with a prenatal diagnosis of a left-sided CDH (liver up and lung-to-head ratio 30%) was delivered by Cesarean section in the 38th week of gestation with a body weight of 3000 grams, body length 54cm and head circumference 35cm. Due to the presence of severe pulmonary hyploplasia and the post-partal challenges offered in maintaining the cardio-pulmonary situation, the neonate was put on Extracorporeal Membrane Oxygenation (ECMO) on the 2nd day and successfully weaned after 5 days enabling surgical correction of the CDH defect on the 12th day.

Surgical access to the diaphragm was obtained through a left-upper abdominal laparotomy. The herniated contents which included part of the left liver lobe, spleen, multiple loops of

small intestines, parts of transverse and descending colon, and stomach were reduced from the left hemithorax and returned to the abdomen. The large size defect was closed using a PTFE patch with approximation to the ventral and dorsal diaphragmatic remnants using interrupted non-absorbable suture. The neonate was discharged 6 weeks after surgery and establishment of regular feeds, in a stable cardio-pulmonary condition.

Two and a half months later, the infant was presented in the emergency room in a reduced general condition with symptoms of mechanical ileus and bilious vomiting. Chest films and ultrasound examinations confirmed the presence of a recurrence with strangulation of the small intestinal bowel loops in the left hemithorax. Emergency surgery was performed with abdominal access gained through the prior laparotomy incision scar. Severe adhesions were removed between the liver, the stomach and the intestinal loops to enable access to the diaphragm. The PTFE patch was found to be retracted on the posterior throracic wall through which the small intestinal loops herniated. The herniated small intestinal loops were returned to the abdomen and the PTFE patch from the prior surgery was removed. The large diaphragmatic defect was then repaired using a tension-free cone-shaped patch which was sutured to the edges of the left hemithorax. After full recovery and restoration of feeds, the infant was discharged 2 weeks after the procedure.

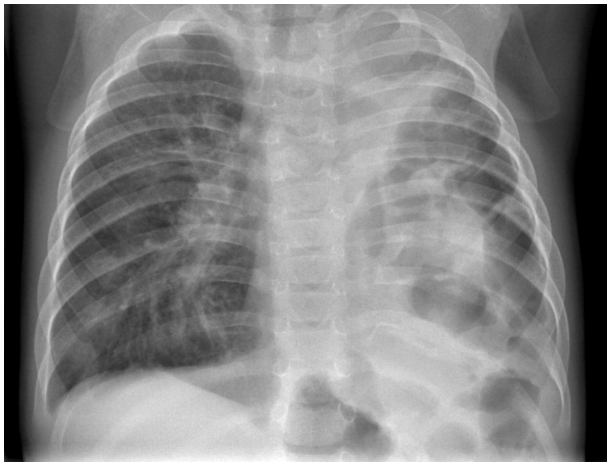

Figure 1. Presence of a recurrence (herniated bowel loops) which was confirmed on a chest film

Regular follow-ups were carried out using clinical assessments and ultrasound on a monthly basis. The follow-up at the 6th month in a clinically unremarkable infant using ultrasound demonstrated the presence of a recurrence which was confirmed on a chest film (Figure 1.).

With the infant being asymptomatic, the repair of the diaphragm was performed through a left thoracotomy as severe adhesions were encountered in the prior laparotomy. The cone-shaped PTFE patch which was disassociated from the diaphragm was removed and replaced by a dome-shaped PTFE patch. The dome-shaped patch was formed by creating two folds on the opposite side of the patch, with suturing of the edges with non-degradable suture material to form a dome (Figure 2.). Considering the geometrical dimensions of the diaphragm, the dome-shaped patch was constructed to demonstrate conformity in mimicking the diaphragmatic morphology (Figure 3.). The PTFE patch was sutured to the edges of the remnants of the left hemi-diaphragm using non-absorbable suture. On the thoracic side, a PP mesh was tailored in the form of a dome and placed on the PTFE patch and sutures to the diaphragmatic edges. Sutures were also placed to directly attach the PP mesh to the PTFE patch. The postoperative course was regular, and follow-up examination after 12 months was uneventful.

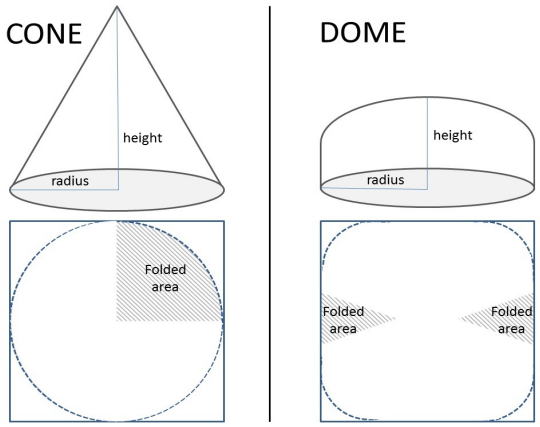

Figure 2. The dome-shaped patch versus cone-shaped counterpart: (1) The dead space in the tip of the cone-shape patch is largely eliminated by the dome-shape; (2) The surface area provided for intra-abdominal contents is spread over a larger perimeter on top of the dome to provide more space for accommodation of abdominal contents and (3) the perimeter on the edge of the dome is larger than that achieved with a cone shape.

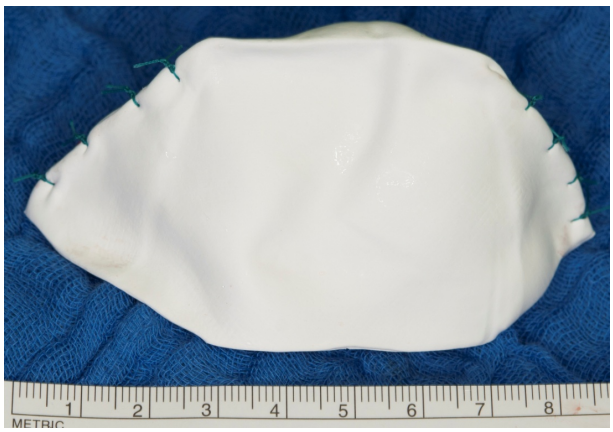

Figure 3. The dome-shaped patch was constructed to demonstrate conformity in mimicking the diaphragmatic morphology

Discussion

With regards to recurrences which occur generally in the early follow-up period, the trend in Gore-Tex® patch repair has shifted towards the employment of large patches tailored in the form of a cone to offer increased volume for the intra-abdominal viscera as well as to decrease the tension on the patch-suture interface (2,3).

The dome-shaped patch offers advantage in many areas when compared to its cone-shaped counterpart: (I) The dead space in the tip of the cone-shaped patch is largely eliminated by the use of a dome-shaped patch; (II) The surface area provided for intra-abdominal contents is spread over a larger perimeter on top of the dome to provide more space for the accommodation of abdominal contents and (III) the perimeter on the edge of the dome is larger than that achieved with a cone shape.

Another advantage of the dome-shaped patches could be hypothesized in relation to chest wall deformities (CWD) and CDH. CWD are musculoskeletal anomalies which have been found to be associated with CDH (4,5). To date, there have not been reports that have correlated these deformities directly to either primary closure or patch repairs. However, in the context of pectus excavatum, CDH patch repairs with cone-shaped patches could be hypothesized to be associated for the early secondary appearance of these deformities as the circular perimeter of the cone-shape patch could cause centripetal tension in an oval hemithorax during growth. The comparatively oval perimeter of the dome-shaped patches hence could be postulated to overcome these short-comings of the cone-shaped patch.

Dome-shaped patches have to be created with PTFE which can be custom tailored and concomitantly sutured with another synthetic biomaterials such as PP. It is important to place PP mesh on the thoracic side and not on the abdominal side which could lead to adhesions that could result in small bowel obstructions. Composite PTFE patch - PP mesh prosthetic patches have been reported to be associated with lower recurrence rates in a series reported with the repair of large size CDH defects (6). However, this report underlines the advantages of using PTFE patch - PP mesh in the form of a dome-shaped construct. Furthermore, natural degradable biomaterials which undergo trans-formation or replacement through scar tissue could be utilized in combination with PTFE patches. However, no experimental studies or clinical data have been reported using this combination.

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KUPOLASTI PAČ PRUŽA OPTIMALNU BIOMEHANIKU ZA SANIRANJE VELIKIH DEFEKATA KOD KONGENITALNE DIJAFRAGMALNE HERNIJE

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Hirurško zbrinjavanje kongenitalne dijafragmalne hernije (CDH) pomoću biomaterijala još uvek nije razjašnjeno. Kod novorođenčeta sa velikom difragmalnom hernijom sa leve strane i ozbiljnom hipoplazijom pluća je dvanaestog dana nakon rođenja urađeno hirurško zbrinjavanje defekta pomoću politetrafluotetilenskog (PTFE) pača. Nakon dva i po meseca, kod deteta se kao urgentno stanje pojavila intestinalna hernija u predelu toraksa, koja se manifestovala kao mehanički ileus. Ponovno javljanje kile sanirano je pomoću kupastog PTFE pača uz približavanje rezidualnoj dijafragmi i rebrima bez zatezanja. Šest meseci nakon druge intervencije, kod deteta se ponovo javila kila koja je otkrivena prilikom kontrolnog pregleda. Ova rekurencija je sanirana pomoću kupolastog PTFE pača i polipropilenskog (PP) pača, što je omogućilo više prostora za smeštanje visceralnih organa. Nalazi kontrolnih pregleda u toku prethodnih dvanaest meseci bili su uredni. *Acta Medica Medianae 2014;53(4):42-45.*

***Ključne reči**: kongenitalna dijafragmalna hernija, ponovno javljanje, kupolasti pač, politetrafluoretilen, polipropilen*