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Full length article

Thoracoamniotic shunting for fetal pleural effusion with hydropic change using a double-basket catheter: An insight into the preoperative determinants of shunting efficacy

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ABSTRACT

Objectives: Although the efficacy of thoracoamniotic shunting (TAS) for fetal hydrothorax is well-recognized, the coexistence of hydrops fetalis is still a clinical challenge. The preoperative determinants of shunting efficacy are not fully understood. In this study, we aimed to investigate the perinatal and postnatal outcomes of hydrops fetalis with pleural effusion treated by TAS using a double-basket catheter, and to discuss the preoperative factors predictive of patients who will benefit from TAS.

Study design: We conducted a retrospective study in hydropic fetuses with pleural effusion treated by TAS between 2007 and 2015. We extracted information regarding postnatal survival and pretherapeutic sonographic findings, including skin-edema thickness, pleural-effusion pocket size, and Doppler readings.

Results: Twelve subjects underwent TAS at a median gestational age of 29^{+5} weeks (range, 25^{+5}–33^{+2} weeks). Skin edema disappeared or regressed in 7. Three experienced early neonatal death and the other 9 ultimately survived after a live birth at a median gestational age of 33^{+4} weeks (range, 29^{+1}–38^{+2} weeks). All surviving children, except for 1, had a pretherapeutic pleural-effusion pocket greater than the precordial-edema thickness. All 3 children that died had precordial-edema thickness equal to or greater than the size of the pleural-effusion pocket.

Conclusions: We achieved a high survival rate (75%) using the double-basket technique. A greater pretherapeutic width of skin edema compared with the pleural-effusion pocket is possibly suggestive of a treatment-resistant condition and subsequent poor postnatal outcome.

Introduction

Fetal pleural effusion (PE) can act as a space-occupying lesion, displacing mediastinal structures and leading to hemodynamic deterioration and nonimmune hydrops fetalis (NIHF). Hydrops has been recognized as the main adverse prognostic factor in fetuses with PE [1–8]. Although the efficacy of thoracoamniotic shunting (TAS) for fetal hydrothorax is well-described [5–13], the coexistence of hydropic change is still a clinical challenge, adding significant morbidity and mortality. The factors that determine the efficacy of TAS and the outcomes in affected fetuses are still not fully understood.

Worldwide, the large majority of fetal shunting operations are performed using double-pigtail catheters. In Japan, double-basket catheters are the only catheters approved for fetal shunting procedures in clinical practice. This type of shunt catheter is short and straight, compared with double-pigtail catheters, and both ends of the tube are basket-shaped. The advantage of the double-basket catheter is its thinness, with an outlet diameter of only 1.6 mm; therefore, this catheter is expected to be less invasive [8].

We aim to investigate the perinatal and postnatal short-term outcomes in fetuses with hydrops and PE treated using TAS with a double-basket catheter. We also discuss the determinants that affect outcome in these fetuses.

Materials and methods

Patients and study design

We retrospectively reviewed the charts of all fetuses with hydrops undergoing TAS at our institution between 2007 and 2015.

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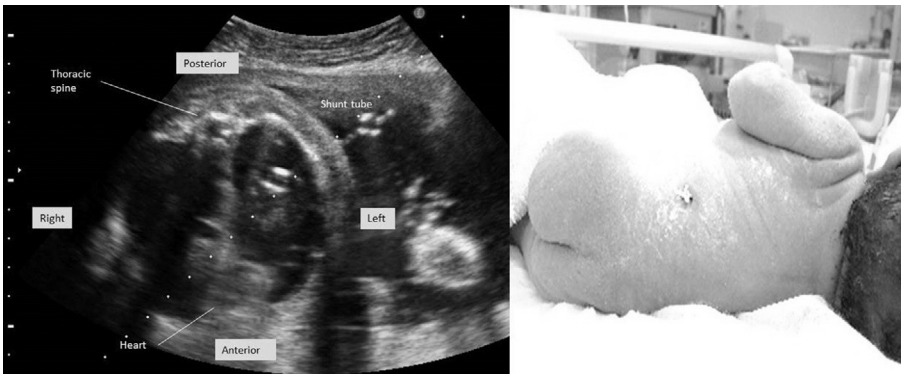

Fig. 1. Ideal insertion position for the shunt tube: the tube is inserted obliquely from behind the baby, perpendicular to the chest wall.

Hydrops fetalis was defined as an abnormal fluid collection in 1 or more fetal compartments; the collections included ascites, pericardial effusion, and skin edema more than PE. Fetuses with PE but without hydrops were excluded from this analysis. During the study period, 2 hydropic fetuses with congenital cystic adenomatoid malformation underwent cyst-amniotic shunting; these fetuses were also not included in this analysis. Maternal demographic characteristics, pretherapeutic sonographic findings, the success rate of the TAS procedure, perioperative complications, postoperative adverse events, gestational age at delivery, and postnatal short-term outcomes were extracted.

Institutional management strategy for fetal pleural effusion with hydrops

Our management policy for fetal PE with hydrops was as follows: if the fetus was diagnosed with PE and hydrops, the mother was referred for further assessment, including maternal serological TORCH screening. Detailed ultrasound examinations were performed to evaluate the fetal anatomy. If structural diseases were detected that were considered to be related to chromosomal abnormalities, fetal karyotyping was offered and performed according to the parents' preference. The mid-cerebral artery peak systolic velocity (MCA-PSV) was measured to detect the likelihood of fetal anemia. If the MCA-PSV value was more than 1.5 multiples of the median for the respective gestational age, cordocentesis was performed to confirm the diagnosis of fetal anemia. Once TORCH infection, fetal anemia, arrhythmia, major structural abnormalities, and lethal chromosome abnormalities were ruled out, we performed thoracentesis, with cytology examination of the drained fluid. Chylothorax was diagnosed if the cell count of the aspirated fluid consisted of more than 80% lymphocytes. If the PE recurred to the same degree after initial thoracentesis, TAS was carefully discussed based on the Japanese standard protocol [11]. The eligibility criterion for TAS included fetal PE that was isolated or associated with bronchopulmonary sequestration (BPS); fetuses <34 weeks' gestation were candidates for TAS. Major structural diseases were considered contraindications for TAS, but fetuses with minor issues, such as a small ventricular septal defect, were not excluded from TAS.

TAS surgical procedure

Combined spinal and epidural anesthesia was used to control maternal pain. General anesthesia or fetal muscular injection of a muscle relaxant drug was never applied, even for excessive fetal movement. We always attempted to insert the shunting tube obliquely, from behind the fetus, perpendicular to the fetal chest wall (Fig. 1). The reason for this oblique posterior insertion was to make it difficult for the fetus to grasp and remove the tube. The aim of the perpendicular insertion was to make the width of tubing passing through the area of fetal skin-edema as short as possible, to reduce the risk of tube obstruction. As it sometimes required a waiting period until the perfect fetal position was presented, epidural anesthesia provided the operator sufficient time and reassurance. A 16-gauge puncture needle with a trocar (5 Fr; outer diameter, 1.6 mm) was inserted under ultrasonic guidance, and the shunt tubes were placed by fetal medicine specialists using a double-basket catheter (Hakko Co., Nagano, Japan) (Fig. 2). If the effusion collected bilaterally, the procedure was performed on both sides.

Ultrasound measurements

All patients underwent a thorough perinatal ultrasonographic evaluation with Doppler analysis, including the resistance index of the umbilical artery (UmA-RI), the resistance index of the mid-cerebral artery (MCA-RI), and the pulsatility index of the ductus venosus (DV-PI). Fetal skin-edema thickness was measured at the level of the 4-chamber view on a transverse scan of the fetal chest by positioning the calipers inside the echoes generated by the sternum and body surface (Fig. 3). The pleural-effusion pocket was defined as the diameter of the largest circle that could be drawn in

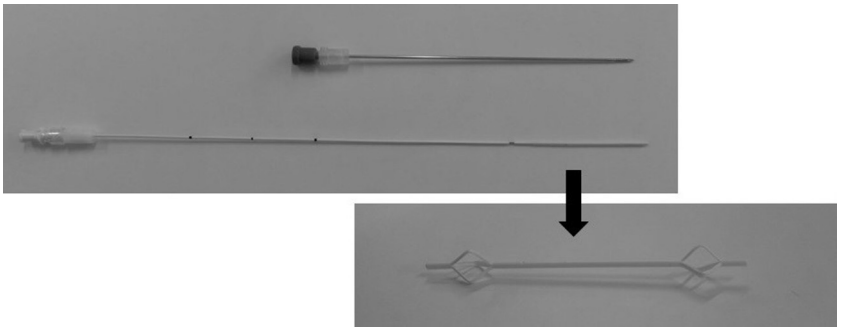

Fig. 2. Design of the double-basket catheter.