

# The Use of Cardiopulmonary Bypass and Extracorporeal Membrane Oxygenation for Support During Removal of Two Teratomas and Hydrops Fetalis

Leighann Burdis, BS, CCP; Donald D. Koch, CCP

Children's Hospital of Pittsburgh, Department of Cardiothoracic Surgery, Pittsburgh, Pennsylvania

**Abstract:** The removal of massive tissue tumors often leads to rapid blood loss and decreased lung compliance because of large volume shifts. Cardiopulmonary bypass (CPB) and extracorporeal membrane oxygenation (ECMO) have both been used as a means of support during resection of sacrococcygeal teratomas (1). Hydrops fetalis is the accumulation of fluid in extravascular spaces and body cavities. This leads to edema and sometimes hypoxia. ECMO has been used for support during treatment of hydrops fetalis (2). This patient was diagnosed, via sonogram, at 30 weeks gestation to have two teratomas and hydrops fetalis. Because of the risk of hemorrhage and poor lung compliance

during removal of these types of tumors, CPB and ECMO were used. This support allowed for successful removal of the tumors. Following removal of the tumors, the patient failed to wean from CPB because of the severity of hydrops. The patient remained on extracorporeal support for treatment of hydrops fetalis. This report describes the perfusion techniques used for support during the removal of teratomas and the treatment of hydrops fetalis. **Keywords:** sacrococcygeal teratoma, hydrops fetalis, cardiopulmonary bypass, extracorporeal membrane oxygenation, high-output cardiac failure. *JECT. 2004;36:182–184*

Sacrocoxygeal teratoma is the most common tumor in the newborn with an incidence of 1 in 40,000 births. This type of tumor originates from more than one embryonic germ cell layer and usually develops as a mass in the sacrococcygeal region. Sacrococcygeal teratomas are commonly very large, well encapsulated, and grossly lobulated. Sacrococcygeal teratomas are highly vascular, and removal of these types of tumors is often associated with death because of high-output cardiac failure and hemorrhage (1). High-output cardiac failure is a result of a large amount of venous return to the heart from the tumor. Because the heart will pump all blood it receives within a given time period, an increase in venous return from the tumor will result in an increase in cardiac output. Feeder vessels of the tumor are often large, resembling those vessels supplying the lower extremities of the fetus. Sacrococcygeal teratomas diagnosed in utero are usually benign. However, sacrococcygeal teratomas associated with hydrops fetalis can be fatal in utero.

Hydrops fetalis is characterized by excessive fluid accumulation in the extravascular compartments and body cavities. This leads to the development of anasarca, ascites, and pleural or pericardial effusion (2). Hydrops is

usually the result of a wide range of mechanisms that are broadly categorized by the presence (isoimmune) or absence (nonimmune) of isoimmunization to an erythrocyte antigen (3). Hydrops fetalis is divided into two major categories, isoimmune hydrops and nonimmune hydrops. Isoimmune hydrops occurs when there is a maternal IgG antibody response to the fetal red blood cell antigen resulting in hemolysis and anemia (2). Nonimmune hydrops is hemolysis and anemia resulting from a cause other than the antigen-antibody response (2). Most cases (50%) of nonimmune hydrops arise from an unknown etiology. Despite advances in the diagnosis and treatment of hydrops, prognosis is poor. Over 90% of fetuses affected with nonimmune hydrops die of profound hypoxia and organ failure.

## CASE DESCRIPTION

The patient was diagnosed, via sonogram, at 30 weeks gestation to have two sacrococcygeal teratomas and hydrops fetalis. The weight of the baby and the teratomas was estimated to be 4.0 kg. The actual weight of the baby was estimated to be 2.0 kg. Because of the high blood flow through the tumors, the fetus was not thriving in the womb. At 31 weeks gestation, a C-section was performed. A large mass about the size of a softball protruded from

Address correspondence to: Leighann Burdis, BS, CCP, 3705 Fifth Avenue, One Children's Place, Pittsburgh, PA 15213. E-mail: burdla@chp.edu

the abdomen, and a second mass of the same size protruded from the coccyx region. Immediately after the C-section, the baby was intubated for mechanical ventilation and cannulated for CPB. The patient was fully heparinized at 3 mg/kg. An 8 fr Biomedicus (Medtronic Inc., Minneapolis, MN), arterial cannula was used to cannulate the right common carotid artery and 10 fr Biomedicus (Medtronic Inc., Minneapolis, MN) venous cannula was used to cannulate the right internal jugular vein. The baby was then placed on CPB for circulatory support. After initiating bypass, the umbilical cord was cut. The baby was transported, while being supported with CPB, to another OR for removal of the teratomas. The CPB circuit consisted of a Dideco Lilliput I oxygenator (Sorin Biomedical, Arvada, CO), a Capiiox 100 cc venous reservoir bag (Terumo, Somerset, NJ), a 40  $\mu$ m Dideco arterial filter (Terumo, Somerset, NJ), a 40  $\mu$ m Dideco cardiectomy reservoir (Sorin Biomedica, Arvada, CO), and a 1/4 in Cobe custom tubing pack (Sorin Biomedical, Arvada, CO). The circuit was primed with 300 cc Plasma-lyte-A (Baxter-Healthcare Corp., Deerfield, IL), 100 cc packed rbc, 0.5 cc beef lung heparin (500 units), 100 cc 25% albumin (25 g), 25 cc NaHCO<sub>3</sub> (25 meq), and 6 cc trasylol (60,000 units). The patient was cooled to a core temperature of 28°C. The heart was allowed to remain beating during the procedure. CPB lasted for 386 minutes. During CPB, 5 units of packed rbc and 2 units of FFP were used. The target range for ACTs was 450–600 seconds. Blood gases were analyzed approximately every 30 minutes to maintain a pO<sub>2</sub> of <150 mm Hg, with all other parameters, including hematocrit and electrolytes, being within normal limits. Blood loss during the surgery was estimated to be 2000 cc. Because of the large amount of blood loss, the dorsal teratoma could not be removed at that time. The patient failed to wean from CPB and was placed on ECMO with the same cannulas used for CPB. The ECMO circuit consisted of a 1/4 in Cobe custom tubing pack (Sorin Biomedical, Arvada, CO), a 30 cc bladder (Medtronic Inc., Minneapolis, MN), a 1500 ECMO oxygenator (Medtronic Inc., Minneapolis, MN), and a 60 cc Gish HE-4 heat exchanger (Gish, Rancho Santa Margarita, CA). The ECMO circuit was primed with 450 cc Plasma-lyte-A (Baxter Healthcare Corp., Deerfield, IL), 200 cc packed rbc, 100 cc 25% albumin (25 g), 0.5 cc (500 units) heparin, 20 mL (20 meq) NaHCO<sub>3</sub>, and 30 mL (30 meq) THAM. During the first 24 hours of ECMO, the patient required 1043 cc of packed rbc, 132 cc of FFP, and 638 cc of platelets. Bleeding subsided during the second 24 hours of ECMO. On the third day of ECMO, the patient was transported to the OR for removal of the dorsal teratoma. The patient remained on ECMO during this procedure. While in the OR, the patient required 810 cc of packed rbc, 250 cc of FFP, 167 cc of platelets, and 90 cc of 5% albumin. Blood loss during this procedure was estimated

to be 850 cc. After removal of the dorsal teratoma, the patient failed to wean from ECMO and remained on ECMO for pulmonary and cardiac support for approximately 9 more days. During the first 24 hours after removal of the dorsal teratoma, the patient required 601 cc of packed rbc, 257 cc of FFP, 407 cc of platelets, and 180 mL of 5% albumin. The bleeding subsided approximately 48 hours after the second procedure, and blood product usage decreased. Once the bleeding slowed down, the patient was trialed to wean off ECMO. ECMO trials consistently failed. After a total of 12 days of ECMO, the patient had no improvement in pulmonary or cardiac function. Support was withdrawn, and the patient died.

## DISCUSSION

CPB and ECMO have both previously been used for support during removal of a sacrococcygeal teratoma (1). Both of these methods were chosen for support because of the risk of hemorrhage and the decrease in lung compliance caused by massive volume shifts during removal of a tumor. CPB was chosen because it allows for better volume control, lower priming volume, better air handling from the venous line, and the ability to use pump suction. Blood loss from the field can be suctioned into the CPB circuit and given back to the patient, which would result in less blood product usage. Because of the small size of the baby (2.0 kg), hemodilution was a concern. CPB offers a significant decrease in priming volume. The priming volume of the neonatal CPB circuit is about 500 cc, and the priming volume of the neonatal ECMO circuit is about 800 cc. To reduce blood loss, hypothermia was used. This allowed for lower pump flows and lower mean arterial blood pressures. When the baby could not be weaned from CPB, ECMO was used for long-term support.

CPB and ECMO were successful as support during the removal of these tumors. Blood gases, pump flows, and volumes were maintained during both procedures. Postop bleeding, however, was excessive, and the baby required large amounts of blood products to maintain pump flows. Blood tests revealed that the baby had nonimmune hydrops fetalis. Nonimmune hydrops fetalis, as previously discussed, has a poor prognosis. This is especially true in cases of unknown etiology.

This report shows that both CPB and ECMO may be used for support during removal of sacrococcygeal teratomas. Blood loss can be minimized through the use of pump suction, hypothermia, and careful surgical technique. The use of ECMO for support of nonimmune hydrops fetalis was unsuccessful in this case. Nonimmune hydrops fetalis is a poorly understood disease; therefore, is difficult to treat and cure. ECMO support should not be excluded for the treatment of nonimmune hydrops fetalis; however, it must be understood that prognosis of nonim-

mune hydrops fetalis is poor. ECMO, when begun early, may help to improve the chances of survival of those babies with nonimmune hydrops fetalis who, otherwise, may have no chance of survival.

If presented with a similar case, there are a few changes that could be made to serve the patient better. The initial mode of support will be ECMO. This will decrease the use of blood products and foreign surface exposure. It was not anticipated, in this case, that the patient would require cardiopulmonary support after surgery, and CPB was chosen because of the benefits previously stated in this report. The addition of a hemofilter to the circuit would allow for removal of intravascular water, bradykinins, and catecholamines during the operative procedure. At the Children's Hospital of Pittsburgh, a 1500 ECMO oxygenator is cur-

rently used for neonatal ECMO procedures. This is done to allow for longer bypass runs and less frequent change out of the oxygenator. A 0800 ECMO oxygenator would allow for a lower priming volume and less foreign surface exposure.

## REFERENCES

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