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MODERN CONCEPTS OF INTRAUTERINE BLOOD TRANSFUSION

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Abstract

Intrauterine blood transfusion (IUHT) is a highly effective treatment for severe fetal anemia, significantly reducing perinatal mortality rates and improving pregnancy outcomes. The most common reason for IUHT remains hemolytic disease of the fetus due to Rh alloimmunization. However, in recent years, the indications for this procedure have expanded to include anemia due to parvovirus infection, fetomaternal hemorrhage, twin-to-twin transfusion syndrome, and certain hereditary blood disorders. Modern advances in ultrasound diagnostics, middle cerebral artery Doppler ultrasound, improved invasive techniques, and advances in fetal medicine have significantly improved the safety and effectiveness of the procedure.

Keywords: intrauterine blood transfusion, fetal anemia, hemolytic disease of the fetus, Rh incompatibility, fetal therapy.



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Intrauterine blood transfusion is a specialized method of intrauterine fetal treatment aimed at correcting severe anemia by transfusing red blood cells directly into the fetal vasculature. Since the first successful implementation of the procedure in 1963, the technique has undergone significant evolution and is now considered the "gold standard" for treating severe fetal anemia.

The introduction of modern prenatal diagnostic methods has made it possible to promptly detect signs of fetal anemia and determine the optimal timing of intervention. Of particular importance is the measurement of peak systolic blood flow velocity in the middle cerebral artery (MCA-PSV), which allows for non-invasive assessment of the degree of anemia.

Indications for intrauterine blood transfusion

The main indications are:

- severe fetal anemia;
- hemolytic disease of the fetus due to Rh or other red blood cell alloantibodies;
- parvovirus B19 infection;
- massive fetomaternal hemorrhage;
- anemia associated with twin-to-twin transfusion syndrome;
- certain hereditary blood disorders.

The most common cause remains maternal Rh alloimmunization. Despite the widespread use of anti-Rh immunoglobulin, cases of severe hemolytic disease of the fetus continue to occur.

Modern Diagnosis of Fetal Anemia

The modern diagnostic algorithm includes:

- ultrasound;
- middle cerebral artery Doppler;



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- assessment of signs of fetal hydrops;
 - cordocentesis if necessary to confirm the diagnosis.

MCA-PSV measurement is the most informative noninvasive diagnostic method. An increase in blood flow velocity greater than 1.5 MoM warrants an invasive assessment of the fetus and consideration of intrauterine blood transfusion.

Procedure

Currently, intravascular transfusion via the umbilical vein under continuous ultrasound guidance is preferred.

The red blood cell mass used must meet strict requirements:

- blood type O(I);
- Rh(D)-negative;
- leukoreduced;
- irradiated;
- cytomegalovirus-negative (or CMV-safe according to local standards);
- with a high hematocrit (usually 75–85%);
- freshly prepared.

The transfusion volume is calculated individually, taking into account:

- gestational age;
- fetal weight;
- initial hematocrit;
- target hematocrit level.

Effectiveness of the Method

According to modern research, fetal survival after intrauterine blood transfusion exceeds 90% in the absence of fetal hydrops and reaches 75–85% in the presence of severe hydrops.



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Most patients require 2–4 consecutive transfusions, spaced 2–4 weeks apart, until the time for safe delivery is reached.

Potential complications

Despite the high effectiveness of the procedure, there remains a risk of complications:

- fetal bradycardia;
- umbilical cord bleeding;
- premature rupture of membranes;
- preterm labor;
- infectious complications;
- intrauterine fetal death.

Modern specialized centers report that the risk of fetal loss associated with the procedure is typically less than 2% per procedure, although this rate varies depending on the operator's experience, gestational age, and the severity of the fetal condition.

Current Trends

Current developments include:

- improving ultrasound navigation;
- early detection of anemia using Doppler ultrasound;
- noninvasive determination of fetal RhD using free fetal DNA in maternal blood;
- personalized calculation of blood transfusion volume;
- improving the prevention of Rh alloimmunization;
- concentrating procedures in specialized fetal medicine centers.



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Particular attention is paid to the standardization of treatment protocols and interdisciplinary collaboration between obstetricians and gynecologists, ultrasound specialists, transfusion specialists, and neonatologists.

Conclusion

Intrauterine blood transfusion is one of the most successful methods of fetal therapy and remains the primary treatment for severe fetal anemia. Modern diagnostic methods, primarily Doppler ultrasound assessment of peak systolic blood flow velocity in the middle cerebral artery, allow for the timely identification of fetuses at high risk for anemia and the initiation of treatment before irreversible complications develop. Performing the procedure in specialized centers using modern technology ensures high fetal survival rates and favorable perinatal outcomes.

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