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Review Article

Cordocentesis: Boon to Fetus

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ABSTRACT

The aim of obstetrics care is to improve and optimise the outcome of pregnancy. Our objective is to avoid preventable death, disease and disability in children.

Cordocentesis, also known as percutaneous umbilical blood sampling, is a critical diagnostic procedure that has significantly advanced fetal medicine. This technique allows for the direct collection of fetal blood, offering valuable insights into fetal physiology, metabolism, and disease. By providing access to real-time data on fetal blood gases, hemoglobin levels, and genetic information, cordocentesis has enabled healthcare professionals to diagnose and manage conditions such as fetal anemia, infections, and genetic disorders with greater accuracy. The procedure has proven particularly beneficial in cases of nonimmune hydrops, severe growth restriction, and structural anomalies, allowing for precise diagnosis and tailored interventions. Furthermore, it has facilitated the correlation of fetal blood data with Doppler ultrasound and fetal heart rate patterns, enhancing the understanding of fetal well-being.

While cordocentesis carries some risks, including the potential for fetal loss and complications like bradycardia, its ability to provide critical information in high-risk pregnancies has made it an invaluable tool in modern obstetrics. Overall, cordocentesis has revolutionized prenatal care by offering access to direct fetal circulation thus opening new areas of prenatal diagnosis and therapy and a means of diagnosing and managing fetal conditions that would otherwise be difficult or impossible to detect.

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INTRODUCTION

Pregnancy and child bearing are attended by certain risks to the mother as well as the foetus. The aim is to improve and optimize the outcome of pregnancy. Fetomaternal medicine is under constant experimentation and evaluation. There is revolution in diagnostic modalities for fetal well being. Foetus is accessible today with increasing clarity with various procedures and imaging technologies. The unborn patient has elevated the importance of prenatal diagnosis and treatment. There are many ethical considerations in the practice of fetomaternal medicine. Our objective is to avoid preventable death, disease and disability in children.[1] Direct cord puncture to obtain foetal blood samples is a new technique which has opened up new vistas and enlarged the scope of foetal medicine.[2]

CORDOCENTESIS OR PERCUTANEOUS UMBILICAL BLOOD SAMPLING

Cordocentesis is a technique by which foetal blood sampling (FBS) is done through the maternal abdomen under ultrasound guidance.[3] This procedure is usually performed at or after 20 weeks of gestation. The indications of foetal blood sampling are becoming rare with introduction of CVS but it allows rapid foetal karyotyping in case of late presentation.[4] Cordocentesis was first described by Daffos and colleagues (1983). In this procedure, the surgeon punctures the umbilical vein at or near its placental origin, with a 22 gauge needle under direct USG guidance and blood is withdrawn. A free loop of cord also can be accessed. Arterial puncture should be avoided because it can result in vasospasm and foetal bradycardia.[5] The umbilical vein at the placenta, cord insertion is the common target but other sites for sampling may include the foetal intrahepatic umbilical vein.[4]

Indications: Cordocentesis can be used to obtain foetal blood cells for genetic analysis when CVS or amniocentesis results are confusing or when rapid diagnosis is necessary. Karyotyping of foetal blood usually can be accomplished within 24-40 hours. Rapid Foetal Karyotyping results are available in 48 hours.

The procedure is indicated in following conditions:

DIAGNOSTIC

- To detect foetal clotting disorders such as immune thrombocytopenia/ haemophilia.
- Haemolytic disease to estimate foetal blood group, haemoglobin, haematocrit and bilirubin.
- Non-immune hydrops to assess haemoglobin, haematocrit and karyotype.
- Severe IUGR
- Foetal acid- base status
- Karyotype
- Glucose and calcium levels
- Endocrine and haematological status of foetus
- Tests for foetal infections
- Suspected Intrauterine foetal infection:
  - Complete blood count
  - Liver enzymes
  - Cultures to isolate the organism and
  - Foetal IgM levels
- Congenital disorders:
  - Haemoglobinopathies
  - Haemophilia
  - Immunodeficiency diseases

THERAPEUTIC

Direct injection of drugs into the foetal circulation for intractable conditions such as supraventricular tachycardia.[5]

In fetal medicine, cordocentesis, also known as percutaneous umbilical blood sampling (PUBS), is a relatively new but very successful

procedure that has both therapeutic and diagnostic uses. The only procedure that offers direct access to the fetal circulation at the moment is PUBS. It is utilized for in utero treatments like pharmaceutical delivery and transfusions for rhesus alloimmunization. Additionally, PUBS makes it possible to evaluate the thyroid function of the fetus, which aids in the diagnosis of thyroid conditions and the control of in utero treatment.

This method is crucial for collecting fetal pathological biomarkers and is safe to perform during the second and third trimesters. By accessing the fetal circulation, PUBS opens new possibilities for prenatal diagnosis and treatment. One significant advantage is its ability to perform direct intravascular transfusions, reducing the need for preterm deliveries, allowing earlier treatments than intraperitoneal transfusions (IPT), and improving survival rates in cases of hydrops. PUBS is also a major advancement in diagnosing fetal hypoxia, acidosis, placental insufficiency, growth restriction, and fetal distress.[6]

Additionally, PUBS can identify fetal platelet phenotypes, enabling in utero platelet transfusions that reduce the risk of intracranial bleeding. At 20 to 22 weeks of pregnancy, it is recommended for all at-risk patients to undergo cordocentesis to address neonatal alloimmune thrombocytopenia. Moreover, PUBS offers direct access to fetal thyroid disease diagnosis and treatment management. The technique has also proven successful in managing fetal tachyarrhythmias, where antiarrhythmic medications like digoxin, verapamil, and amiodarone are administered through the placenta to treat non-hydropic fetuses.[7]

Cord compression and fetal bradycardia may result from an iatrogenic umbilical cord hematoma.[8]

Cordocentesis is easier to perform when the placenta is positioned anteriorly. However, when the placenta is posterior, the procedure becomes more challenging due to fetal parts being in the path of the needle.

After carefully considering the benefits, risks, and available options, written informed consent is obtained. Ideally, the sample should be collected from the placental umbilical cord origin, as it provides more stability. If needed, a midsegment (free loop) of the cord can be used instead. The umbilical vein is the preferred site due to its lower risk of causing fetal bradycardia. If the placenta is positioned anteriorly, a transplacental approach might be necessary, although this increases the risk of fetal-maternal hemorrhage and potential sensitization. When assessing a fetus for hemolytic anemia, the placenta is avoided, and a free loop is chosen for sampling.

To look for bradycardia, the fetal heart rate is tracked. External fetal cardiac monitoring is done for at least an hour if the fetus is viable. Fetal heart rate tracing is usually nonreactive with modest tachycardia when pancuronium has been given. The mother is advised to get in touch with her healthcare provider prior to discharge in the event that she has fever, uterine pain, bleeding, fluid leakage, or contractions. She is told that the infection may appear gradually, with myalgias and a low-grade fever, much like a viral sickness. There are no restrictions on activity. Test results are arranged for the patient, and if the patient is Rh-negative, the fetus is typed and, if necessary, RhoGAM is administered.[9]

Alternatively if cordocentesis not possible:

- Hepatic vein
- Cardiac sampling

Causes of fetal distress after cordocentesis:

- Cord Rupture
- Cord Spasm
- Tamponade from cord hematoma
- Excessive bleeding from the puncture site

Death that occurs as a result of a surgery might be linked to an already compromised fetal status or the procedure itself.

Complications of Cordocentesis:

- Fetal death
- Bradycardia
- Amnionitis
- Cord hematoma
- Umbilical cord bleeding
- Fetal maternal hemorrhage
- Premature rupture of membranes
- Preterm labor
- Abruptio placentae
- Complications secondary to premature

delivery

- Maternal sepsis, followed by adult respiratory distress synodrome
- Risk of emergency cesarean section
- Failure to obtain sample
- Bleeding from puncture site
- Intrauterine infection

The risk of bradycardia underscores the importance of conducting cordocentesis near a delivery suite if the fetus is deemed viable.

Most complications are transitory and followed by complete fetal recovery. The overall procedure-related fetal death rate is about 1.4% but varies according to indications for the procedure and fetal status during the procedure.[9]

DISCUSSION

Counselling

Alternative techniques i.e amniocentesis or chorionic villi sampling and their pros and cons should be reviewed.

Benefits

This is particularly crucial near term, as the presence of an abnormal karyotype may influence the decision on the mode of delivery or the need for intervention due to fetal distress. Quick results are also vital between 20 to 24 weeks of pregnancy, especially if pregnancy termination remains a consideration.

If a karyotypic abnormality is suspected, cordocentesis provides faster test results (1-3 days), compared to amniocentesis, which takes 10-14 days.

Risks

The risk of cordocentesis varies depending on the indication. For example, fetuses with nonimmune hydrops have a higher procedure-related loss rate (25%) compared to those with severe growth restriction (13.8%), structural anomalies (6.6%), or those undergoing the procedure for prenatal diagnosis (1.3%). Patients should be made aware of the general loss rate for the specific condition, along with any additional risks associated with the procedure.

Counseling should also address potential complications beyond fetal death, especially for extremely premature fetuses. One common issue is bradycardia, which occurs in 6.6% of cases. However, these episodes are typically brief and unlikely to have significant consequences. Research from the University of Iowa indicates that bradycardia is more common when the umbilical artery is punctured compared to the vein (21% vs. 3.4%, respectively). It is also more frequent in fetuses with severe growth restriction. The smooth muscle in the umbilical artery is more susceptible to spasm than in the vein, and in a hypoxic environment, it reacts more strongly to catecholamines.

Training of Faculty

Although teaching models are available, the best way to gain experience is by practicing ultrasound-guided amniocentesis or chorionic villus sampling. Once the operator is proficient with these techniques, they can attempt cordocentesis under supervision in cases involving fetuses with lethal anomalies. This process is followed by supervised diagnostic procedures and, eventually, therapeutic ones.

Supervision ensures that the procedure is appropriate and that the patient has received proper counseling. Typically, performing at least one procedure per month is necessary to maintain skill. Cordocentesis should only be conducted in centers with active fetal diagnostic and treatment units, where the volume of procedures allows operators to retain their expertise.

Rapid Karyotype:

The most common reason for performing cordocentesis is to obtain a rapid karyotype following the detection of a fetal anomaly on ultrasound. The risk of an abnormal fetal karyotype associated with structural abnormalities, early-onset growth restriction, or severe oligohydramnios ranges from 12% to 24%. Knowing the fetal karyotype can influence pregnancy management in the following ways:

1. The mode of delivery may be adjusted if fetal distress is identified.
2. The place of delivery may be changed if the patient was referred from a lower-level facility.
3. The need for repeated, costly antenatal testing may be reduced.

4. Accurate counseling on recurrence risk is made possible (which could be missed if a stillborn fetus is delivered).
5. The option for pregnancy termination is provided.[10]

The future of cordocentesis

We now have a better understanding of embryonic physiology, metabolism, and illness because to the groundbreaking decade of cordocentesis. Additionally, it has made it possible to correlate blood gas data with fetal heart rate and Doppler patterns.[10]

The future of cordocentesis

The past decade of cordocentesis have offered a significant opportunity to study the fetus, improving our knowledge of fetal physiology, metabolism, and diseases. It has also allowed for the correlation of blood gas measurements with Doppler and fetal heart rate patterns.

CONCLUSION

Cordocentesis is an emerging innovative technique in fetal medicine having dual roles diagnostic and therapeutic. Cordocentesis can be a valuable diagnostic tool in certain high-risk pregnancies, providing crucial information about fetal health. It allows for the early detection of genetic disorders, infections, and blood-related issues, offering the potential for timely medical interventions. However, due to its invasive nature and associated risks, it is typically reserved for situations where other diagnostic methods are inconclusive or not possible. While it can be a boon to both the fetus and the parents when used appropriately, it should always be considered with careful consideration of the potential risks and benefits.

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