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SFM Fetal Therapy Practice Guidelines: Fetal Interstitial Laser

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Abstract

Fetal laser therapy was first used in complicated monochorionic pregnancies such as twin-to-twin transfusion syndrome or twin-reversed arterial perfusion sequence. There are some other less common indications such as amniotic band syndrome, chorioangiomas, lower urinary tract obstructions, sacrococcygeal teratomas, and fetal thoracic masses. These practice guidelines discuss the indications, contraindications, and risks of the procedure along with information for patients and draft consent form.

Keywords
- chorioangioma
- fetal therapy
- interstitial laser
- selective fetal reduction

Introduction

Fetal laser therapy was first used in complicated monochorionic pregnancies such as twin-to-twin transfusion syndrome (TTTS) or twin-reversed arterial perfusion (TRAP) sequence. There are some other less common indications such as amniotic band syndrome (ABS), chorioangiomas, lower urinary tract obstructions (LUTOs), sacrococcygeal teratomas (SCTs), and fetal thoracic masses.

Indications

1. **Selective fetal reduction in complicated monochorionic twin pregnancy:** Selective fetal reduction is offered in conditions in cases with impending death in one twin when the pregnancy is remote from term, preferably between 18 and 26 weeks gestation. This is done as the death of one twin can lead to severe neurological morbidity in the surviving twin that is reported in as high as 30% due to acute feto–fetal transfusion because of the presence of placental anastomoses in monochorionic twins. The indications include:
   a. TTTS when laser photocoagulation of placental anastomotic vessels is not feasible or stage III and IV
   b. TRAP when the diagnosis is made earlier in pregnancy when radio frequency ablation (RFA) is technically difficult due to the larger size of the RFA electrode.
   c. Selective fetal growth restriction (sFGR) is when the diagnosis is made prior to the lower limit of viability ($<$ 26 weeks) and there is a progression from type 2 to type 3 sFGR
   d. A genetic defect in one twin
   e. Major structural malformation in one twin
2. **Fetal hyperechoic lung lesions such as bronchopulmonary sequestration, microcystic congenital pulmonary airway malformation (CPAM), or a hybrid lesion:** The aim is interruption of vascular supply to the mass (BPS)/obliteration of microcystic congenital cystic adenomatoid malformation. A detailed fetal morphological ultrasound examination, advanced fetal echocardiography, and

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karyotype analysis by amniocentesis should be done prior to the procedure. It can be attempted in cases of any of the above lesions when the fetus is at risk of perinatal death in cases such as:
   a. Severe mediastinal shift with cardiac dextroposition
   b. Hydrops and/or pleural effusion and severe pulmonary compression
   c. Bilateral lung compression (no visualization of the lung ipsilateral to the lung mass and an observed/expected lung-to-head circumference ratio less than 30% for the contralateral lung),
3. **Placental chorioangioma:** The aim is the interruption of vascular supply to the mass by laser coagulation of the feeder vessel. It can be attempted in cases when the fetus is at risk of perinatal death such as:
   a. High output fetal heart failure prior to fetal viability
   b. Symptomatic polyhydramnios
4. **ABS:** The aim is in utero lysis of intrauterine amniotic band with the hope of restoring blood flow to the affected fetal limb before irreversible ischemia sets in. It can be attempted in cases of:
   a. Evidence of compromised blood supply
   b. Affected fetal limb with normal Doppler flow above the constriction and abnormal, but present, flow below the constriction.
5. **Sacrococcygeal teratoma:** The aim is reduction/interruption of vascular supply to the solid tumors with arteriovenous shunting leading to vascular steal phenomenon. It can be attempted in cases of high-output fetal cardiac failure prior to fetal viability
6. **Lower urinary tract obstruction:** The aim is to relieve bladder outlet obstruction by fulguration of (anterior or posterior) valves through fetal cystoscopy. It can be attempted in cases of:
   a. Extremely dilated bladder
   b. Increased wall thickness
   c. Dilated urethra ("keyhole sign")
   d. Bilateral hydronephrosis
   e. Oligohydramnios
   f. "Favorable" fetal urinalysis

Contraindications

1. Preterm prelabor rupture of membranes
2. Preterm labor
3. Suspected abruption
4. Chorioamniotic separation

Maternal Risks

Laser therapy is relatively safe for the mother. Rare complications include:

1. Abdominal pain and peritoneal irritation due to leakage of blood or amniotic fluid in the abdominal cavity
2. Infection and chorioamnionitis
3. Abruptio placentae
4. Intra-amniotic bleeding
5. Preterm prelabor rupture of membranes
6. Spontaneous preterm labor
7. Hematoma at the needle insertion site

Fetal Risks

1. In utero death of one or both fetuses
2. Cerebral injury (cystic periventricular leukomalacia, intraventricular hemorrhage, posthemorrhagic ventricular dilatation, cerebral atrophy, and arterial ischemic stroke) and long-term neurodevelopmental impairment.
3. Pseudo-ABS
4. Aplasia cutis and bowel atresia (rare)

Patient Information

Lasers can be used for various purposes for fetal therapy. The most common indication is in the termination of one fetus in a monochorionic twin pregnancy. Due to the presence of placental anastomoses, intracardiac potassium chloride cannot be used in such cases. So, vaso-occlusive techniques for cord coagulation can only be used. This prevents acute feto–fetal transfusion through placental anastomoses. An 18 gauge spinal needle is introduced through the maternal abdomen and a 400 µm diode or neodymium–yttrium aluminum garnet (Nd:YAG) laser fiber is passed under ultrasound guidance, into the abdomen of the fetus to be reduced, at the level of umbilical cord insertion. The laser is fired in short (6–10 s) pulses at 20 to 40 W burst till flow ceases on color Doppler. It can be used for other indications such as fetal thoracic masses resulting in hydrops, chorioangiomas leading to hydrops, LUTOs, SCTs leading to hydrops and ABS. It is a relatively safe procedure with very few maternal and fetal risks.

General Counseling Points

It is very difficult for the couple to understand and deal with the disease pathology and also the emotional stress associated. Hence, preprocedure care and counseling have an important role in setting the expectations from the procedure. The couple should be counseled by a multidisciplinary team on all the steps of the procedure and postprocedure care. It is also considered vital to answer any questions related to the procedure appropriately. Informed consent for the procedure should be taken after the counseling.

1. Explain about the need and rationale for doing the procedure
2. Always explain regarding all the available treatment options
3. Describe the procedure in brief and explain what to expect during the procedure
4. Describe the maternal and fetal risks associated with the procedure.
5. Discuss the success and failure of the procedure and postoperative complications
6. Describe the follow-up of pregnancy after the procedure

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7. Discuss the neonatal outcomes and long-term neurodevelopmental effects

Counseling Statement for Medical Records

Should include:

1. Ultrasound findings in underlying pathology and the severity of the condition
2. Mention about growth and any coexisting congenital anomaly in either twin in the case of monochorionic twins.
3. All the treatment options available explained to the couple should be mentioned
4. Treatment is indicated by staging and outcomes with and without treatment.
5. Common maternal and fetal complications

Consent

I, ……., & my husband/ family member ……(name and relation) have understood the condition that the fetus is likely to be affected from. The expected progression of the problem, its likely consequences, and complications thereof as well as the various management options that are available to us at this gestational age were explained. The possible fetal interventions with the advantages and disadvantages of each and the costs involved were also discussed in detail. All possible complications to the mother and fetus were also explained in detail and include preterm delivery, premature membrane rupture, bleeding, infection, miscarriage, and even fetal demise. We understand that the procedure will be performed under local/regional anesthesia with or without maternal sedation. Maternal risks and risks to the mother's life are therefore minimal but not nil. We accept the risks involved after fully understanding them and agree to go ahead with the procedure on our free will.

Patient's signature Husband/Relative's signature
Date/ time Date/ time

Preoperative Checklist and Patient Preparation

1. Detailed ultrasound checklist:
   a. Diagnosis
   b. Mapping of placenta
   c. Location of the intertwin membrane in case of twins
   d. Identify the site for entry of instruments
2. Case record checklist:
   a. Comprehensive case review and detailed history
   b. Consent
   c. Relevant blood and urine investigations
3. Preanesthetic check-up and relevant investigations checklist: blood testing for complete blood count, type, liver function test, renal function test, coagulation profile, electrolytes
4. Preoperative medication checklist:
   a. Nil per oral for 8 hours
   b. One ringer lactate on the morning of surgery at the rate of 100 ml/hour
   c. Antibiotic prophylaxis—1 g ceftriaxone or 2 g cefazolin 30 minutes before needle insertion
   d. Intramuscular (IM) progesterone (17 alpha hydroxyprogesterone caproate) on the day of surgery
   e. Tablet nifedipine 10 mg stat 30 minutes before procedure for tocolysis or tablet indomethacin orally 50 mg every 6 hours started 12 hours before
5. After 24 to 26 weeks of gestation, a course of antenatal corticosteroids is administered in case of preterm delivery after consultation with a neonatologist.

Personnel

1. Operator: Trained in ultrasound and ultrasound-guided procedures
2. Assistant trained in ultrasound and handling ultrasound probe
3. Nurse to set tray and provide things
4. Sonographic assistant to handle ultrasound machine
5. Anesthetist for sedation/regional anesthesia

Operating Room Requirements

The procedure may be performed in an operation theater as a daycare procedure under intravenous (IV) sedation and strict aseptic conditions. A good resolution color Doppler ultrasound machine is mandatory.

Equipment checklist:

1. Ultrasound machine
2. Laser machine set at power 30 to 40 W with foot switch control
3. Disposable laser fiber with connector, 400 or 600 microns
4. Sterile covers for camera, ultrasound probe
5. Sterile sample tube for amniotic fluid (if sample needed)
6. Standard universal sets for operative site disinfection and sterile draping
7. 18 G needle for primary entry into the uterus
8. Surgical dressing

Anesthesia:

1. Local anesthesia: 1% lignocaine. IV sedation (midazolam) can be considered if required.
2. Spinal/epidural anesthesia can be given in patients with a short cervix who will simultaneously require a cervical cerclage to be placed

Procedure Steps

Selective fetal reduction in complicated monochorionic twin pregnancy

Procedure:

1. Paint the parts and drape the patient as for any other surgical procedure
2. Infiltrate the needle insertion site with 10 mL of 1% solution of Xylocaine

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3. Insert an 18 G spinal needle under ultrasound guidance with a target to reach the intra-abdominal fetal vessels
4. Pass the 400 or 600-micron diode laser fiber through the spinal needle and advance it to a couple of millimeters beyond the tip of the needle
5. Fire short (6 to 10 sec) pulses of laser at 20 to 40 W bursts till blood flow ceases on color Doppler
6. Confirm cardiac activity in the normal twin using Doppler

Note:

1. If cervical length is less than 25 mm, preferable to plan cerclage in the same sitting
2. Amnioreduction may be performed in case of associated gross polyhydramnios
3. If pregnancy is beyond viable gestation age, antenatal corticosteroid administration must be considered

Follow-Up:

1. Ultrasound examination after 24 hours to redocument absent cardiac activity in the reduced twin and to check cardiac activity in the other twin
2. Middle cerebral artery (MCA) peak systolic velocity was measured in the surviving twin to detect fetal anemia
3. Discharge after 24 hours
4. Weekly follow-up for 4 weeks then two weekly follow-ups or as per standard protocol
5. Fetal magnetic resonance imaging (MRI) to be performed at 3 to 4 weeks of procedure to document evidence of intracranial hemorrhage and cerebral injury.
6. Delivery by 37 weeks

Fetal Hyperechoic Lung Lesions

Procedure Steps:

1. Clean, paint, and drape the patient.
2. Administering pancuronium 2 mg/kg by IM injection under transabdominal ultrasound guidance for fetal paralysis
3. Insert an 18G needle under ultrasound guidance through the fetal thorax into the lung mass
4. Pass a 400 or 600-µm laser fiber through the 18G-needle
5. Advance the laser fiber (2 mm beyond the tip) up to the proximal branch of the main systemic feeding artery identified by color Doppler to achieve contact with the feeding artery in cases of BPS. For microcystic CPAM, insert the tip of the needle and laser fiber into the fetal lung lesion. The tumor is gradually photocoagulated from the distal to the proximal border while slowly withdrawing the needle along with the laser fiber.
6. Perform coagulation with a Nd:YAG laser (15–50 W).
7. The procedure is said to be completed if blood flow through the feeding vessel stops in cases of BPS or visualization of a distinct "echogenic area" at the site of the lesion in cases of microcystic CPAM.

Note: For congenital high airway obstruction syndrome (CHAOS): Fetal bronchoscopy-assisted laser therapy is described for the treatment of CHAOS, using a 2-mm fetoscope, tracheal decompression in fetuses with laryngeal atresia can be achieved with Nd:YAG laser vaporization.

Chorioangioma

Route:

1. Percutaneously under transabdominal ultrasound guidance
2. Fetoscopic

Procedure: Same as described for selective fetal reduction. The most commonly used laser: Nd:YAG, 20 to 40 W.

Amniotic band syndrome

Almost all cases described in the literature have been performed with Nd:YAG laser/Nd:YAG using a fetoscope.

Sacrococcygeal Teratoma

Same as described for selective fetal reduction. The most commonly used laser: Nd:YAG, 20 to 40 W.

Fetal Lower Urinary Tract Obstruction

Laser fulguration of the anterior/posterior urethral valve using Nd:YAD laser by fetal cystoscopy.

Postoperative Checklist

1. Document the fetal heart activity of the fetus and also show it to the patient at the end of the procedure. Also, document the single largest pocket of amniotic fluid for the fetus.
2. The patient should be observed in the operation theater recovery area for 2 hours after which she can be shifted to the ward.
3. If the woman is Rh negative (nonisoimmunized), anti-D 300 ug should be given.
4. An ultrasound scan should be done after 24 hours to assess possible complications such as fetal demise, the occurrence of inadvertent septostomy or membrane separation and cervical length. Doppler of the MCA is done in the case of monochorionic twins.
5. If no complaints from the patient, she can be discharged 24 to 8 hours postprocedure, with the following advice:
   a. Avoid overstraining/lifting heavy weights for a week
   b. Report to the hospital immediately if there is substantial leaking, bleeding, pain, generalized feeling of unwellness, or fever
   c. Continue IM progesterone weekly till 36 weeks
6. Detailed procedure report and follow-up plan is generated and one copy should be handed over to the patient at the time of discharge.
7. Patients should be followed up on an outpatient department basis for monitoring by the ultrasound, the frequency of which is based on the indication of the procedure.

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Equipment and Devices

Currently, two lasers exist that can be used:

1. Nd:YAG laser (1,064 nm)
2. Diode laser (940 nm)—closer to the hemoglobin absorption spectrum, used more commonly due to its smaller size and lower cost.
   The therapeutic efficacy of both lasers is equivalent.

Invasive Report Template

Patient name
Age
Hospital ID
Contact number
Obstetric history: G P A L; Type of conception:;
Consanguineous:
Gestational age at diagnosis
Detailed ultrasound report
Location of placenta
Hydrops: Yes/no
Fetal MRI (if any)
Indication
Procedure name (date and period of gestation)
Maternal anesthesia
Starting number of fetus:
Uterine entry: Midline, right/left, upper/lower quadrant
No of attempts: Single/double/multiple
Amnioreduction: Yes/no
Cerclage: Yes/no
Intraoperative complications:
Finishing number of fetus
Postprocedure cardiac activity
Postoperative advice
Follow-up ultrasound
Postprocedure MRI (after 4–6 weeks in case of monochorionic twins)

Conflict of Interest
None declared.

Suggested Reading

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