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SFM Fetal Therapy Practice Guidelines: Radiofrequency Ablation of Fetal Umbilical Cord

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Abstract

In radiofrequency ablation (RFA), the ions in the tissue surrounding the probe's uninsulated tip are noticeably stirred up by the electrode's high-frequency alternating current. The surrounding tissue experiences thermal coagulation necrosis as a result of the frictional heat.

RFA is used in complicated monochorionic twin pregnancies with selective fetal growth restriction (FGR), TRAP, and TTTS. RFA may also be considered in giant chorioangioma with favorable vascular anatomy and giant sacrococcygeal teratoma with imminent hydrops. It serves as a substitute to laser.

Keywords

- monochorionic twin
- radiofrequency ablation
- selective FGR
- twin reversed arterial perfusion sequence
- twin twin transfusion syndrome

Radiofrequency ablation (RFA) procedure entails the ions in the tissue surrounding the probe's uninsulated tip are noticeably stirred up by the electrode's high-frequency alternating current. The surrounding tissue experiences thermal coagulation necrosis as a result of the frictional heat.[1–3]

Indications

Complicated monochorionic twin pregnancies with

a. Selective FGR
b. TRAP (twin reversed arterial perfusion)
c. TTTS (twin twin transfusion syndrome)

RFA may also be considered in

a. Giant chorioangioma with favorable vascular anatomy
b. Giant sacro coccygeal teratoma with imminent hydrops

Indications Explanations

1. Selective FGR

Selective FGR type 2 and type 3 carry a high risk of intrauterine demise with consequent co-twin damage or demise. Typically, the risk of intrauterine demise is high when the growth-restricted fetus shows deterioration in the form of abnormal ductus venosus pulsatility index (DV PI). Selective feticide with RFA is indicated when there is deterioration.

Selective FGR type 1 is usually stable and can be expected to reach beyond viability (at least 32 weeks) in the vast majority of cases. However, in a small proportion, when the smaller twin develops

a. Discordancy of greater than 45%
b. Anhydramnios leading to stuck twin
c. Abnormal DV PI

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Then, RFA is indicated.

2. TRAP Sequence

In cases of monochorionic pregnancies complicated with TRAP, the pump twin is at risk of hydrops and sudden demise if

a. There is a progressive increase in the size of the perfused twin beyond 16 weeks
b. The abdominal circumference of the perfused twin is greater than 50% of that of the pump twin
c. Signs of cardiac compromise or hyperdynamic circulation in the pump twin

In such a scenario, cord occlusion is indicated

3. TTTS

The preferred modality of treatment for all stages of TTTS is fetoscopic laser coagulation of intertwin anastomoses of placental vessels. However, in stage 3 and stage 4, some parents do not accept the low survival rates associated with the procedure and may choose selective feticide.

In such a scenario, cord occlusion is indicated

4. Giant Tumors

Giant chorioangioma or giant sacrococcygeal teratoma poses the risk of hyperdynamic circulation ultimately leading to cardiac compromise, hydrops, and intrauterine demise. In certain scenarios, the feeding artery may be amenable to ablation by RF.

Maternal Risks

Risks to the mother are rare: <1 in 1000

a. Injury to the bowel or bladder
b. Injury to inferior epigastric vessels leading to rectus sheath hematoma
c. Injury to superficial uterine artery branches leading to hemoperitoneum
d. Exit energy burns if grounding plates are malfunctioning or not placed in full contact with the patient's skin

Fetal Risks

1. Technical failure

Uncommon but may rarely happen in TRAP fetuses with hydrops

2. Procedure-related miscarriage ($\sim$ 1–5%)
3. Chorionic vessel rupture and bleeding (for transplacental approach)
4. Preterm birth / preterm prelabor rupture of membranes ($\sim$ 10–15%)
5. Co-twin demise/damage (5%)

Other Risks

a. Preterm prelabor rupture of membranes (5–10%)
b. Procedure-related miscarriage (within 2 weeks of procedure) (2–5%)
c. Chorionic vessel rupture (if transplacental needle entry)
d. Rh allo-immunization (Rh-negative pregnancy)

Equipment and Devices, and Vendors

There are two principal types of RF electrodes:

a. Multi-tine RF electrode
b. Single-tine RF electrode (►**Table 1**)

Preoperative Checklist and Patient Preparation

Preoperative

1. Consent
2. Antibiotic prophylaxis—1 g of ceftriaxone 30 minutes before electrode insertion
3. Lignocaine test dose
4. Confirm Rh status
5. Intravenous access for the mother
6. Vaginal micronized progesterone 200 mg on the day and then for 2 days
7. Nitroglycerine (NTG) patch 2 hours before the procedure
8. Indomethacin 50 mg per oral stat followed by 25 mg Q6h (until 48 hours post-procedure)

Table 1 Details of RFA needle

Aspect	Multi-tine	Single-tine (pencil-tip)
Tine heating	Temperature-dependent	Resistance dependent
Coagulation zone	Spherical	Bullet shaped
Coagulation width	From 1.5 to 5 cm	From 1.5 to 3.5 cm
Electrode size	16 G for 3 tines/14G for 5 tines	17G
Recommended settings	110°C at the tines, 150 watts, 3 minutes cycle	90–95°C at the tine, variable watts, 5 minutes cycle
Vendor	ACCESS DEVICES 28, 12th Cross, Indiranagar 1st Stage Bangalore - 560 038 Tel: 91 80 25282068/ Ashok - 98441 17366/ Ramesh- 98441 52284 www.accessdevices.in	Innovative Therapeutics Pvt Ltd, 8/467/2, Manalodai Street, Nehru Street 4th Cross Street, Arthi Nagar, Saraswathi Nagar, Thirumullaivoyal, Chennai, Tamil Nadu 600062 044 3559 4099

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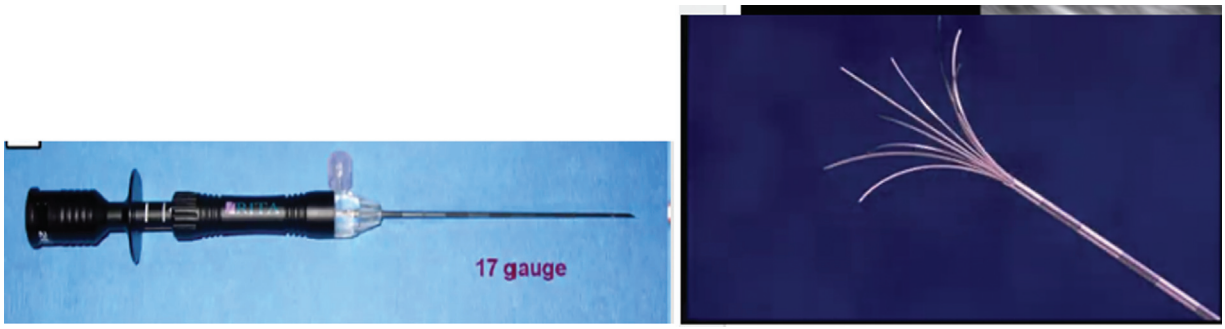

Fig. 1 Radiofrequency ablation needle.

Personnel Required

1. Operator
2. RF technician trained in operating the RF console
3. Circulating nurse to set tray and provide things
4. Sonographic assistant to handle ultrasound machine

Operating Room Requirement

The procedure may be performed in a clean ultrasound procedure room or an operation theater.

A good resolution color Doppler ultrasound machine is required.

Tray setting

1. Sterile Prep kit (sterile drapes, probe cover, sterile gel, SS cup, sponge forceps, gauzes)
2. 1% Lignocaine 5mL for maternal anesthesia
3. 11-blade scalpel
4. Atracurium + fentanyl for fetal anesthesia
5. RF electrode: Single-tine or multi-tine ►**Fig. 1**

1. Suction apparatus (if amnioreduction is planned)
2. 5 mL syringe (for lignocaine), 1 mL syringe (for fetal anesthesia), 23 g spinal needle (for fetal anesthesia)

Procedure Steps

Before prepping the maternal abdomen, fetal accessibility is ascertained. Maternal repositioning to lateral decubitus, Trendelenburg position, and external version of the fetus may all be employed as necessary to manipulate the fetus into a reasonable position.

1. Maternal abdomen is prepped and draped as usual
2. The ultrasound probe is sanitized with antiseptic and draped in a sterile manner
3. Access route is planned:
   a. No maternal vessels in the abdominal wall or uterine serosa with color Doppler or power Doppler at pulsed repetition frequency (PRF) set around 1 kHz
   b. Nonplacental access to the amniotic cavity of the target fetus
   c. Fetal abdominal entry: ventral entry is preferred. If not feasible, dorsal entry is preferred over lateral entry
   d. Beware of a tightly wound cord around the fetal trunk in the line of fire (color Doppler)
4. Fetal anesthesia (optional): Atracurium (0.4 mg/kg expected fetal weight [EFW]) + fentanyl (15 µg/kg EFW) mixed in a single syringe and given through a 23 g spinal needle directly into the fetal buttock, deltoid, or umbilical vein, whichever is easiest to access.
5. Maternal lignocaine infiltration from the skin up to the peritoneum. Infiltration up to the myometrium decreases the discomfort of needle entry slightly but comes with the cost of myometrial focal contraction that makes subsequent needle manipulation difficult
6. A small 0.5 mm stab incision is made in the skin using 11 blades. The introducer needle with trocar is then passed percutaneously through the myometrium into the amniotic cavity with a sharp controlled jab to avoid tenting the membranes.
7. Once inside the amniotic cavity, fine manipulation of the needle as well the anesthetized fetus to be done such that the needle entry is in the desired target zone as stated above ►**Fig. 2**
   Tip: When there is no direct access to the target fetal sac, proceed through the amniotic cavity of the nontarget fetus and then enter sharply at the intertwin membrane.
8. The fetus is entered with a sharp controlled jab.
   Tip 1: Keep the needle tip as perpendicular to the fetal trunk surface at the point of entry as possible
   Tip 2: The entry must be sharp otherwise fetus will roll away
   Tip 3: The jab should be well controlled otherwise overshoot injury to the fetus or mother can happen
   Tip 4: The entry should be very close to the fetal insertion of the umbilical cord if ventral access is chosen. If dorsal access is chosen (the default access for single tine), choose a point on the fetal back exactly opposite the fetal cord insertion site or as close to this point as possible, in the paramedian plane, to avoid the spine.
9. Ventral access: Once inside, under continuous ultrasound visualization, the tines are opened in a petal-like fashion fully and gently pulled back to hitch against the ventral wall encapsulating the intra-abdominal portion of the umbilical cord.
   Dorsal access: Multi-tine electrode is advanced as close to the cord insertion site as possible and the tines are

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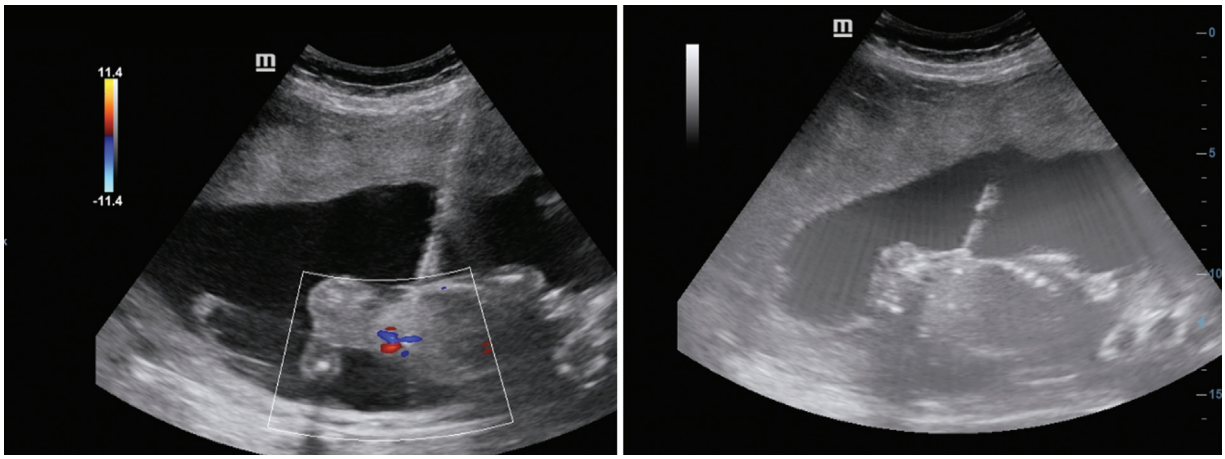

Fig. 2 Radiofrequency ablation procedure.

opened almost but not fully so as to oppose the intra-abdominal portion of the umbilical cord.

The single-tine electrode is advanced as close to the cord insertion site as possible to "touch" the intra-abdominal portion of the umbilical cord vessels (but not puncture it).

10. After visually checking the tine tips are within the fetal abdomen, the RF generator is switched on with the following settings:
    Multi-tine: Tip temperature 110°C, watt 150W, heating time 3 minutes, cool down 3 minutes. This consists of one cycle.
    Single-tine: Continuously adjust the wattage to maintain a tip temperature between 85 and 95°C for 5 minutes followed by cool down for 3 minutes. Alternatively, it can be 6 minutes of heating followed by 2 minutes of cooling. The former has the advantage of fewer false positives due to transient vasoconstriction, while the latter has the advantage of requiring fewer cycles.
11. Typically, when coagulation is proceeding the RF energy causes a visible interference pattern on the ultrasonography monitor. In both the multi-tine and the single-tine systems, safety settings will switch off the RF console when the tine tip pierces the fetal abdomen and is exposed to the amniotic fluid. However, auto switch-off will not happen if the tip pierces the uterine wall!
12. The surgical endpoint is the cessation of flow in the extra fetal portion of the umbilical cord. Typically, a vertically oriented segment of the cord is chosen, PRF is set at 0.9 kHz and a color box is placed for at least 30 seconds before declaring complete cessation. Nonvertical segments, higher PRF, and less time may lead to false results since partial occlusion would cause fetal bradycardia, fetal hypotension, and vasospasm.

The fetal heart may continue in idioventricular rhythm for a variable period of time, usually between 15 and 30 minutes after complete cord occlusion.

Postoperative Checklist

1. Middle cerebral artery peak systolic velocity (MCA PSV) of the co-twin is assessed immediately, 20 minutes and 60 minutes after the procedure to exclude severe exsanguination from the co-twin
2. Document no free fluid in maternal flanks by ultrasound immediately at the end of the procedure and after 3 hours post-procedure
3. Document fetal heart activity and also show it to the mother at the end of the procedure and after 3 hours
4. Mother is given a couch for lying down for approximately 30 minutes after which she is allowed to ambulate and remain within the premises for the next 3 or 4 hours
5. If no complaints from her, she is allowed to go home with the following advice:
    a. Avoid overstraining/lifting heavy weights for a week
    b. About 2 to 3% may experience light spotting of fluid or blood per vaginum—this is of no consequence
    c. Report to the hospital immediately if there is substantial leaking, bleeding, pain, generalized feeling of unwellness or fever
    d. Continue indomethacin 25 mg 6 hourly for a total of 48 hours, vaginal progesterone 200 mg once daily for two more days
6. A detailed procedure report is generated and one copy is handed over to the mother at the time of discharge.

Post-Monitoring of Mother and Fetus

1. Mother's pulse and blood pressure (BP) recorded before the procedure, during the procedure, and immediately after the procedure
2. Pulse and BP were recorded 30 minutes, 1 hour and 3 hours after procedure. If no tachycardia, no further monitoring is required
3. Fetal heart activity is documented during and end of the procedure. Document after 3 hours before sending mother home

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4. Maternal flanks are to be imaged and looked for free fluid 3 hours after the procedure. Free fluid with normal vitals usually is indicative of leaked amniotic fluid. This will usually get absorbed over 24 hours but may necessitate painkillers. If in doubt regarding the nature of the fluid, admission and close monitoring with or without a diagnostic tap will be required
5. Follow-up scans are scheduled after 1, 2, and 4 weeks (neurosonography of the co-twin) from the procedure and thereafter according to the clinical situation
6. Technical failure is rare but may happen in certain situations:
   a. Large TRAP with hydrops
   b. Anomalous fetus with difficulty in correctly placing the electrode
   c. Tangential access with respect to the intra-abdominal portion of the umbilical cord
   d. Chorioangioma/Sacrococcygeal teratoma—high-velocity circulation acting as a heat sink
   e. Large fetal bladder in proximity to the tines

In case of technical failure due to noncorrectable reasons, another method of cord occlusion relevant to the situation must be considered. The high-risk situation for technical failure is best identified before the procedure and alternate arrangements are arranged beforehand and the patient is accordingly counseled before the procedure.

7. Delivery
   a. Timing of delivery will depend on the clinical profile of the co-twin and obstetric indications
   b. The mode of delivery is usually obstetric indications. Infrequently, if the reduced twin is overlying the cervix, a cesarean may be indicated

Invasive Report Template

Patient name
Age
Husband name
Hospital ID
Gestational age
Procedure name
Indication
Maternal anesthesia
Fetal anesthesia
Control: Continuous ultrasound guidance
Insertion needle: 17 g (single-tine)/14 g or 16 g (multi-tine)
RF system used: Single-tine/multi-tine
Uterine entry: Midline, right/left, upper/lower quadrant
Target fetal entry: Ventral/dorsal/lateral
No of cycles:
Amnioinfusion: Yes/no
Amniodrainage: Yes/no
Intraoperative complications:
Postoperative advice:

Conflict of Interest
None declared.

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Suggested Reading

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