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ORIGINAL ARTICLE

Radiofrequency Ablation in Complicated Monochorionic Pregnancy: Initial Experience

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Abstract To evaluate outcomes of complicated monochorionic pregnancies intervened by radiofrequency ablation (RFA) and report the initial experience. It is a retrospective case series of 15 cases of complicated monochorionic twin pregnancies intervened by RFA in Mediscan Systems Chennai, a tertiary referral Fetal Medicine center, from February 2015 till February 2017. Perinatal outcomes were available for all 15 cases. Main indication for RFA was sIUGR in 10 cases, of which 2 had coexistent Twin to Twin Transfusion syndrome. The procedure was technically successful in all cases. Median gestational age at procedure was 22.6 weeks (IQR 21, 25.6). The median number of RFA cycles to attain cardiac asystole was 4 (IQR 3, 7). Four of the fifteen cases (27%) had procedure related complications of which 3 occured within 2 weeks of procedure. There were 2 cases of preterm premature rupture of membranes which occurred within 2 weeks of procedure. One case had a miscarriage within 2 weeks of procedure at 21 weeks, another one had a mid-trimester loss 4 weeks after the procedure at 26 weeks. The median gestational age at delivery was 35 weeks (IQR 29.3, 35.5). Seventy-eight percent of the live borns were delivered after 34 weeks. The median procedure delivery interval was 10.4 weeks (IQR 4.1, 13.6). Median birth weight at delivery was 2000 g (IQR 1300, 2600). The present series had a live birth rate of 87%. In this initial small series, there was a good outcome in terms of live birth rates and take home baby rates. The efficacy needs to be ascertained by larger series and long term neurological outcome.

Keywords Monochorionic twin pregnancies · Selective fetal reduction · Radiofrequency ablation

Abbreviations

AGA	Appropriate for gestational age
BPC	Bipolar cord occlusion
CTEV	Congenital talipes equinovarus
DV	Ductus venosus
FR	Fetal reduction
IQR	Interquartile ranges
IUD	Intra uterine death
KT	Karyotyping
LSVC	Left superior vena cava
MCDA	Monochorionic diamniotic
MOM	Multiples of median
MRI	Magnetic resonance imaging
NICU	Neonatal intensive care unit
PPROM	Preterm premature rupture of membranes
RFA	Radio frequency ablation
TAPS	Twin anemia polycythemia sequence
TTTS	Twin to twin transfusion syndrome

Introduction

The peculiarities in the angio-architecture of placenta subjects monochorionic twin pregnancies to unique complications which makes these cases challenging to the fetal therapist at all levels. In many situations, selective

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termination of one fetus becomes a necessity to improve the chances of survival of the normal co-twin and to optimize the outcomes because spontaneous demise of one fetus in a monochorionic gestation is associated with co-fetal death in 12–25% of cases and risk of neurological sequelae in 18–25% of the surviving infants [1].

A variety of occlusive techniques have been used to achieve selective termination in monochorionic twin pregnancies, including Bipolar Cord Coagulation (BPC), laser cord coagulation and cord ligation.

Radiofrequency ablation was first introduced in fetal therapy by Tsao et al. in 2005 in acardia twins. The high frequency alternating current produces frictional heat resulting in high tissue temperature. This causes tissue necrosis and coagulation, which results in obliteration of blood supply thereby selectively reducing the abnormal twin. Advantage of radiofrequency ablation appears to be a smaller membrane defect with a 14 or 17 gauge radiofrequency ablation (RFA) needle (1.4-mm diameter) and is performed solely under ultrasound guidance, thus making it a less invasive option when compared to endoscopic technique [2–4].

Materials and Methods

It is a retrospective case series of initial 15 cases of monochorionic pregnancies that underwent selective reduction using RFA from February 2015 through February 2017 for which follow up was obtained.

All patients underwent detailed evaluation by two senior operators prior to intervention. Selective IUGR was defined as an estimated fetal weight of $<$ the 10th centile in one twin. In cases discordant for anomalies there had to be a risk of intrauterine demise of the anomalous fetus that would jeopardize the co-twin or the anomaly was not lethal but would have significant morbidity and handicap in survivors.

Since most of the patients were referred from other district or state, inpatient care for 48–72 h for the procedure was advised.

RFA was performed following standard protocol. A radiofrequency generator (Angiodynamics-Rita 1500X) and RITA-StarBurst SDE electrosurgical device and 14 gauge radiofrequency needle yielding a spherical area of ablation of 2 cm was used through deployment of 3 or 5 tines. After informed consent, the procedure was performed under local anesthesia with antibiotic prophylaxis and tocolysis. The procedure was done under continuous ultrasound guidance. The RFA needle was introduced percutaneously through a small stab incision on the maternal abdomen avoiding placenta as far as possible. Once the needle was inside the amniotic cavity, it was guided into the abdomen of the targeted twin and positioned at the intrafetal portion of the umbilical cord (Fig. 1). The tines were deployed once the needle positioned. Thermal energy was applied until an average temperature of 110 °C was achieved in all the 3 tines for 3 min, constituting one thermal cycle. After a cooling time of 1 min, thermal cycles were repeated till cessation of blood flow was demonstrated in the umbilical cord by pulsed wave and color Doppler. RFA needle was withdrawn once cardiac asystole was confirmed using power, color and pulsed Doppler velocimetry. Post procedure, ultrasound for measurement of middle cerebral artery peak systolic velocity was performed, immediately, 24 and 48 h of the procedure. At 72 h, a detailed ultrasound was performed for the surviving twin and the patient was discharged and sent back to the primary consultant for further obstetric care with a follow up proforma sheet. The referring doctor was briefed on the follow up with a request to update the follow up details. Delivery details and postnatal follow-up was done by telephonic calls either with the consultant obstetrician, neonatologist or from the patient directly.

Results

There were a total of 15 monochorionic twin pregnancies that were intervened with RFA (Table 1). Fourteen out of the fifteen cases were referred for a second opinion for complicated monochorionic twin pregnancy. All were monochorionic diamniotic twins. All of them were closely followed up and outcomes were obtained in all the 15 cases. The median maternal age at intervention was 26 years.

Fig. 1 RFA needle in situ

Table 1 MCDA twin pregnancies intervened with RFA with pregnancy outcomes

Sl. no.	Gestational age at pro (weeks)	Indication	Gestational age at delivery (weeks)	Procedure delivery interval (weeks)	Procedure related complication	Perinatal outcome
1	26.5	sIUGR	35.5	9	Nil	Liveborn
2	28.3	sIUGR	34.1	5.4	Nil	Liveborn
3	22.6	Post laser TAPS	36.3	13.4	Nil	Liveborn
4	17.6	sIUGR	35	17.1	Nil	Liveborn
5	25.6	sIUGR	27.6	2	PPROM	Liveborn
6	26.1	sIUGR	29.3	3.2	Nil	Liveborn
7	22.2	sIUGR	36.1	13.6	Nil	Liveborn
8	23.4	sIUGR	35	11.3	Nil	Liveborn
9	23.3	TTTS	35.2	11.5	Nil	Liveborn
10	17.2	Dis Anomaly	35.5	18.3	PPROM	Liveborn
11	21.1	Dis Anomaly	36.1	15.1	Nil	Liveborn
12	20.3	sIUGR + TTTS	21	0.4	Miscarriage	Mid trimester loss
13	22.3	sIUGR	32	10.4	Nil	Liveborn
14	25.2	Dis Anomaly	35.4	10.2	Nil	Liveborn
15	21.6	sIUGR + TTTS	26	4.1	Nil	Mid trimester loss

Dis Anomaly; *PPROM* preterm premature rupture of membranes; *sIUGR* selective intrauterine growth retardation; *TAPS* twin anemia polycythemia sequence; *TTTS* twin to twin transfusion syndrome

Table 2 Distribution of cases according to indication

Indication	N %
Selective IUGR	8 (53)
Selective IUGR with TTTS	2 (13.3)
Discordant anomaly	3 (20)
TTTS	1 (6.6)
Post laser TAPS	1 (6.6)

IUGR intrauterine growth retardation; *TAPS* twin anemia polycythemia sequence, *TTTS* twin to twin transfusion syndrome

The indications for intervention are listed in Table 2. The commonest indication for intervention was selective IUGR in 53% (8/15) of cases (Fig. 2), followed by discordant fetal anomaly in 20% (3/15) cases. Two of fifteen (13.3%) cases had Twin to twin transfusion syndrome (TTTS) and coexistent selective IUGR, 1/15 (6.6%) case was intervened for TTTS and 1/15 (6.6%) was a case of post laser twin anemia polycythemia sequence (TAPS).

The threshold for intervention in selective IUGR was high resistant, absent or reversal of 'a' wave in ductus venosus. As per the Gratacos staging, of the 8 cases with selective IUGR, 7 had Type 3 and 1 had Type 2 IUGR. The discordancy in weight in all cases were more than 50% except for one case where the discordancy was 25%.

Of the 2 cases of TTTS with coexistent s-IUGR, one case was TTTS stage 2 with sIUGR Type 2, 29% discordant weight and reversal of 'a' wave in ductus venosus of the donor fetus and the donor was reduced. The other case was TTTS stage 4 with sIUGR type III with a weight discordancy of 60% and high resistant flow in ductus venosus in the donor fetus. Considering the severity of growth restriction and Doppler findings in the donor, a decision to reduce the smaller fetus was made.

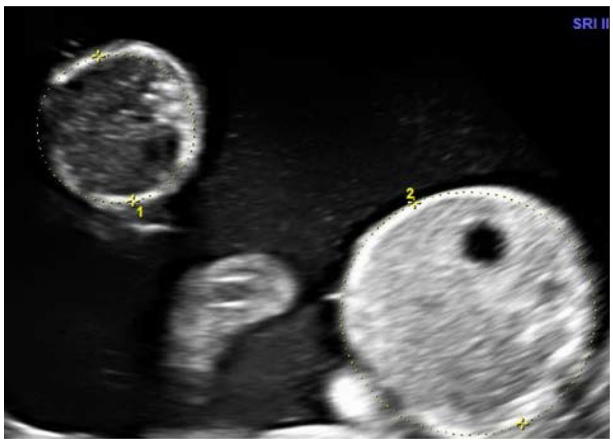

Fig. 2 Transverse section of abdomen of a monochorionic diamniotic (MCDA) twin at 20 weeks with selective IUGR

In the case of TTTS stage IV, the donor was growing normally with normal doppler. The recipient was reduced as there was reversal of 'a' wave in ductus venous, with a CHOP score 13. Of the 3 cases with discordant anomaly, 1

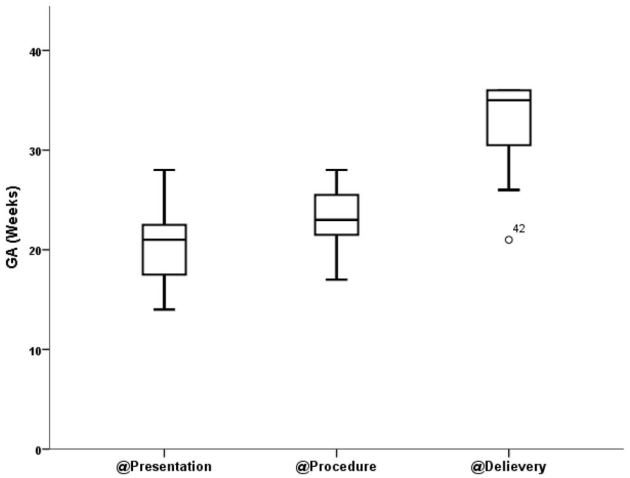

Fig. 3 Gestational age at presentation (median 21.3 weeks, IQR 17.4, 23.2 weeks), at intervention (median 22.6 weeks, IQR 21, 25.6 weeks) and at delivery (median 35 weeks, IQR 29.3, 35.5 weeks). Boxes represent medians and interquartile ranges (IQR) and whiskers indicate ranges

was a case of Dandy Walker malformation with persistent left superior vena cava and agenesis of ductus venosus, one case was non-immune hydrops with cystic hygroma and one was a case of occipital encephalocele with atrio ventricular septal defect. All the three cases had amniocentesis for karyotype prior to reduction.

The median gestational age at presentation was 21.3 weeks (IQR 17.4, 23.2), median gestational age at intervention was 22.6 weeks (IQR 21, 25.6), and the median gestational age at delivery was 35 weeks (IQR 29.3, 35.5) (Fig. 3).

Technically, the procedure was successful in all the cases requiring only a single entry with RFA needle in all cases. The median number of thermal cycles needed to attain asystole was 4 (IQR 3, 7). Cases with late gestation age necessitated more number of cycles. The gestational age at procedure was influenced by the time of referral.

Four of the fifteen cases (27%) had procedure related complications; 3 occurred within 2 weeks of the procedure. There were 2 cases of PPROM which occurred within 2 weeks of the procedure, both of which were managed conservatively and had live born babies. One had an LSCS at 27.6 weeks and the other had an elective LSCS at 35.5 weeks. One case had a miscarriage within 2 weeks of the procedure at 21 weeks, another one had a mid-trimester loss 4 weeks after the procedure at 26 weeks.

Table 3 shows the distribution of gestational age at delivery. The preterm delivery rates were 14.3% (2/14) < 28 weeks, 7.1% (1/14) between 28 and 34 weeks and 78.6% (11/14) of them delivered after 34 weeks. The one case which was a miscarriage was excluded from the denominator to calculate the preterm delivery.

Table 3 Distribution of gestational age at delivery

Gestational age at delivery (weeks)	N = 15	%
< 24 (miscarriage)	1	6.7
< 28	2	13.3
28–34	1	6.7
34.1–36.6	11	73.3
> 37	0	0

The median procedure delivery interval was 10.4 weeks (IQR 4.1, 13.6). The median birth weight was 2000 g (IQR-1300, 2600). Of the live born, 77% (10/13) was delivered by cesarean section.

Discussion

Until 2015 February, authors had been using bipolar cord occlusion as the method for selective fetal reduction for complicated monochorionic twin pregnancies in their center. RFA was introduced in their center in February 2015 and the authors wanted to evaluate their initial case series.

Like all fetal interventional procedures, the most common complication in methods deployed for selective fetal reduction is iatrogenic preterm premature rupture of membranes. Current evidence suggests that these complications are lesser with device with a smaller-diameter. This small diameter is a definitive advantage that RFA has over other fetal reduction techniques such as bipolar cord coagulation (BPC). Another advantage of RFA over BPC is that BPC requires the visualization of the umbilical cord proximal to its insertion into the fetal abdomen and hence in cases of oligohydramnios, amnio infusion is necessary. This amnio infusion and amnio reduction prolongs the operative time and this in turn increases complications. Amnio infusion is avoided in RFA as the intra-abdominal portion of the umbilical vessels is targeted. Additionally, the tines of the RFA device anchors the fetus and the fetus can be moved away from placenta or membrane, thus avoiding thermal injury to the co-twin [5].

While it is understood that this is a preliminary series, authors compared their results with the most recent article published on the same topic by Kumar et al. [6] (Table 4).

The indication for intervention was predominantly anomalies and TTTS in their series, whereas it was selective IUGR in the present study. Table 5 details the outcome in relation to the indication. Post procedure MRI was not done in all cases. MRI was suggested as an option considering logistics and feasibility. The median gestational age at delivery, technical success and the immediate

Table 4 Comparison of present data with a similar recent study

	N = 100	Our study N = 15
Median GA at procedure (weeks)	18 (12.1–27.6)	22.6 (21,25.6)
Median GA at delivery (weeks)	35 (24–41)	35 (29.3 35.5)
Complications	18 (18%)	4 (27%)
Within 2 weeks	3%	1 miscarriage, 2 PPROM
Midtrimester loss	3%	1 (7%)
Co-twin demise	12%	0
Preterm delivery (< 34 weeks) [%]	33.3	27
Technical success (%)	100	100
Liveborn rate (%)	78	87

Table 5 Outcomes in relation to indication (N = 15)

Indication	Median Procedure delivery interval (weeks)	Outcome	Complication
sIUGR = 8	9.7	All liveborn	PPROM
sIUGR + TTTS = 2	2.2	Both pregnancy loss	1-Miscarriage, 1-midtrimester loss
TTTS = 1	11.5	Liveborn	None
Post laser TAPS = 1	13.4	Liveborn	None
Discordant for anomaly = 3	15.1	All live born	PPROM—1 case

PPROM preterm premature rupture of membranes; *SIUGR*; *TAPS* twin anemia polycythemia sequence; *TTTS* twin to twin transfusion syndrome

complication rate paralleled in both the studies. The live birth rate in the present study was 87% in comparison to 78% in the above group. The same group in their initial series of 35 cases of SFR done by RFA reported a live born rate of 88.6% [5]. The initial enthusiasm of RFA having a high live birth rate was moderated by a lower live birth rate by larger series. Similar outcomes of lower live birth rates were reported by other investigators like Bebbington et al. [2] in a larger series. A comparative study of BPC/RFA done by Roman et al. [7] has reported lower rates of PPROM with RFA. The overall fetal survival rate was similar in both the methods.

Another systematic review of minimally invasive intervention for selective fetal reduction in complicated monochorionic pregnancies (RFA, BPC and laser cord occlusion), by Rossi et al. [8] demonstrated a 79% survival of co-twin with perinatal loss rate of 19% in cases intervened with RFA. Depending on the energy applied, RFA can take a longer period of time for coagulation to take place. This would allow a greater interval of time during which altered blood flow dynamics might disadvantage the co-twin. This could be further exacerbated if the probe needed to be repositioned during the procedure to achieve a complete effect. The goal of RFA should be the rapid application of high energy to achieve coagulation as quickly as possible. Using a step-wise approach starting at a lower wattage, with progressive increases in energy, might have contributed to the decreased overall survival seen with this procedure by some authors [2].

The disadvantages of RFA that needs mention are, RFA needle is disposable and expensive, requires a specialized generator and is not contributory in cases of selective reduction in a monoamniotic twin gestation as it does not allow transection of the umbilical cord of the target fetus. The length of RFA needle (12 cm) also makes its use difficult in obese patients and bigger fetuses.

In authors' initial experience, they have had a good outcome of live birth rate of 87%. The gestational age at delivery was less than 37 weeks in all the cases with 27% of them delivering before 34 weeks. The authors plan to continue this into a larger series with evaluation of long term neurological outcomes of the survivors.

Conclusions

The preliminary experience with RFA appears to be an effective alternative for selective fetal reduction in complicated monochorionic twin pregnancies.

However, larger series and long-term neurological follow-up, currently underway in this series, is necessary to ascertain the efficacy of this method of selective fetal reduction.

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Compliance with Ethical Standards

Conflict of interest None.

Ethics Approval The ethical committee was not approached as this was considered to be a clinical audit of outcome after an accepted foetal intervention.

References

1. Ong SS, Zamora J, Khan KS, Kilby MD. Prognosis for the co-twin following single-twin death: a systematic review. BJOG. 2006;113:992–8.
2. Bebbington MW, Danzer E, Moldenhauer J, Khalek N, Johnson MP. Radiofrequency ablation vs bipolar umbilical cord coagulation in the management of complicated monochorionic pregnancies. Ultrasound Obstet Gynecol. 2012;40:319–24.
3. Deprest JA, Audibert F, Van Schoubroeck D, Hecher K, Mahieu-Caputo D. Bipolar coagulation of the umbilical cord in complicated monochorionic twin pregnancy. Am J Obstet Gynecol. 2000;182:340–5.
4. Deprest J, Jani J, Gratacos E, et al. Fetal intervention for congenital diaphragmatic hernia: the European experience. Semin Perinatol. 2005;29:94–103.
5. Paramasivam G, Wimalasundera R, Wiechec M, Zhang E, Saeed F, Kumar S. Radiofrequency ablation for selective reduction in complex monochorionic pregnancies. BJOG. 2010;117:1294–8.
6. Kumar S, Paramasivam G, Zhang E, Jones B, Noori M, et al. Perinatal- and procedure-related outcomes following radiofrequency ablation in monochorionic pregnancy. Am J Obstet Gynecol. 2014;210:454.e1-6.
7. Roman A, Papanna R, Johnson A, et al. Selective reduction in complicated monochorionic pregnancies: radiofrequency ablation vs. bipolar coagulation. Ultrasound Obstet Gynecol. 2010;36:37–41.
8. Rossi AC, D'Addario V. Umbilical cord occlusion for selective feticide in complicated monochorionic twin: a systematic review of literature. Am J Obstet Gynecol. 2009;200:123–9.