

Elective fetal reduction by radiofrequency ablation in monozygotic diamniotic twins decreases adverse outcomes compared to ongoing monozygotic diamniotic twins



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BACKGROUND: Multifetal pregnancy reduction is a technique used to reduce the fetal number to mitigate the risks of adverse outcomes associated with multiple gestations. Monozygotic diamniotic twin pregnancies are subject to unique complications, contributing to adverse pregnancy outcomes. Thus, patients have an option to electively reduce 1 fetus to improve outcomes.

OBJECTIVE: This study aimed to compare outcomes of elective reduction of monozygotic diamniotic twins by radiofrequency ablation to planned ongoing monozygotic diamniotic twins.

STUDY DESIGN: We performed a retrospective review of 315 monozygotic diamniotic twin gestations that underwent first-trimester ultrasound within 1 institution. Planned electively reduced twins were compared with ongoing monozygotic diamniotic twins. All reductions were performed via radiofrequency ablation of the cord insertion site into the fetal abdomen. The primary outcome was preterm birth at <36 weeks' gestation. Secondary outcomes included gestational age at delivery; preterm birth at less than 37-, 34-, 32-, and 28-weeks' gestation; unintended loss; and adverse perinatal outcomes.

RESULTS: Among 315 monozygotic diamniotic pregnancies, 14 (4.4%) underwent elective multifetal pregnancy reduction, and 301 (95.6%) were planned ongoing twins. The mean gestational age of radiofrequency ablation in the elective multifetal pregnancy reduction group was 15.1±0.68 weeks. Patients who underwent elective multifetal pregnancy reduction had significantly higher maternal age ($P<.01$) and were more likely to be Asian ($P<.01$). Moreover, they were more likely to have undergone in vitro fertilization ($P=.03$) and chorionic villus sampling ($P<.01$). There was a significantly higher rate of term deliveries in the elective radiofrequency ablation group compared with ongoing twins (gestational age, 38 weeks [interquartile range, 36.1–39.1] vs 35.9 weeks [interquartile range, 34.0–36.9]; $P<.01$). Patients with ongoing pregnancies had a trend of increased rate of preterm birth at <36 weeks'

gestation (odds ratio, 3.4; 95% confidence interval, 1.0–12.0; $P=.06$), a significantly increased risk of preterm birth at <37 weeks' gestation (odds ratio, 8.0; 95% confidence interval, 2.4–26.4; $P<.01$), and no difference at less than 34-, 32-, or 28-weeks' gestation. All patients who underwent elective radiofrequency ablation had successful pregnancies with no pregnancy losses or terminations. Of ongoing gestations, 36 required procedures, including 16 (5.3%) medically indicated radiofrequency ablation, 14 (4.6%) laser ablation, and 6 (1.9%) amnioreductions. Furthermore, 22 patients (7.3%) with planned ongoing twins had total pregnancy loss at <24 weeks' gestation. Notably, 12 patients (4.0%) had unintended loss of 1 fetus before 24 weeks' gestation in the ongoing pregnancy cohort, and 12 patients (4.0%) had unintended loss of both fetuses before 24 weeks' gestation. Moreover, 5 patients (1.7%) in the ongoing pregnancy group had intrauterine fetal demise at >24 weeks' gestation and 10 patients (3.3%) electively terminated both fetuses. There was no significant difference in loss rates between the 2 groups.

CONCLUSION: In this study of monozygotic diamniotic twins, patients who elected to undergo multifetal pregnancy reduction had significantly lower rates of preterm birth at <37 weeks and a lower trend of preterm birth at <36 weeks' gestation without an increased risk of pregnancy loss. Median gestational age at delivery was significantly higher in the elective multifetal pregnancy reduction group (38 weeks) than in the ongoing pregnancy group (35.9 weeks). Further research is needed to clarify if multifetal pregnancy reduction improves long-term outcomes.

Key words: elective multifetal pregnancy reduction, laser, monozygotic, multiple gestation, prematurity, preterm birth, radiofrequency ablation, selective fetal growth restriction, twin anemia polycythemia sequence, twin pregnancy outcomes, twin reversed arterial perfusion, twin-twin transfusion syndrome

Introduction

Twin pregnancies are associated with a significantly higher risk of

preterm birth,¹ maternal complications,² and neonatal morbidity and mortality than singleton gestations.^{3,4} In addition, twin pregnancies are often complicated by preterm premature rupture of membranes (PPROM),⁵ gestational diabetes mellitus,^{6,7} fetal growth restriction (FGR),^{5,8} and hypertensive disorders of pregnancy.⁹ Monozygotic diamniotic twin pregnancies face even greater risks because of the underlying angioarchitecture of the single placenta.¹⁰ Unique risks

of monozygotic diamniotic twins that occur in 15% of monozygotic pregnancies include twin-twin transfusion syndrome (TTTS),^{11–15} twin reversed arterial perfusion (TRAP),^{16,17} selective FGR (sFGR) and birthweight discordance,^{8,11,18–21} and twin anemia polycythemia sequence (TAPS),^{17,22} all of which contribute to adverse pregnancy outcomes.^{9,23}

Multifetal pregnancy reduction (MPR) was developed in the 1980s and

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AJOG MFM at a Glance

Why was this study conducted?

This study aimed to determine if elective multifetal pregnancy reduction (MPR) in monochorionic diamniotic twins reduces the incidence of preterm birth and other complications compared with ongoing monochorionic diamniotic twin gestations.

Key findings

Elective MPR in monochorionic diamniotic twin gestations reduced the rate of preterm birth at <37 weeks' gestation without an increased risk of pregnancy loss and resulted in a higher gestational age at delivery compared with ongoing monochorionic diamniotic twin gestations.

What does this add to what is known?

This study suggested that MPR in monochorionic diamniotic twins by radiofrequency ablation is a reasonable alternative to reduce the risk of preterm birth.

is a technique used to reduce the fetal number to mitigate the risks of adverse outcomes, especially preterm birth.^{1,24}

MPR is considered separately from selective termination, which is performed for a specific indication, such as a fetal chromosomal abnormality, anomaly, or severe growth restriction.^{1,23,25,26} Within our institution, there has been an increasing trend of using elective MPR since 1993 for twin gestations.^{26–28} Notably, elective MPR has been documented to reduce the odds of preterm delivery without an increased risk of pregnancy loss in dichorionic diamniotic twin pregnancies,^{24,29} and MPR for monochorionic twins in triplet and quadruplet gestations has been shown to be effective before 16 weeks.³⁰ Selective termination by cord occlusion techniques has higher risks than intrathoracic potassium chloride injection used in dichorionic diamniotic twins, although it has been shown to be a safe, effective method in complicated monochorionic pregnancies.^{31–33} In most studies reporting outcomes with radiofrequency ablation (RFA) in monochorionic pregnancies, the procedure was performed for severe complications, such as TRAP, TTTS, sFGR, or a fetal anomaly.^{17,33–35} To date, there are limited data reporting outcomes of RFA performed specifically in monochorionic diamniotic twins for an elective indication. This study aimed to compare pregnancy outcomes in electively

reduced monochorionic diamniotic twins and ongoing monochorionic diamniotic gestations at a single institution.

Materials and Methods

This study included a retrospective cohort of monochorionic diamniotic twin pregnancies that underwent first-trimester ultrasound within 1 institution from 2007 to 2020. The time frame of the study was specific to when MPR was first offered at our institution for monochorionic diamniotic pregnancies. All patients with identified monochorionic diamniotic twin pregnancies were counseled within the first trimester on the unique risks of monochorionic diamniotic twins and the option for MPR. Specifically, they were educated on associated risks of the procedure, including loss of the remaining fetus, PPRM, complete pregnancy loss before 24 weeks' gestation, and risks of neurologic morbidity and fetal demise of the non-reduced fetus. The elective reduction group consisted of monochorionic diamniotic twins undergoing fetal reduction by RFA before 17 weeks' gestation to theoretically mitigate the risks of a monochorionic diamniotic twin gestation. That is, there was no evidence of a structural anomaly or complications, such as early TTTS, TRAP, or sFGR, at the time of RFA. The ongoing monochorionic diamniotic group consisted of women with monochorionic diamniotic twins who planned to continue with a

twin pregnancy with no recognizable abnormality at the time of the first-trimester ultrasound. Additional patient demographic information and data were extracted from the electronic medical record. All data collections were performed with institutional review board approval.

MPR procedures were performed via RFA under ultrasound guidance in the interventional radiology suite. Patients were given intravenous sedation, local anesthesia, and skin preparation using a chlorhexidine-based solution. Grounding pads were placed, and a Boston Scientific 16-gauge, 15 cm LeVeen needle with a 2-cm array was inserted into the fetal abdomen just at or above the cord insertion. Every effort was made to avoid going through the placenta during the procedure. If there was an anatomic abnormality or velamentous cord insertion detected in 1 fetus, that fetus was chosen to be reduced; otherwise, the fetus to be reduced was based on ease of access with the LeVeen needle. Prongs were deployed, and 10 W of energy was delivered for about 30 seconds and then power was increased by 10 W in 30-second intervals to 50 W or when impedance dropped and cessation of vascular flow within the umbilical cord was confirmed. The patient was observed for several hours, and absence of fetal cardiac activity was documented. Patients were encouraged to obtain a fetal brain magnetic resonance imaging (MRI) at 20-, 24-, and 28-weeks' gestation.

Maternal baseline characteristics, including maternal age, prepregnancy body mass index (BMI), parity, race and ethnicity, insurance type, incidence of Müllerian anomaly of the uterus, and use of invasive testing and in vitro fertilization (IVF) were collected. The primary outcome was defined as preterm birth at <36 weeks' gestation. Secondary maternal outcomes were defined as gestational age (GA) at delivery; preterm birth at less than 37, 34, 32, and 28 weeks; incidence of preeclampsia; PPRM at <34 weeks' gestation; preterm labor; postpartum hemorrhage; FGR; and gestational diabetes mellitus. In addition, fetal outcomes were defined as incidence (in at least 1 twin for the

ongoing twin group) of selective FGR, TTTS, TRAP, TAPS, fetal anomaly, and neonatal intensive care unit (NICU) admission. Moreover, birthweight percentiles of <tenth percentile were reported.

Pregnancy loss rates were evaluated at <24 weeks' gestation. Total loss of pregnancy was defined as either miscarriage or elective termination of the remaining fetus in the elective RFA group or both fetuses in the ongoing pregnancy group. Unintended pregnancy loss was defined as unplanned loss of a fetus or fetuses.

Maternal demographic data were assessed using the Student *t* test or a Wilcoxon rank-sum test for continuous variables, and a chi-square or Fisher exact test for categorical variables. Univariable logistic regression was used to compare maternal and neonatal outcomes between ongoing twins and reduced singletons.

Results

From January 2007 to August 2020, we identified 375 viable monochorionic diamniotic twin gestations via first-trimester ultrasound at 2 sites within the Mount Sinai Hospital. Among these, complete follow-up data were available for 315 patients (84%). Of these pregnancies, 14 (4.4%) underwent elective MPR, and 301 (95.6%) were planned ongoing twins. The mean GA of RFA in the elective MPR group was 15.1 ± 0.68 weeks. The 14 RFA procedures were performed from 2012 to 2020 with 5 RFA procedures performed from 2012 to 2015 and 9 performed from 2016 to 2020.

Baseline maternal characteristics between elective RFA and planned ongoing gestations are reported in Table 1. Patients who underwent elective MPR had significantly higher maternal age and were more likely to be of Asian race vs all other races ($P < .01$) compared with patients with ongoing twins. Moreover, they were more likely to have undergone IVF ($P = .03$) and chorionic villus sampling ($P < .01$). Pre-pregnancy BMI, previous term and preterm births, insurance type, and incidence of Müllerian anomalies of the uterus were similar for both groups.

The incidence rates of adverse perinatal outcomes are shown in Table 2. There were significantly more term deliveries in the elective MPR group compared with the ongoing twin cohort (GA, 38 weeks vs 35.9 weeks; $P < .01$). Patients with ongoing pregnancies had a trend of increased rate of preterm birth at <36 weeks' gestation ($P = .06$), a significantly increased risk of preterm birth at <37 weeks' gestation compared with patients who underwent elective MPR ($P < .01$), but no difference in preterm birth at less than 34-, 32-, or 28-weeks' gestation. No difference was found in the incidence of FGR, preeclampsia, gestational diabetes mellitus, or preterm labor between the 2 groups. Notably, no patient in the elective RFA group had PPRM at <34 weeks, and no patient in the elective RFA group developed postpartum hemorrhage. No difference was found in the rate of NICU admission or birthweight percentile of <tenth percentile. Indications for delivery were available for 5 of 14 patients in the elective RFA group and 269 of 301 patients in the ongoing twin pregnancy group. For the elective RFA group, the most common indications were spontaneous term labor (40%), hypertensive disorder of pregnancy (20%), and preterm labor (20%). For the ongoing pregnancy group, the most common indications were FGR (22%), preterm labor (18%), PPRM (13%), and hypertensive disorder of pregnancy (12%).

As shown in Table 2, in the ongoing pregnancy group, 59 pregnancies (19.6%) developed sFGR, 52 (17.3%) developed TTTS, 1 (0.3%) developed TRAP, and 6 (2%) developed TAPS. Of ongoing gestations, 36 required further procedures, including 16 medically indicated RFA (5.3%), 14 laser ablation (4.6%), and 6 amnioreductions (1.9%). In addition, in 20 of the ongoing pregnancies (7.9%), a fetal anomaly was identified in 1 fetus, and in 4 gestations (1.6%), a fetal anomaly was identified in both fetuses. Moreover, data on fetal brain MRIs were available for 7 of 14 patients, and of these patients, the surviving fetuses all had normal MRIs.

Differences in pregnancy loss rates are reported in Table 3. All patients who underwent elective RFA delivered a live-born infant and did not have any pregnancy losses or terminations. In the ongoing pregnancy cohort, 273 of 301 patients (90.7%) delivered at least 1 live-born infant. In addition, there was no complication related to the elective RFA procedure, such as leaking, chorion-amnion separation, or placental bleeding. Moreover, 22 patients (7.3%) with planned ongoing twins had a total pregnancy loss of at <24 weeks' gestation. In the ongoing pregnancy cohort, 12 patients (4.0%) had an unintended loss of 1 fetus before 24 weeks' gestation, and 12 patients (4.0%) had an unintended loss of both fetuses before 24 weeks' gestation. Overall, 5 patients (1.7%) in the ongoing pregnancy group had intrauterine fetal demise (IUFD) at >24 weeks' gestation, and 10 patients (3.3%) electively terminated both fetuses. There was no significant difference in the loss rates between the 2 groups.

Comment

Principal findings

This study compared outcomes of elective RFA in monochorionic diamniotic twin pregnancies with outcomes of planned ongoing monochorionic diamniotic gestations. We found that elective pregnancy reduction was associated with lower rates of preterm delivery at 37 weeks' gestation without an increased risk of pregnancy loss. Moreover, we found that elective pregnancy reduction was associated with a significantly higher median GA at delivery. However, there was no significant difference in preterm delivery at <36 weeks' gestation, preeclampsia, FGR, gestational diabetes mellitus, preterm labor, NICU admissions, or birthweight percentile of <tenth percentile between the 2 groups. Interestingly, although there was no significant difference in these adverse outcomes, no patient in the elective RFA cohort had postpartum hemorrhage or PPRM at <34 weeks' gestation.

TABLE 1
Maternal demographics

Variable	Elective RFA (n=14)			Ongoing pregnancy (n=301)			P value
	n	Mean±SD	Range	n	Mean±SD	Range	
Maternal age at delivery (y)	14	37.3±5.2	28–45	301	32.8±6.0	18–52	<.01
Prepregnancy BMI (kg/m ²)	11	21.9±5.0	17.8–34.8	265	23.9±4.8	15.2–41.5	.17
	n	Median (IQR)	Range	n	Median (IQR)	Range	
Previous term births	14	1 (0–1)	0–2	301	0 (0–1)	0–9	.28
Previous preterm births	14	0 (0–0)	0–0	301	0 (0–0)	0–2	.41
	n (%)			n (%)			
Race and ethnicity ^a							<.01
Asian	6 (42.9)			28 (9.3)			
Black or African American	1 (7.1)			21 (7.0)			
White	7 (50.0)			199 (66.1)			
Other or more than 1 race	0 (0)			51 (16.9)			
Insurance type							.50
Private	14 (100)			264 (87.7)			
Public	0 (0)			32 (10.6)			
Self-pay	0 (0)			5 (1.7)			
Spontaneous vs artificial reproductive technologies							
Spontaneous pregnancy	4 (28.6)			208 (69.1)			<.01
IUI	1 (7.1)			8 (2.7)			.34
Clomid	0 (0)			4 (1.3)			>.99
IVF	8 (57.1)			72 (23.9)			<.01
Egg donor	1 (7.1)			8 (2.7)			.34
Unknown	0 (0)			7 (2.3)			>.99
Invasive testing performed							
CVS	10 (71.4)			59 (19.6)			<.01
Amniocentesis	0 (0)			22 (7.3)			.61
None	4 (28.6)			218 (72.4)			<.01
Müllerian anomaly of the uterus ^b	1 (7.1)			4 (1.3)			.21

Data are presented as number, mean±SD, or number (percentage), unless otherwise indicated.

BMI, body mass index; CVS, chorionic villus sampling; IQR, interquartile range; IUI, intrauterine insemination; IVF, in vitro fertilization; RFA, radiofrequency ablation; SD, standard deviation.

^a Two patients had “unknown or not reported” race and ethnicity; ^b One patient had missing data on Müllerian anomaly of the uterus.

Rao. Pregnancy outcomes in elective monochorionic diamniotic multifetal pregnancy reduction. *Am J Obstet Gynecol MFM* 2021.

Results

Studies have evaluated the outcomes of MPR in higher-order pregnancies. Specifically, elective MPR has been associated with a decreased risk of preterm birth at both <37 and <34 weeks' gestation without an increased risk of pregnancy loss compared with ongoing gestations in dichorionic diamniotic twin gestations.²⁴ In addition, although studies have assessed the safety and

efficacy of medically indicated RFA in complicated monochorionic pregnancies, no study has explored the comparative outcomes of elective RFA in the setting of monochorionic diamniotic twins compared with ongoing monochorionic diamniotic pregnancies. This study aimed to elucidate the clinical efficacy of elective RFA to augment current literature on monochorionic pregnancies.

Current literature, including studies by Kumar et al,³³ Lee et al,¹⁷ Rahimi-Sharbat et al,³⁵ Ting et al,³⁰ and Wang et al,³⁶ evaluate outcomes following RFA but do not specifically compare elective RFA of monochorionic diamniotic twins with ongoing twin monochorionic diamniotic twin pregnancies. To determine perinatal outcomes following RFA in complex monochorionic pregnancies, Kumar

TABLE 2
Maternal and neonatal adverse pregnancy outcomes

Variable	Elective RFA (n=14)		Ongoing pregnancy (n=301)		Ongoing pregnancy vs elective RFA	
	n	Median (IQR)	n	Median (IQR)	P value	
GA at delivery (wk)	14	38 (36.1–39.1)	273	35.9 (34–36.9)	<.01	
	n/N observed (%)		n/N observed (%)		OR (95% CI)	P value
Preterm delivery (wk)^a						
<37	4/14 (28.6)		208/273 (76.1)		8.0 (2.4–26.4)	<.01
<36	3/14 (21.4)		139/273 (50.9)		3.4 (1.0–12.0)	.06
<34	2/14 (14.3)		67/273 (24.5)		2.0 (0.4–8.9)	.39
<32	2/14 (14.3)		38/273 (13.9)		1.0 (0.2–4.5)	.97
<28	0/14 (0)		9/273 (3.3)		—	—
FGR (at least 1 twin)	2/14 (14.2)		67/301 (22.3)		1.7 (0.4–7.9)	.49
Preeclampsia	1/14 (7.1)		45/301 (15.0)		2.3 (0.3–17.9)	.43
PPROM at <34 wk	0/14 (0)		23/280 (8.2)		—	—
Preterm labor	3/14 (21.4)		77/278 (27.7)		1.4 (0.4–5.1)	.61
Postpartum hemorrhage	0/9 (0)		27/268 (10.1)		—	—
Gestational diabetes mellitus	1/14 (7.1)		26/301 (8.6)		1.3 (0.2–9.8)	.85
Procedures for monochorionic diamniotic pregnancies						
Medically indicated RFA	—		16/301 (5.3)		—	—
Amnioreduction	—		6/301 (1.9)		—	—
Laser ablation	—		14/301 (4.6)		—	—
No procedure	—		267/301 (88.7)		—	—
Fetal anomaly						
1 fetus	—		20/254 (7.9)		—	—
2 fetuses	—		4/254 (1.6)		—	—
Monochorionic diamniotic twin outcome						
sFGR	—		59/301 (19.6)		—	—
TTTS	—		52/301 (17.3)		—	—
TRAP	—		1/301 (0.3)		—	—
TAPS	—		6/301 (2.0)		—	—
None	—		205/301 (68.1)		—	—
Birthweight percentile (at least 1 twin)						
<tenth percentile	4/12 (33.3)		63/269 (23.4)		0.6 (0.2–2.1)	.43
NICU admission (at least 1 twin)	3/10 (30.0)		139/267 (52.1)		2.5 (0.6–10.0)	.18

Data are presented as number, median (IQR), or number (percentage), unless otherwise indicated.

BMI, body mass index; CVS, chorionic villus sampling; FGR, fetal growth restriction; GA, gestational age; IQR, interquartile range; IUI, intrauterine insemination; IVF, in vitro fertilization; NICU, neonatal intensive care unit; PPROM, preterm premature rupture of membranes; RFA, radiofrequency ablation; SD, standard deviation; sFGR, selective fetal growth restriction; TAPS, twin anemia polycythemia sequence; TRAP, twin reversed arterial perfusion; TTTS, twin-twin transfusion syndrome.

^a Among patients with a successful pregnancy beyond 24 weeks' gestation (n=287).

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TABLE 3

Comparison of loss rates between ongoing twins with 2 to 1 singletons

Variable	Elective RFA (n=14) n/N observed (%)	Ongoing pregnancy (n=301) n/N observed (%)	P value
Total pregnancy loss at <24 wk	0/14 (0)	22/301 (7.3)	.61
Unintended loss in ongoing pregnancies at <24 wk: 1 fetus lost	—	12/301 (4.0)	
Unintended loss in ongoing pregnancies at <24 wk: 2 fetuses lost	—	12/301 (4.0)	
IUFD at >24 wk	0/14 (0)	5/301 (1.7)	>.99
Complete elective termination	—	10/301 (3.3)	

Data are presented as number (percentage), unless otherwise indicated.

IUFD, intrauterine fetal demise.

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et al³³ prospectively investigated 100 cases of selective RFA of which 72 were monochorionic diamniotic twins. The authors found a survival rate of 78% following RFA with delivery at <32 weeks' gestation occurring in 17.9% of cases. Tsao et al³⁴ reported similar safety and efficacy findings in RFA of 13 monochorionic gestations with evidence of TRAP sequence.

Similarly, Rahimi-Sharbat et al³⁵ recently reported the outcomes of RFA for selective fetal reduction in monochorionic twins based on indication with an overall survival of the cotwin following RFA as 71.3%. Moreover, Wang et al³⁶ reported on how indications for 272 RFA procedures may affect the perinatal outcomes of monochorionic pregnancies. The authors compared outcomes of RFA in pregnancies affected by TTTS, selective intrauterine growth restriction, TRAP, discordant anomaly, and MPR. They found that pregnancies with elective RFA had a higher cotwin survival rate and higher take-baby-home rate compared with all other outcomes. However, similar to Ting et al,³⁰ these authors only consider the outcomes of elective reduction in monochorionic diamniotic pregnancies as part of a larger elective reduction group that included dichorionic triamniotic, monochorionic triamniotic, and dichorionic quadramniotic pregnancies. The optimal timing of performing an RFA has not been established. Lee et al³⁷ found a higher incidence of IUFD when

RFA was performed at <19 weeks' gestation for the indication of TRAP.

Like the aforementioned studies, most cases of selective RFA were performed at a later GA compared with our study. Recently, Ting et al³⁰ evaluated the risk factors associated with selective fetal reduction both before and after 16 weeks' gestation in monochorionic multiple pregnancies. Although the authors found that ablation cycles of 4 or more confers the greatest risk for loss of the cotwin after RFA, they reported that RFA before and after 16 weeks' gestation had comparable outcomes. We found a survival rate of the cotwin of 100% and a mean gestational age at the timing of the procedure, of 15.1 ± 0.68 weeks. We highlighted not only the safety but also the feasibility of performing elective RFA in the early second trimester of pregnancy.

This study explored the loss rates and adverse outcomes when comparing elective RFA with planned ongoing monochorionic diamniotic twin pregnancies. In finding that there is a significantly lower rate of preterm delivery before 37 weeks' gestation without a significant difference in loss rates, this study provided evidence that planned elective RFA before 17 weeks' gestation may be offered as a viable MPR therapy for monochorionic diamniotic gestations.

Clinical implications

Monochorionic diamniotic pregnancies, which account for 20% of all twin

gestations, are often associated with increased morbidity, mortality, and overall perinatal complications.³⁸ Because 15% of monochorionic pregnancies are associated with unique outcomes, such as TTTS,^{11–15} TRAP,^{16,17} sFGR,^{8,11,18–21} and TAPS,^{17,22} it is important to mitigate these risks with therapeutic options.⁹ Specifically, TTTS, which is associated with 8% to 10% of monochorionic diamniotic pregnancies, can lead to fetal loss in 70% to 100% of pregnancies if it presents before 26 weeks' gestation and can lead to perinatal loss even after laser treatment in 30% to 50% of pregnancies.¹² In addition, in twin pregnancies, the incidences of PPRM, gestational diabetes mellitus,^{6,7} FGR,^{5,8} and gestational hypertension and preeclampsia are higher. Elective MPR can offer a valuable intervention to eliminate the unique risks of monochorionic gestations, such as TTTS, TRAP, sFGR, and TAPS, and can mitigate the risks associated with adverse maternal outcomes.

Research implications

This study provided evidence that elective RFA can mitigate the risks of adverse neonatal and maternal outcomes in monochorionic diamniotic pregnancies. This direct comparison of elective RFA in monochorionic diamniotic gestations with ongoing gestations revealed a lower incidence of preterm birth at <37 weeks' gestation without associated risk for increased pregnancy loss. Further research should evaluate

the long-term neonatal and maternal outcomes in elective RFA gestations compared with ongoing monochorionic diamniotic gestations.

Strengths and limitations

This study directly compared a cohort of elective 2-to-1 MPR in monochorionic diamniotic twins with ongoing monochorionic diamniotic pregnancies. Current literature has evaluated the safety and efficacy of RFA in complicated monochorionic gestations, but other studies have not directly evaluated the efficacy of early, elective intervention in high-risk monochorionic diamniotic pregnancies. Our findings, indicating a lower incidence of preterm birth at <37 weeks' gestation without an associated increase in pregnancy loss for elective RFA, might help inform intervention options for monochorionic diamniotic pregnancies.

This study's main limitation was the size of the elective RFA cohort. The small sample size of the RFA group may have prevented us from finding significant differences in the less common outcomes. Many patients with monochorionic diamniotic twins may not be aware of the option for elective reduction, thereby limiting the number of patients undergoing this procedure. In addition, when no anomaly was found in either fetus during elective RFA procedures, the fetus with the easiest access via LeVeen needle was chosen to be reduced. Thus, there may be selection bias in terms of choosing which fetus to reduce.

The American College of Obstetricians and Gynecologists (ACOG) endorses delivery timing of uncomplicated monochorionic diamniotic twins at 34 to 37.6 weeks' gestation.³⁹ As the protocol at our institution is to typically deliver monochorionic diamniotic pregnancies at 37 weeks' gestation, there may be some bias to favor RFA when considering preterm birth at <37 weeks' gestation as our secondary outcome. Thus, the generalizability of this study must be taken into consideration in the context of regional and institutional protocol and adherence to ACOG guidelines.

Moreover, given the lack of any outcomes in elective RFA until this study, there was no information to correctly counsel patients about the risks of this procedure. The retrospective nature of this study conducted for more than 13 years may also have led to additional missing data. Another limitation was the lack of long-term neonatal outcomes in our study. Further research should evaluate whether elective MPR improves long-term maternal and neonatal outcomes.

Conclusions

Depending on a patient's social history, personal beliefs, and medical background, MPR in the absence of medical indication can offer a method of optimizing pregnancy and neonatal outcomes. Moreover, elective RFA in monochorionic diamniotic twin gestations seems to be a safe and effective procedure to achieve a higher GA at delivery and reduce the risk of preterm birth at <37 weeks' gestation without an increased risk of unintended pregnancy loss. In addition, it eliminates the unique risks of monochorionic diamniotic twins, such as TTTS, TRAP, TAPS, and sFGR, and the need to undergo additional procedures. Thus, elective RFA may be a reasonable therapeutic option that can be discussed with patients with proper counseling in the context of current literature. ■

Supplementary materials

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.ajogmf.2021.100447>.

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