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Application and Influencing Factors of Radiofrequency Ablation in Monochorionic Pregnancy

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Abstract

Objective: The aim of the study was to investigate the pregnancy outcomes and possible influencing factors concerning complicated monochorionic (MC) multiple pregnancies undergoing selective fetal reduction using radiofrequency ablation (RFA).

Methods: This retrospective cohort study included 54 women with complicated MC multiple pregnancy who underwent selective fetal reduction using RFA at the Maternal and Child Health Hospital of Guangxi Zhuang Autonomous Region from January 2015 to March 2020. According to the indications for RFA, the 54 women were divided into three groups: complex complications ($n = 30$), structural anomalies ($n = 18$), and triplet pregnancy ($n = 6$). According to the gestational age for RFA, all patients were divided into three groups: $16–19^{+6}$ weeks ($n = 17$), $20–23^{+6}$ weeks ($n = 17$), and $24–26^{+6}$ weeks ($n = 20$). We analyzed the pregnancy outcomes (including the overall survival rate (OSR), gestational age at delivery, birth weight of newborns) and postoperative complications such as miscarriage, and intrauterine fetal death (IUFD) according to the indications and gestational age of reduction by using suitable statistical testing.

Results: The OSR was 83.3% (45/54). The mean ± standard deviation (SD) of gestation at the time of reduction was 21.6 ± 3.2 weeks. The GA at delivery was 34.0 (32.0, 37.5) weeks. The mean ± SD of newborns' birth weight was 2118 ± 685 g. The overall rates of miscarriage, PROM, and IUFD were 9.3% (5/54), 7.4% (4/54), and 7.4% (4/54), respectively. According to the indications for reduction, the OSR for complex complications, structural anomalies, and triplet pregnancy groups were 83.3% (25/30), 83.3% (15/18), and 83.3% (5/6), respectively. Statistically significant differences were only found in the mean birth weight among the three groups ($P < 0.05$). No significant difference was found in the rate of miscarriage, and mean gestation at delivery among the three groups ($P > 0.05$). In the group with complex complications, the OSR of twin-to-twin transfusion syndrome, selective intrauterine growth restriction, twin reversed arterial perfusion sequence, and twin anemia polycythemia sequence were 66.7% (6/9), 93.3% (14/15), 80.0% (4/5), and 100.0% (1/1), respectively, with no significant difference among these groups ($P > 0.05$). According to the gestational age of reduction, the OSRs among the three groups were 82.4% (14/17), 76.5% (13/17), and 90.0% (18/20), respectively, and the rate of miscarriage, IUFD, and mean gestation age at delivery among these groups showed no significant difference ($P > 0.05$).

Conclusion: Selective fetal reduction by RFA is an important treatment method for complicated MC multiple pregnancy, although it may lead to complications like miscarriage, and IUFD. The indication of reduction seems to affect the pregnancy outcome. An optimal treatment plan should be selected according to the patient's conditions in clinical practice.

Keywords: Twins; Monochorionic pregnancies; Fetal reduction; Radiofrequency ablation; Pregnancy outcomes; Influencing factors

Introduction

A monochorionic (MC) twin (MCT) is a single oocyte twin formed by the division of a single zygote after fertilization. In

MC pregnancy, the presence of placental vascular anastomoses and uneven distribution of placental sharing may lead to specific complications including twin-to-twin transfusion syndrome (TTTS), selective intrauterine growth restriction (sIUGR), twin reversed arterial perfusion (TRAP) sequence, and twin anemia polycythemia sequence (TAPS). The incidence of fetal structural abnormalities and perinatal morbidity and mortality is higher than that of dichorionic pregnancies and single pregnancies.[1] After death of the affected fetus, the cotwin may experience major insult to the brain and other important organs or even undergo intrauterine demise because of sudden exsanguinations through vascular anastomoses. Some parents may choose to terminate the MC pregnancy because of the high risk of adverse pregnancy.

Blood vessel ablation is used in MC multiple pregnancies or when the survival of the two fetuses in MCT pregnancy is not ensured; in particular, radiofrequency ablation (RFA) has been used in clinical practice.[2] Most of the existing literature comprise single-center studies, wherein the success rate of RFA and the rate of postoperative complications were different. The reported overall survival rate (OSR) of the remained fetus after RFA reduction is 63.6% to 92%.[3–6]

The factors influencing the success rate are complex and still not well understood.

Since the application of RFA at our institution, the outcomes of some patients with complicated MC pregnancy were improved after selective reduction. However, we encountered several difficulties and were unsure of the treatment at times. Thus, to improve the clinical application of RFA in complex MC multiple pregnancy, we concluded the pregnancy outcomes of 54 patients who underwent reduction by RFA and analyzed the possible factors which could influence the success rate of RFA.

Methods

Materials

This is a retrospective cohort study. From January 2015 to March 2020, 60 patients with MC multiple pregnancies were treated by RFA at the Fetal Medicine Center of Maternal and Child Health Hospital of Guangxi Zhuang Autonomous Region, China; among these, six patients were excluded because they were still pregnant until March 2020. Finally, 54 pregnant women who had delivered were included in this study.

Ethics

All procedures performed in this study were in accordance with the ethical guidelines of the ethics committee of the Maternal and Child Health Hospital of Guangxi Zhuang Autonomous Region (2015.1). The pregnant women and their families were fully informed about the current condition, prognosis, treatment advice, and related risks. Informed consent was obtained from all study participants.

Inclusion and exclusion criteria

The inclusion criteria (indications for RFA reduction) are as follows: patients with following conditions at 16 to 27^{+6} weeks of gestation: (1) triplet or other multiple pregnancies involving MCT; (2) discordant MCT with fatal malformation or chromosomal abnormalities in one fetus; (3) TTTS III (critical abnormal Doppler studies) or IV (hydrops) indicating reduction or failure to undergo fetoscopic laser coagulation; (4) severe sIUGR, a large weight difference between the two fetuses (>35%), continuous decrease or reversal of the umbilical artery end-diastolic blood flow of the small fetus, accompanied by oligohydramnios; and (5) TRAP Ib (the abdominal circumference ratio of the pumped twin is less than 50% and there is no complication) or above.[7–10]

The exclusion criteria (RFA reduction contraindications) were as follows: symptoms of threatened abortion or ultrasound suggesting a cervical tube length of less than 2.5 cm; urinary and reproductive system infection; piercing difficulties caused by fetus position, placenta position, and other factors; serious internal and surgical diseases, abnormality of coagulation or liver function, and other abnormalities in the mother.[7]

Grouping method

According to the indication of reduction, 54 patients were divided into three groups as follows: MCT with specific complications (n = 30), MCT with severe structural malformations in one fetus (n = 18), and triplet pregnancy (n = 6, without specific complications). Specific complications included TTTS, sIUGR, TRAP, and TAPS.

According to the gestational age (GA) of reduction, patients were divided into three groups: 16 to 19^{+6} weeks (n = 17), 20 to 23^{+6} weeks (n = 17), and 24 to 26^{+6} weeks (n = 20). The technical specification suggests that RFA should be performed at 14 to 26 weeks. In this study, we choose 24–26^{+6} weeks as the third group. RFA was performed at 26–27 weeks in three patients with severe growth restriction according to ultrasound examination (the GA of these fetuses based on ultrasound was less than 26 weeks). A poor pregnancy outcome would have if we do nothing.

Perioperative management

Ultrasonography was used to observe fetal structure, growth and development, Doppler of fetal blood flow, amniotic fluid, and placenta position. All RFA procedures were performed under continuous ultrasound guidance. Other surgical equipment includes the ablation instrument (S-1500; MEDSPHERE) and 17G radiofrequency needle (MEDSPHERE, the length of the needle is 15 cm and the diameter of ablation range is 2 cm). After local anesthesia and intramuscular sedation, the 17G radiofrequency needle was inserted into the abdominal umbilical cord insertion site of the targeted fetus. The radiofrequency energy was applied until the temperature of the probe umbrella reached 100 °C for several minutes; this was repeated up to two to three cycles as necessary to confirm complete cessation of blood flow. The heartbeat and Doppler flow of the retained fetus were monitored in real time during the operation.

Contraction inhibitors were used after the operation. Ultrasound examination was conducted 24 hours after the operation. The perinatal outcomes were tracked in all patients, including miscarriage (spontaneous abortion without obvious reasons before 28 weeks), intrauterine fetal death (IUFD; death of the retained fetus after reduction), premature delivery (delivery before 37 weeks), term delivery, premature rupture of membranes (PROM), GA at delivery, and neonatal birth weight.[7,11]

Statistical analysis

SPSS software (version 16.0; IBM Corporation, Armonk, NY) was used for statistical analysis of data. Enumeration data were expressed as percentages and frequencies. Chi-square test or Fisher exact test was performed for between-group comparisons. Normally distributed measurement data were expressed as mean ± standard deviation (SD). Analysis of variance was used for comparison among multiple groups. Nonnormally distributed measurement data were expressed as median (interquartile ranges). Kruskal-Wallis H rank sum test was used for comparison among multiple groups. All statistical tests were two-tailed, and a P value less than 0.05 was considered to indicate statistically significant differences.

Results

Patients' clinical and demographic data

During the study period, 54 patients with complicated MC pregnancy including MC diamniotic twins (n = 45), MC triamniotic (MCTA) triplets (n = 7), and dichorionic triamniotic triplets (n = 2) underwent RFA. In two patients with dichorionic triamniotic triplet pregnancy, it was essential

to reduce one fetus of MC diamniotic twins. All the triplets were reduced by one fetus, leaving a twin pregnancy.

The mean ± *SD* of patients' age was 29 ± 4 years. Eight women (14.8%) conceived by assisted reproductive technology, and the remaining conceived naturally. The mean ± *SD* of cervical length was 30 ± 3 mm. The mean ± *SD* of gestation at the time of reduction was 21.6 ± 3.2 weeks. The reductions were technically successful in all patients.

Overall pregnancy outcome

The OSR of the remained fetus was 83.3% (45/54), the GA at delivery was 34.0(32.0,37.5) weeks. Among the live births, 17.8% (8/45) were delivered at 28 to 31^{+6} weeks, 20.0% (9/45) at 32 to 33^{+6} weeks, and 62.2% (28/45) after 34 weeks. Thirty patients (66.7%) delivered vaginally, and the rest delivered by cesarean section. The mean ± *SD* of newborns' birth weight was 2118 ± 685 g.

Overall, the miscarriage rate was 9.3% (5/54), and the pregnancy ended in miscarriage within one week after reduction in 1.9% (1/54), within one to two weeks in 3.7% (2/54), and after one month of the RFA procedure in 3.7% (2/54). The rate of miscarriage was 15.8% (3/19) in cases where the targeted fetus was located below the uterine cavity, higher than other locations (5.7%, 2/35). Three of five patients who experienced miscarriage were complicated with TTTS III.

The rate of PROM was 7.4% (4/54). PROM occurred within one week after reduction in 1.9% (1/54) and within seven to ten weeks in 5.6% (3/54, gestation age: 32^{+2}–34^{+1} weeks). The IUFD rate of the cotwin was 7.4% (4/54). Of these cases, fetal demise was diagnosed within 12 hours after reduction in 1.9% cases (1/54; in this case, the operation was complex and challenging requiring three cycles of RFA coagulation because of the complex congenital heart disease and spinal dysplasia in the affected fetus), within 36 hours in 1.9% (1/54; the surgical indication of this case was MCTA complicated with TRAP). After labor induction, we found that the umbilical cord of the centerless teratoid was broken from the abdominal wall, likely associated with the tip of the RFA instrument being too close to the abdominal wall of the centerless teratoid and the three cycles of RFA coagulation. Furthermore, fetal demise occurred after two weeks of the operation in 1.9% (1/54, the indication was MCTA); one case was a stillbirth recorded at 39 weeks of gestation and required to be induced.

Pregnancy outcomes of the retained fetus based on the indications for RFA

Statistically significant differences were only found in the mean birth weight among the three groups according to the indications (*P* < 0.001; Table 1).

No statistically significant differences were found in the fetal OSR, miscarriage rate, IUFD incidence, mean GA at delivery, and mean birth weight among the four groups according to different complications (*P* > 0.05; Table 2).

Pregnancy outcomes of retained fetuses based on the time of RFA

The mean GA at the time of the reduction was 21.6 ± 3.2 days (16–26^{+6} weeks). No statistically significant differences were found in the OSR, miscarriage rate, IUFD incidence, mean GA at delivery, and mean birth weight among the three groups based on the time of RFA (*P* > 0.05; Table 3).

Three patients with serious complications accepted selective reduction over 26 weeks. We reduced the smaller fetus (estimated fetal weight: 750 g) with cardiac malformation at 26^{+3} weeks in case complicated with TTTS IV. In this patient, PROM occurred 6 weeks after surgery and the fetus was delivered at 32^{+3} weeks. The remaining two cases were diagnosed as sIUGR II, and the estimated fetal weight difference between the twins was 44.0% (750/420 g) and 51.7% (870/420 g), respectively. Given the high possibility of adverse outcomes, the patients and their families decided to accept RFA reduction after repeated communication and finally delivered at term.

Discussion

Because of the presence of placental vascular anastomoses in MCT, the incidence of neurological injury to the cotwin after single fetal death is 26%, which is approximately 4.8 times higher than that of dichorionic twin, and the risk of sudden death of the cotwin is 15%.[12] Selective fetal reduction is a feasible treatment method to minimize the impact on the normal cotwin in patients with severe complications. Fetal intracardiac injection of potassium chloride is contraindicated in MC pregnancy because of the risk of transmission of the cardiotoxic agent to the cotwin through intraplacental anastomoses. RFA is easier to perform, less traumatic, and is more convenient to carry out for fetal reduction than other technique, such as fetoscopic laser surgery. It is the most commonly used procedure for reduction

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Table 1

Pregnancy outcomes of the retained fetus based on the indications for RFA.

Items	Total (*N* = 54)	Specific complications (*n* = 30)	Structural malformations (*n* = 18)	Triplets (*n* = 6)	χ^2/H/F	*P*
OSR	45 (83.3)	25 (83.3)	15 (83.3)	5 (83.3)	0.24	>0.999*
Miscarriage	5 (9.3)	4 (13.3)	1 (5.6)	0	0.90	0.804*
IUFD	4 (7.4)	1 (3.3)	2 (11.1)	1 (16.7)	2.47	0.410*
Preterm delivery	8/45 (17.8)	3/25 (12.0)	4/15 (26.7)	1 (20.0)	1.68	0.495*
GA at delivery (week)	34.0 (32.0,37.5)	35.0 (32.0,38.0)	35.0 (31.0,38.0)	34.0 (30.0,35.5)	1.33	0.515†
Birth weight (g)	2118 ± 685	2192 ± 622	2101 ± 808	1794 ± 624	20.74	<0.001‡

Data are presented as *n* (%), median(interquartile ranges), or mean ± standard deviation.

*Compared using χ^2 test.

†Compared using Kruskal-Wallis *H* rank sum test.

‡Compared using analysis of variance.

GA: Gestational age; IUFD: Intrauterine fetal death; OSR: Overall survival rate; RFA: Radiofrequency ablation.

Table 2

Pregnancy outcomes of the retained fetus based on different type of complications.

Items	Total (N = 30)	TTTS II-IV (n = 9)	sIUGR II-III (n = 15)	TRAP (n = 5)	TAPS (n = 1)	χ^2/F	P
OSR	25 (83.3)	6 (66.7)	14 (93.3)	4 (80.0)	1(100.0)	3.53	0.346*
Miscarriage	4 (13.3)	3 (33.3)	1 (6.7)	0	0	3.82	0.284*
IUFD	1 (3.3)	0	0	1 (20.0)	0	5.26	0.200*
GA at delivery (week)	34.7 ± 3.0	35.3 ± 3.2	34.0 ± 3.3	36.0 ± 1.6	35.0 ± 0.0	0.56	0.649†
Birth weight(g)	2192 ± 622	2333 ± 781	2143 ± 633	2240 ± 493	1850 ± 0	0.22	0.884†

Data are presented as n (%) or mean ± standard deviation.

*Compared by the χ^2 test.

†Compared using analysis of variance.

GA: Gestational age; IUFD: Intrauterine fetal death; OSR: Overall survival rate; sIUGR: Selective intrauterine growth restriction; TAPS: Twin anemia polycythemia sequence; TRAP: Twin reversed arterial perfusion; TTTS: Twin-twin transfusion syndrome.

of complicated MC pregnancies.[2] In 2002, RFA was first used in the treatment of pregnancy reduction in the second trimester. Chinese researchers and clinicians started using this technology from 2011.[13–15]

Prognosis of the remained fetuses after RFA reduction

The OSR of the remained fetus was different in different research centers with different sample size and surgical indications. It has been reported that the OSR was 63.6% to 92%.[3–6] The mean GA at delivery was 31^{+4} to 36^{+6} weeks, and the rate of preterm delivery before 37 weeks was 51.4% to 71.1%, before 34 weeks was 26.9% to 59.0%, and the mean birth weight of newborns was 1575 to 2494 g.[16–20] In our study, the OSR was 83.3%, the GA at delivery was 34.0 (32.0,37.5) weeks, the rate of preterm delivery before 34 weeks was 37.8%, and the mean birth weight of the newborn was 2118 ± 685 g. These results were consistent with existing studies.

The main postoperative complications of RFA were the preterm prelabor rupture of membranes (PPROM), miscarriage, premature delivery, IUFD, and neurological injury of the surviving fetuses.[5] Reportedly, the incidence of PPROM in that study was 5% to 20%. In our study, the incidence was 7.4% (4/54). Preterm prelabor rupture of membranes occurred on the day of RFA in 1.8% (1/54). Some studies reported that the risk of PPROM was positively correlated with the diameter of the umbilical cord,[15,20,21] and the incidence increased in TTTS cases with a large difference in the amniotic fluid volume and uneven distribution of amniotic cavity pressure.[22]

A domestic study showed that the miscarriage rate after RFA was 17.3% (27/156).[23] The rate of miscarriage increased when the targeted fetus was located below the uterine cavity.[24] In our study, the rate of miscarriage in patients, wherein the targeted fetus was located below was higher than in other patients (15.8% vs. 5.7%). This fact suggested that the risk of miscarriage may be related to the reduction indications and the location of the targeted fetus.

The incidence of IUFD after reduction was 3% to 15%, and it mostly occurred within two weeks after surgery.[15,25] A domestic study showed that more than two cycles of surgical circulation was an independent risk factor for IUFD.[26] In this study, two retained fetuses in one case of MCTA triplet pregnancy with TRAP died within 24 hours after the operation. According to the postdelivery examination, we found that the umbilical cord root of the fetus acardiacus was broken off from the abdominal wall, and the retained fetuses eventually bled to death. The procedure in this case was carried out early and required more than two cycles; the ablation site was too close to the skin at the root of the umbilicus. We thought that IUFD after RFA might be related to the position of the targeted fetus and the experience of reduction. In addition, several studies reported that the incidence of neurological injury of the retained fetus after RFA was 3% to 6%.[3,17,21]

Correlation between different reduction indications and the pregnancy outcomes of the remained fetus

The pregnancy outcomes of the remained fetus were associated with surgical indications. Paramasivam et al.[3] showed that the survival rate of the remained fetus was the lowest

Table 3

Pregnancy outcomes of retained fetuses based on the time of RFA.

Items	16–19^{+6} wk (n = 17)	20–23^{+6} wk (n = 17)	24–26^{+6} wk (n = 20)	χ^2/H/F	P
OSR	14 (82.4)	13 (76.5)	18 (90.0)	1.22	0.594*
Miscarriage	1 (5.9)	3 (17.6)	1 (5.0)	1.84	0.501*
IUFD	2 (11.8)	1 (5.9)	1 (5.0)	0.86	0.826*
GA at delivery (week)	35.5 (32.0,38.0)	36.0 (33.0,38.0)	33.5 (31.5,35.5)	2.96	0.228†
Birth weight (g)	2224 ± 837	2201 ± 562	1957 ± 647	0.65	0.529‡

Data are presented as n (%), median(interquartile ranges), or mean ± standard deviation.

*Compared using the χ^2 test.

†Compared using Kruskal-Wallis H rank sum test.

‡Compared using analysis of variance.

GA: Gestational age; IUFD: Intrauterine fetal death; OSR: Overall survival rate; RFA: Radiofrequency ablation; wk: Weeks.

(77.8%) after reduction in the structural anomaly group, and the rate was 88.6% in the group with specific complications. Another domestic study found similar results in that the rate was lowest in the structural anomaly group (53.8%).[6] The live birth rate was 83% to 91% in triplet pregnancies, which reduced one fetus, but there was no statistically significant difference compared with patients with specific complications.[3,15] In our cohort, the survival rate of the remained fetus was same in three groups with different indications, but the rate of IUFD was as high as 16.7% (1/6) in the triplet pregnancy group. These twins died two weeks after RFA. Moreover, the mean birth weight of newborns in the triplet pregnancy group was the lowest ($P < 0.001$), which was consistent with previous literature.[27] The problem of reducing the number of fetuses in triplet pregnancy deserves further study.

The pregnancy outcome of the remained fetus was correlated with the types of specific complications. One meta-analysis study found that the survival rate of the TTTS group was significantly lower than the other reduction indication group (69.23% *vs.* 80.35%, $P = 0.03$). The incidence of the PROM was also higher, while the comparison of preterm birth and IUFD rate between the two groups was not statistically significant.[22] Other studies also found similar findings.[6,17,23] In our study, compared with the other indications group, the survival rate was lower in TTTS cases (66.7% *vs.* 90.5%) than other cases, and the miscarriage rate was as high as 33.3%, but there was no statistical difference. The lower survival rate in the TTTS cases might be related to the preexisting cardiac dysfunction of fetuses. During the reduction procedure, the blood pressure of the targeted fetus decreases gradually, and the cotwin may experience ischemic shock and neurological injury due to sudden exsanguinations through vascular anastomoses.[5] The pregnancy outcomes of the cotwin may be related to the stage of TTTS. Further research is needed to confirm these speculations.

In our study, the pregnancy outcome was better in sIUGR than TTTS cases, suggesting that smaller fetus, thinner umbilical cord, and less amniotic fluid could contribute to the success of the operation. This finding was consistent with previously published studies.[9,17,20] The survival rate of the TRAP group was 80%. Another study indicated that the relatively poor outcome of TRAP cases might be related to the obvious edema of the centerless teratoid, which could increase the surgical circulation and duration of RFA.[24]

Correlation between the reduction timing and pregnancy outcomes of the retained fetus

The correlation between the GA at reduction and pregnancy outcomes were analyzed. Although the technical difficulty of reduction and operation cycles were positively correlated with GA at operation, no statistically significant differences were found in the rate of overall live birth, IUFD, and GA at delivery after reduction.[15] Kumar *et al.*[17] divided patients into two groups (<20 and >20 weeks of gestation) and found that there were no statistically significant differences in pregnancy outcomes. A similar finding was noticed in our cohort. It was reported that RFA for TRAP before 19 weeks could increase the risk of IUFD.[12] But we found that IUFD occurred in one case that required reduction at 23 weeks, and the average GA of reduction in five TRAP cases was 22 weeks.

The technical specification for selective fetal reduction by RFA formulated in our country suggests that RFA should be performed between 14 and 26 weeks of gestation. The procedure will be easier when reduction is performed at small GA. Less residual necrotic tissue and surgical irritation are good for better pregnancy outcome. However, chromosomal and structural abnormalities of the retained fetus cannot be ruled out if reduction is carried out at an early GA. Essentially, an appropriate time for selective reduction should be determined according to the specific clinical conditions. A domestic study showed that reduction after 26 weeks may increase the risk of preterm birth, but the retained fetus had a high survival rate and the complications related to surgery did not show a significant increase.[28] In our cohort, three patients with serious complications accepted selective reduction after 26 weeks and eventually carried to term. If the pregnancy continues without intervention, there is a high possibility of adverse pregnancy outcomes. Consistent with existing literature, we believed that selective reduction by RFA is feasible for patients with complex complications over 26 weeks of gestation.

Strengths and limitations

As the first fetal medicine center in the region, our center has performed selective fetal reduction used a standardized technique. Hence, these are the representative patients of our region. Since using this procedure, we have attained considerable experience in the diagnosis and treatment for complicated MC pregnancy.

The limitations of this study include the single-center design and small sample size. Furthermore, our data analysis was not based on the staging of complications, and the statistical analysis method was relatively simple. There are many mixed factors affecting the clinical success rate of RFA. A larger sample size and more detailed statistical methods are needed to confirm whether the indication and timing of RFA are the critical factors.

Some of our patients returned to the local hospital after undergoing reduction; hence, some information about the newborns such as Apgar score, umbilical cord blood pH value, and neonatal intensive care unit occupancy rate is missing. These cases were not routinely examined by fetal cranial magnetic resonance after reduction, and hence, the neurological development of the remained fetus after birth was not tracked.

Conclusions

Selective fetal reduction by RFA is an important and feasible treatment method in complicated multiple MC pregnancies. The indication of reduction seems to affect the pregnancy outcome. The mean birth weight in the triplets group was lower than in other indication groups. Careful consideration should be given to assess whether to retain a twin pregnancy after RFA in MC triplet pregnancy. There was no significant difference in the prognosis of the retained fetus with respect to different timing of reduction. A larger sample size and further research are needed to validate our findings.

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Author Contributions

HW did the project development and manuscript reviewing. PP did the project development, data management, and manuscript editing. DH did the manuscript drafting and data collection and analysis. LT did the data management and technical support. ZY and GQ did the technical support. All authors agreed to be personally accountable for the author's own contribution and to ensure that questions related to the accuracy of any part of the study. All authors approved the submitted version.

Conflicts of Interest

None.

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