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OUTCOMES OF PRENATAL INTERVENTION FOR MONOCHORIONIC DIAMNIOTIC TWIN PREGNANCIES COMPLICATED BY TWIN REVERSED ARTERIAL PERFUSION (TRAP) SEQUENCE IN HA NOI OBSTETRICS AND GYNECOLOGY HOSPITAL

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ABSTRACT

Objective: To evaluate of prenatal management outcomes in monochorionic diamniotic twin pregnancies complicated by twin reversed arterial perfusion (TRAP) sequence in Ha Noi Obstetrics and Gynecology Hospital.

Material and Methods: An interventional study combined with longitudinal follow-up was conducted on 15 patients with acardiac twin in TRAP sequence who underwent selective umbilical cord laser photocoagulation, delivered at Hanoi Obstetrics and Gynecology Hospital, and whose neonates were followed for at least six months postpartum from January 2020 to December 2021.

Results: The mean gestational age at intervention was 19.05 ± 3.36 weeks, and the mean operative time was 40.1 ± 9.0 minutes. The intraoperative complication rate was 0%; there were no complications within 24 hours postoperatively, and 26.67% of cases developed complications within 7 days after surgery.

Conclusion: The average gestational age at intervention was approximately 19 weeks, with an average operative time of 40 minutes. The intraoperative complication rate was low.

Keywords: Twin reversed arterial perfusion (TRAP) sequence, management of TRAP sequence, surgical treatment of TRAP sequence.

1. INTRODUCTION

Twin reversed arterial perfusion (TRAP) sequence is a severe variant of twin-to-twin transfusion syndrome (TTTS) [1, 2]. In TRAP sequence, the pump twin has a normally functioning circulatory system but perfuses part of its blood through abnormal placental vascular shunts, delivering it from its umbilical artery into the umbilical circulation of the second twin (the acardiac twin) [2]. This abnormal circulatory pathway places an increased hemodynamic load on the pump twin, which may lead to cardiac failure, polyhydramnios, hydrops fetalis, and ultimately stillbirth. Each year, Hanoi Obstetrics and Gynecology Hospital receives numerous cases diagnosed with TRAP sequence; however, most are detected late or lack effective interventional treatment options, resulting in a very high fetal mortality rate. Currently, our fetal intervention center is performing prenatal treatment for TRAP sequence cases using laser photocoagulation and bipolar electrocautery to selectively occlude the umbilical cord of the acardiac twin. To evaluate the treatment, we conducted a study "Outcomes of prenatal intervention for monochorionic diamniotic twin pregnancies complicated by twin reversed arterial perfusion (TRAP) sequence in Ha Noi Obstetrics and Gynecology Hospital"

2. MATERIAL AND METHODS

2.1. Study Subjects

All patients who underwent selective umbilical cord occlusion of the acardiac twin by laser photocoagulation for TRAP sequence, delivered at Hanoi Obstetrics and Gynecology Hospital, and followed for at least 6 months postpartum during 2020–2021, fulfilled the study inclusion criteria.

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- Inclusion Criteria:

+ Complete prenatal care and delivery records at Hanoi Obstetrics and Gynecology Hospital.

+ Neonates who survived and were followed for at least 6 months postpartum.

+ Patients who voluntarily provided informed consent to participate in the study.

- Exclusion Criteria:

+ Fetuses with severe congenital anomalies detected prenatally by ultrasound (e.g., cardiac or cranial malformations).

+ Fetuses with congenital anomalies confirmed by prenatal diagnosis and indicated for termination of pregnancy.

+ Cases with incomplete medical records outside the study period, those without intrauterine surgery, or those lacking sufficient neonatal follow-up up to 6 months postpartum.

During the study period, 15 pregnant women were enrolled who fulfilled the study's inclusion criteria.

2.2. Methods

Our study is a large interventional study with prospective longitudinal follow-up, using total population sampling. We collected pre-intervention ultrasound data to select patients, perform fetal surgery, and follow up to evaluate treatment efficacy based on obstetric outcomes and neonatal results. This paper focuses on the outcomes of selective umbilical cord laser photocoagulation for the treatment of the acardiac twin in TRAP sequence.

- Study design: Interventional study with prospective longitudinal follow-up.

- Sampling method: Convenience sampling.

2.3. Study Procedures: (1) Selection of cases meeting the study inclusion criteria, (2) Performance of fetal surgery and post-operative follow-up, (3) Data collection, (4) Data processing and analysis, (5) Presentation of results and discussion..

2.4. Study Variables: Characteristics of the study population (maternal age, conception method, maternal medical conditions, placental location), TRAP treatment methods (gestational age at surgery, surgical technique), surgical characteristics (anesthesia method, duration of surgery, volume of amniotic fluid removed, intraoperative complications, length of hospital stay), postoperative complications (fetal complications, maternal complications).

2.5. Ethical Considerations

The study was approved by the Ethics Committee of Hanoi Obstetrics and Gynecology Hospital under decision number CS/PSHN/DC/20/16. All data used in this study were authorized by Hanoi Obstetrics and Gynecology Hospital for use and publication. In addition, all members of the research team declared no conflicts of interest.

3. RESULT

Table 1. General characteristics of the study population

General characteristics	n=15	%
Maternal age, years		
Mean age (mean ± SD) (Min–Max)	28,27 ± 4,4 (21-38)	
Conception method		
IVF	3	20
Spontaneous	12	80
Maternal medical conditions prior to intervention		
Healthy	10	66,67
Diabetes mellitus	0	0
Preeclampsia	0	0
Other	5	33,33
Placental location		
Anterior	4	26,67
Posterior	11	73,33
Gestational age at surgery		
Mean age (mean ± SD) (Min–Max)	19,05 ± 3,36 (16-26,6)	

The mean maternal age was 28.27 ± 4.4 years, and 80% of pregnancies were conceived spontaneously. Most pregnant women were healthy (66.67%). The placenta was predominantly located on the posterior uterine wall (73.33%), and the mean gestational age at surgery was 19.05 weeks.

Table 2. Characteristics of laser photocoagulation surgery for the treatment of acardiac twin in TRAP sequence

Characteristics	n=15	%
Anesthesia method		
Local anesthesia with sedation	15	100
Spinal anesthesia	0	0
General anesthesia	0	0
Duration of surgery (minutes)		
Mean duration (mean ± SD) (Min–Max)	40,1 ± 9,0 (30 - 60)	
Volume of amniotic fluid removed (ml)		
Mean volume (mean ± SD) (Min–Max)	593,9 ± 425,7 (300 - 900)	
Intraoperative complications		
Fetal	0	0
Maternal	0	0
Mean postoperative hospital stay (days)	5,0 ± 2,93	

In selective umbilical cord laser photocoagulation for the acardiac twin, 100% of patients received local anesthesia with sedation. The mean duration of surgery was 40.1 minutes, and the mean volume of amniotic fluid removed was 593.9 mL, with an intraoperative complication rate of 0% for both mothers and fetuses.

Table 3. Postoperative Complications

Characteristics	n=15	%
Maternal complications	0	0
Pregnancy complications within 24 hours post-surgery		
Intra-amniotic bleeding	0	0
Placental abruption	0	0
Chorioamnionitis	0	0
Pregnancy complications within 7 days post-surgery		
Stillbirth	2	13,34
Rupture of membranes	0	0
Miscarriage	2	13,34

Within 24 hours post-surgery, none of the pregnant women experienced complications such as intra-amniotic bleeding, placental abruption, or chorioamnionitis. After 7 days post-surgery, 2 out of 15 cases (13.34%) had stillbirths, and 2 out of 15 cases (13.34%) resulted in miscarriage.

4. DISCUSSION

The study cohort comprised 15 pregnant women with acardiac twins in TRAP sequence who underwent selective umbilical cord laser photocoagulation, delivered at Hanoi Obstetrics and Gynecology Hospital, with neonatal follow-up extending for at least 6 months postpartum between January 2020 and December 2021. The mean maternal age was 28.27 ± 4.4 years, ranging from 21 to 38 years, which is quite comparable to the mean maternal age reported in the study by L. Lew [3, 4]. This observation can be attributed to the fact that women aged 18–35 years represent the reproductive age group, which is associated with a higher incidence of acardiac twin in TRAP sequence compared to other age groups. Approximately 80% of cases were naturally conceived twin pregnancies, all arising from a single oocyte that subsequently underwent cleavage to form two embryos.

Regarding maternal medical conditions, as shown in Table 1, more than 66.67% of the pregnant women were healthy. Five cases had pre-existing maternal conditions prior to surgery, including a history of thyroid surgery and hepatitis B infection. Maternal comorbidities may increase the risk during pregnancy, particularly elevating anesthetic and procedural risks when surgical intervention is indicated, and may contribute to both preoperative and postoperative complications [5]. These cases require thorough evaluation and coordinated obstetric and anesthetic management before, during, and after surgery to ensure procedural safety, optimize surgical outcomes, and minimize preoperative, intraoperative, and postoperative complications.

In our study, 73.33% of acardiac twin cases had posterior placental implantation, which is three times higher than the proportion with anterior placental implantation (26.67%). Placental location can significantly influence the procedure of selective umbilical cord laser photocoagulation for acardiac twins. According to published reports, anterior placental implantation poses greater surgical challenges, including difficulty in determining the trocar entry site, limited visualization of the surgical field, and increased complexity for the surgeon in identifying the cord axis and vascular anastomoses or targeting the laser to specific structures. These challenges can prolong the duration of surgery and thereby contribute to an increased risk of intraoperative complications [5].

In our study, the mean gestational age at the time of intervention for acardiac twins was 19.05 ± 3.36 weeks, ranging from 16 to 26.6 weeks. Currently, there remains considerable debate regarding the optimal timing for surgical intervention in the management of acardiac twins [6]. A retrospective study by Lewi et al. indicated that the diagnosis of acardiac twins in monochorionic diamniotic pregnancies can be made as early as the late first trimester (11+0 to 13+6 weeks) using nuchal translucency measurement and prenatal screening tests. However, fetal interventions should preferably commence after 16 weeks of gestation to avoid complications such as miscarriage, preterm rupture of membranes, clubfoot, and structural fetal injuries... [3, 7]. Therefore, our protocol recommends surgical intervention for acardiac twins in TRAP sequence between 16 and 26 weeks of gestation in cases presenting with one or more poor prognostic indicators.

Two commonly used methods for the treatment of acardiac twins are laser photocoagulation and bipolar electrocautery. In this study, 100% of cases underwent selective umbilical cord laser photocoagulation for the acardiac twin. Experts recommend using bipolar electrocautery for gestational ages beyond 20 weeks due to the larger umbilical cord diameter, which facilitates the procedure. In our study, with a mean gestational age at surgery of 19 weeks, laser photocoagulation was preferred [8].

Regarding the characteristics of selective umbilical cord laser photocoagulation for acardiac twins (Table 3), 100% of the patients received local anesthesia with sedation. This is also the most commonly employed anesthetic approach in fetal medicine centers worldwide. Local anesthesia combined with sedation is considered optimal for this minimally invasive procedure, as it ensures patient immobility, provides

an optimal surgical field for the surgeons, and simultaneously minimizes maternal and fetal anesthetic-related complications [9].

The mean duration of surgery was 40.1 ± 9.0 minutes, ranging from 30 to 60 minutes. The average operative time in our study is comparable to that reported in other international studies, such as the study by Sago [5]. In our study, some surgical procedures lasted up to 60 minutes, typically in cases with anterior placental implantation, where the surgical field was limited, making trocar entry site determination more challenging.

In the surgeries, the mean volume of amniotic fluid removed in polyhydramnios cases was 593.94 ± 425.69 ml. Reducing the amniotic fluid to a normal level helps decrease intrauterine pressure, thereby lowering the risk of preterm labor and post-procedural rupture of membranes. However, care must be taken to avoid rapid aspiration, as sudden reduction of intrauterine pressure may increase the risk of placental abruption. No intraoperative complications, such as intra-amniotic bleeding, placental abruption, fetal heart rate loss, amniotic fluid embolism, or anesthesia-related adverse events, were observed. Furthermore, the mean postoperative hospital stay was 5.0 ± 2.93 days, primarily for monitoring maternal and fetal complications and for the administration of tocolytics and antibiotics according to protocol.

No maternal complications were observed following selective umbilical cord laser photocoagulation for acardiac twins in our study. In contrast, the study by Sago reported maternal complications in 10.7% of 150 surgical cases, with 6.0% classified as severe and 4.7% as mild [5]. The main maternal complications include placental abruption, which accounts for the majority of cases, as well as amniotic fluid embolism and Mirror syndrome. Another study described one case of placental abruption and two cases of Mirror syndrome among 181 acardiac twin pregnancies [5]. Some mild maternal complications have been reported in the literature, such as amniotic fluid leakage into the peritoneal cavity or uterine wall bleeding, but these are very rare. In our study, no maternal complications were observed, which may be attributed to the fact that our center is newly established with a limited number of surgical cases, over 90% of patients were healthy prior to surgery, and strict perioperative and postoperative protocols were followed to prevent and promptly detect maternal complications.

Regarding fetal complications, 4 out of 15 cases in our study experienced pregnancy-related complications within 7 days post-surgery, including 2 cases of stillbirth and 2 cases of miscarriage. No cases of post-procedural intra-amniotic infection, intra-amniotic bleeding, or placental abruption were observed. In the study by Sago, the incidence of preterm rupture of membranes within 7 and 28 days post-laser was 3.9–6%, and the rate of stillbirth was reported at 10–12%, which is broadly comparable to the findings of our study [5].

Common fetal complications following surgical intervention include preterm rupture of membranes, stillbirth, and recurrence of acardiac twin. However, a 25-year review of laser-assisted fetal surgeries conducted at various centers worldwide noted that in published studies, data on post-procedural complications such as TAPS, acardiac twins, or preterm rupture of membranes were often unavailable, unreported, or lacked standardized definitions [9].

Preterm rupture of membranes is generally considered one of the most important causes of preterm labor following selective umbilical cord laser photocoagulation for acardiac twin pregnancies with retention of the pump twin [9]. To enable systematic evaluations in these areas, standardized definitions are required when reporting outcomes such as neonatal survival (e.g., survival at 28 days postpartum), PPROM (e.g., before 32 weeks of gestation), TAPS, recurrence of acardiac twin, and the associated post-surgical complications [9]. The findings of our study regarding post-surgical complications are largely consistent with those reported in several previously published studies [9]. Post-surgical complications are crucial for planning patient monitoring, minimizing risks, and refining surgical techniques, as well as for preoperative preparation to reduce the likelihood of adverse events. Furthermore, reporting post-surgical complications with clearly defined diagnostic criteria contributes valuable data for systematic reviews and meta-analyses evaluating the efficacy of the treatment method.

5. CONCLUSIONS

In this study, 100% of patients with acardiac twin in TRAP sequence underwent selective umbilical cord laser photocoagulation. Local anesthesia with sedation was used for all procedures, and the operative time was relatively short. Most cases experienced no intraoperative or early postoperative complications.

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