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Review Article

Twin Reversed Arterial Perfusion (TRAP) Sequence: A Complication of Monochorionic Pregnancy

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Abstract

The incidence of multiple gestations has risen substantially with the increasing use of assisted reproductive technologies, contributing to a higher prevalence of complications inherent to monochorionic (MC) twin pregnancies. MC twins are uniquely susceptible to vascular disorders due to shared placental circulation, with twin reversed arterial perfusion (TRAP) sequence representing one of the most severe manifestations. TRAP occurs in approximately 2.5% of monozygotic twins and is characterized by reversed perfusion from the pump twin to an acardiac twin through large arterioarterial and venovenous anastomoses. Early diagnosis relies on first trimester ultrasound and Doppler confirmation of retrograde arterial flow. Prognostic factors include a high acardiac-to-pump size ratio, evidence of cardiac compromise, and rapid acardiac growth. Management ranges from expectant surveillance to minimally invasive fetal interventions. Although emerging data support earlier intervention in selected cases, optimal timing remains uncertain, and further high-quality evidence is needed. TRAP sequence continues to pose a major clinical challenge, reinforcing the importance of specialized monitoring in MC pregnancies.

Keywords: *Twin Reversed Arterial Perfusion (TRAP) Sequence; Monochorionic Pregnancy; MC Twins*

Introduction

Over the past three decades, the incidence of multiple pregnancies has risen markedly, largely due to increased use of assisted reproductive technologies. Multiple gestations pose substantial clinical challenges, as they are associated with significantly higher perinatal morbidity and mortality, including an increased risk of long-term neurodevelopmental impairment, compared to single pregnancies. They also exhibit higher rates of preterm birth and intrauterine growth restriction, both of which contribute considerably to adverse perinatal outcomes [1,2].

The real number of multiple pregnancies is difficult to estimate, because a large number end in early miscarriages, while there is also the possibility of a case of a vanishing twin in the early embryonal phase, where one embryo may "vanish" due to different factors. Consequentially, the pregnancy may continue with one or two fetuses, depending on the initial number of embryos. However, according to literature so far, it has been estimated that about one in eighty-nine conceptions may result in a twin pregnancy, while the application of assisted reproductive techniques has drastically increased the incidence of multiple pregnancies worldwide [2,3].

Monochorionic (MC) twin pregnancies are at increased risk of perinatal morbidity and mortality compared with dichorionic gestations, mostly owing to conditions arising from their placental vascular arrangement, such as twin-twin transfusion syndrome (TTTS), twin anemia-polycythemia sequence and twin reversed arterial perfusion sequence [2,4].

Typical complications with MC twins are:

1. Twin-to-twin transfusion syndrome (TTTS)
2. Spontaneus twin anaemia polycythemia sequence (TAPS)
3. Twin reversed arterial perfusion sequence (TRAP)
4. Monoamniotic pregnancy
5. Conjoined twinning.

Twin reversed arterial perfusion (TRAP) sequence is a rare variant of interfetal transfusion in monochorionic twins, which occurs in approximately 2.5 % of monozygotic twins. It's characterized by placental anastomoses between a normally developed twin and an acardiac mass. Interfetal transfusion implies reversed perfusion of the commonly singular umbilical artery of the affected twin via a large-caliber arterio-arterial anastomosis. The consequence of that is disrupted development of the heart and the upper body. While the affected fetus has no chance of survival, the healthy twin- pump is also at risk due to excessive strain on the heart [2,5,6].

Characteristics of the MC placenta

In MC placenta, fetal vessels from each twin meet along the border between the placental territories. They may connect directly to form superficial vascular anastomoses or perfuse the common placental cotyledon by deep anastomoses of arterioles and venules. The imaginary line along the surface of the placenta connecting these anastomoses is called the vascular equator. This portion of the common placenta may represent 5 - 10% of the common vascular volume for each twin and is called the third circulation [2,3,7,8].

Vascular anastomoses can be found in any number, size and arrangement between the arteries and veins. Arteriovenous (AV) anastomoses occur when the common placental cotyledon is perfused by an artery from one twin and drained by a vein from the other. This results in a unidirectional transfer of volume, hemoglobin and substances from one fetus to the other. Arterio-arterial (AA) and veno-venous (VV) anastomoses connect directly to each other across the chorionic surface and allow bidirectional flow between twins based on pressure gradients. In most MC twins, the net exchange between twins remains balanced in their shared circulation [2,7,8].

Pathogenesis of TRAP sequence

Two principal mechanisms have been proposed to account for the pathogenesis of the TRAP sequence [9]. The first involves an abnormal placental vascular configuration arising during the early stages of monochorionic placentation. The second suggests a primary defect in cardiac embryogenesis, potentially attributable to chromosomal abnormalities or environmental influences. In this context, the acardiac fetus receives its circulation through vascular anastomoses between the umbilical vessels of the twins, resulting in perfusion with deoxygenated blood supplied by the pump- twin [10].

The perinatal mortality rate of the pump-twin has been reported to be as high as 50% - 55%. Accordingly, early prediction of the TRAP sequence or identification of associated risk factors is essential for improving clinical outcomes. Several parameters have been proposed for assessing the likelihood of adverse outcomes in the pump twin during the second trimester. Those are [11,12]:

- Acardiac-pump twin weight ratio > 50%, indicating a large acardiac twin.
- Discrepant pump-to-acardiac umbilical venous diameter ratio.
- Acardiac twin exhibiting a developed body and upper limbs.
- Acardiac-to-pump abdominal circumference ratio > 50%.
- Monoamnionic gestation.
- Findings consistent with high-output cardiac failure, including umbilical venous pulsations, tricuspid regurgitation, absent or reversed ductus venosus A-wave, hydrops fetalis, or polyhydramnios.
- Progressive enlargement of the acardiac twin.
- Elevated peak middle cerebral artery velocity.
- Umbilical artery pulsatility index ratio (acardiac/pump) < 1.

However, the rarity of acardiac twinning precludes large studies validating these predictive variables.

Diagnosis of TRAP

Ultrasound (US) is crucial in the diagnosis of twin pregnancy. The ideal period is between 11+0-13+6 weeks of gestation (w.g.). US details that are important to note in the first trimester are: determining crown-rump length- CRL, location of placenta/placentas and characteristics of the amniotic membranes. If the pregnancy is >14 w.g., gestational age is determined by measuring head circumference [7]. Determining chorionicity and amnionicity in twin pregnancy is a necessity. With US <13+6 w.g. chorionicity is identified with approximately 95% certainty. The presence of two placentas is the detection of the characteristic “lambda” or “delta” sign (thickening at the site of membrane insertion). An additional US sign is the presence of 2 placental masses. Detection of different sexes of the fetuses indicates dizygotic pregnancy [2,3,13,14]. Amnionicity is determined by the so-called T-sign (presence of an intraamniotic septum) [2-4,13-15].

TRAP sequence is typically identified in the first trimester and is defined by a severely malformed twin that continues to grow and may exhibit movement despite the absence of intrinsic cardiac activity; only rarely is a rudimentary, pulsatile heart observed. Hydrops and cystic hygroma are common, particularly later in gestation. Doppler assessment demonstrates the hallmark finding of reversed arterial perfusion through an arterioarterial (AA) anastomosis, and in some cases the acardiac twin’s cord originates directly from the pump twin’s cord. TRAP is distinguishable from early single fetal demise by persistent movements and characteristic retrograde perfusion [3].

Development of TRAP requires: a substantial AA and VV anastomosis, and discordant embryonic development or early intrauterine demise of one monochorionic twin, allowing reversed flow. In dichorionic pregnancies, early demise results in a vanishing twin, whereas in MC pregnancies placental anastomoses may prevent resorption. Consequently, any first-trimester single demise in a monochorionic twin pregnancy need prompt evaluation for TRAP, including Doppler assessment of the umbilical artery for reversal flow [4].

The pathognomonic Doppler finding may be detectable as early as the first trimester. Retrograde arterial flow from the pump twin to the acardiac twin alters fetal hemodynamics and cardiac function, potentially progressing to congestive or chronic high-output cardiac failure if untreated. Color Doppler remains the primary modality for assessing fetal status in utero. Commonly evaluated Doppler parameters include the umbilical artery and middle cerebral artery pulsatility indexes, middle cerebral artery peak systolic velocity, and the cerebroplacental ratio [15].

TRAP sequence should be suspected when persistent intrafetal blood flow is observed. The differential diagnosis includes intra-amniotic or placental tumors (e.g. chorioangioma, placental cysts, teratoma) and early single fetal demise in monochorionic gestations.

Acardiac fetuses are clinically classified as pseudocardiac (rudimentary cardiac tissue present) or holocardiac (no cardiac structures). Morphologically, four subtypes are recognized: acardius acephalus, acardius anceps, acardius acormus, and acardius amorphus. Although descriptive, this classification has limited prognostic utility. Acardiac size correlates with perinatal risk. Beyond estimated weight, the abdominal circumference (AC) ratio between the acardiac and pump twins has been proposed as a prognostic measure. A prenatal grading system based on acardiac size and signs of pump-twin cardiac strain distinguishes Type I (AC ratio < 50%) from Type II (AC ratio > 50%), aiding identification of severe cases [12].

Management and treatment of TRAP sequence

The management options of TRAP include expectant management or fetal intervention with cord occlusion of the acardiac twin. Management of TRAP sequence aims to protect the pump twin and prolong gestation. Karyotyping of the pump twin is recommended. In Europe, early second-trimester prophylactic interruption of reversed perfusion is commonly performed. In the US, intervention is generally reserved for cases in which the acardiac-to-pump weight ratio exceeds 50%, the acardiac mass enlarges rapidly, or the pump twin exhibits cardiac compromise or anemia, reflecting a more conservative approach. In the absence of high-risk features, weekly ultrasound surveillance is undertaken until perfusion to the acardiac twin ceases or its relative size stabilizes over two consecutive examinations [12].

Recent evidence favors fetal intervention over expectant management, particularly when the pump twin shows signs of cardiac compromise or when poor prognostic factors such as polyhydramnios, a large acardiac mass, or monoamnionicity are present [13].

The objective of intrauterine therapy is to interrupt perfusion from the pump twin to the acardiac mass. Available techniques include ultrasound- or fetoscopy-guided bipolar cord coagulation, radiofrequency ablation, microwave ablation, laser coagulation of the umbilical cord, and interstitial laser ablation [12,13].

According to updated ISUOG Practice Guidelines (2025) a range of minimally invasive procedures-such as cord coagulation, cord ligation, photocoagulation of placental anastomoses, radiofrequency ablation (RFA), and intrafetal laser-are used to prevent pump-twin deterioration in TRAP sequence. These interventions yield an approximate pump-twin survival rate of 80%. Management may be prophylactic or expectant, with intrauterine treatment reserved for evidence of cardiac strain in the pump twin or increased perfusion and growth of the acardiac mass, assessed either by estimated fetal weight or by the acardiac-to-pump size ratio. Accordingly, close surveillance in a specialized fetal medicine center is essential. Nevertheless, intensive ultrasonographic and Doppler monitoring cannot fully prevent unexpected fetal demise [12-16].

When intervention is indicated, procedures performed before 16 weeks' gestation may offer benefit. The rate of preterm birth before 32 w.g. is roughly 10%, and earlier treatment is associated with a later gestational age at delivery. This has prompted consideration of elective intervention at 12-14 w.g., although current evidence remains observational and limited by small sample sizes, precluding definitive comparison of fetal loss rates with later procedures. This uncertainty underlies the ongoing TRAP Intervention Study (TRAPIST), a multicenter randomized controlled trial evaluating early (12-14 w.g.) versus later (16-18 w.g.) treatment. At present, no consensus exists regarding the optimal timing of delivery following either expectant or interventional management; therefore, decisions should be individualized based on treatment success, Doppler parameters, and the pump twin's cardiac status [15].

Prognosis, complication and management of TTTS

TRAP sequence is rare, and current evidence is insufficient to define the optimal timing or modality of intervention. Significant heterogeneity among published studies further limits comparability and increases bias. More rigorous data are needed to establish best practices and to assess long-term neurodevelopmental outcomes for pump twins. Advances in robotic technology-including miniaturized instruments, improved simulation, and telesurgical capability are likely to drive the next phase of robotic fetal surgery [16,17].

Conclusion

In the conclusion, MC pregnancies remain high-risk and require specialized management despite generally favorable outcomes in most MCDA gestations. TRAP sequence, in particular, poses persistent challenges, as optimal technique and timing of intervention are not yet clearly defined. Emerging evidence favors earlier treatment when intervention is warranted, but consensus remains lacking, underscoring the need for further high-quality studies.

Bibliography

1. Oliver E., *et al*. "Comparison of international guidelines on the management of twin pregnancy". *European Journal of Obstetrics and Gynecology and Reproductive Biology* 285 (2023): 97-104.
2. Jasovic-Siveska E. "Twin-to-twin transfusion syndrome: a complication of monochorionic pregnancy". *Obstetrics and Gynecology International Journal* 16.2 (2025): 61-63.
3. Coady AM and Bower S. "Twining's Textbook of Fetal Abnormalities E-Book". 3rd edition. Elsevier Health Sciences (2022).
4. Leombroni M., *et al*. "Diagnostic accuracy of ultrasound in detecting birth-weight discordance in twin pregnancy: systematic review and meta-analysis". *Ultrasound in Obstetrics and Gynecology* 50.4 (2017): 442-450.
5. Klaritsch P. "Complications in monochorionic twin pregnancies". *Journal of Perinatal Medicine* (2025).
6. Ye X., *et al*. "Twin reversed arterial perfusion sequence: Prenatal diagnosis and treatment". *Maternal-Fetal Medicine* 4.4 (2022): 262-267.
7. Miller JL. "Twin to twin transfusion syndrome". *Translational Pediatrics* 10.5 (2021): 1518-1529.
8. Lynn L Simpson and Russell S Miller. "Twin-Twin Transfusion Syndrome". In: Editor(s): Joshua A. Copel, Mary E. D'Alton, Helen Feltovich, Eduard Gratacós, Deborah Krakow, Anthony O. Odibo, Lawrence D. Platt, Boris Tutschek, Obstetric Imaging: Fetal Diagnosis and Care (Second Edition), Elsevier (2018).
9. Wataganara T., *et al*. "Morphology, intrafetal vascular pattern, and umbilical artery Doppler indices of acardiac twins". *Prenatal Diagnosis* 40.8 (2020): 958-965.
10. Søgaard K., *et al*. "Acardiac twins: pathophysiology, diagnosis, outcome and treatment. Six cases and review of the literature". *Fetal Diagnosis and Therapy* 14.1 (1999): 53-59.
11. Wong AE and Sepulveda W. "Acardiac anomaly: current issues in prenatal assessment and treatment". *Prenatal Diagnosis* 25.9 (2005): 796-806.
12. Ye X., *et al*. "Twin reversed arterial perfusion sequence: prenatal diagnosis and treatment". *Maternal-Fetal Medicine* 4.4 (2022): 262-267.
13. Sorrenti S., *et al*. "Counselling in fetal medicine: Complications of monochorionic diamniotic twin pregnancies". *Journal of Clinical Medicine* 13.23 (2024): 7295.
14. "ISUOG Practice Guidelines: ultrasound assessment of fetal biometry and growth". *Ultrasound in Obstetrics and Gynecology* 53.6 (2019): 715-723.

15. A Khalil., *et al*. "ISUOG Practice Guidelines (updated): role of ultrasound in twin pregnancy". *Ultrasound in Obstetrics and Gynecology* 65.2 (2025): 253-276.

16. Klaritsch P. "Complications in monochorionic twin pregnancies". *Journal of Perinatal Medicine* (2025).

17. Vitucci A., *et al*. "Timing of intra-fetal laser therapy for twin reversed arterial perfusion (TRAP) sequence: Retrospective series and systematic review and meta-analysis". *International Journal of Gynecology and Obstetrics* 159.3 (2022): 833-840.

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