The twin pregnancy complicated by the twin-to-twin transfusion syndrome, caused by the existence of the bilateral arterio-arterial anastomosis

**Michał Szuber, Mariola Ropacka, Wiesław Markwitz, Grzegorz H. Breborowicz**

**Abstract**

Introduction: The twin-to-twin transfusion syndrome (TTTS) is a severe complication of monochorionic (MA) twin pregnancies, caused by a net inter-twin transfusion of blood from one fetus (the donor) towards the other fetus (the recipient) through placental anastomoses. TTTS is most often driven by unidirectional arterio-venous anastomoses, and mitigated by bidirectional arterio-arterial or veno-venous anastomoses. In contrast to this concept some cases describe AA anastomoses as a cause of the TTTS. Case presentation: We describe the case of the monochorionic twin pregnancy complicated by the TTTS. In the course of this pregnancy the typical for TTTS symptoms occurred: fetal growth discordance, impaired Doppler blood flow in the compromised fetus. With the pregnancy developing the symptoms deteriorated, finally forcing us to finish the pregnancy by caesarean section. TTTS was most probably caused by the single bi-directional arterio-arterial anastomosis discovered in US scan. Discussion: Unidirectional arterio-venous (AV) anastomoses often result in twin-twin transfusion syndrome (TTTS). However, oppositely directed anastomoses may compensate for the circulatory imbalance and either prevent, delay the onset, or moderate the severity of TTTS. Intuitively, higher pressure gradient, oppositely-directed AV anastomoses (indicated as VA) would be expected to compensate better for TTTS than lower pressure gradient arterio-arterial (AA) anastomoses. In other study the angioarchitecture of 395 monochorionic twin placentas was studied. Mortality was highest in the absence of an arterio-arterial anastomosis (42%) and lowest in the presence of an arterio-arterial anastomosis (15%). But if mortality occurred, pregnancies with double mortality usually had an arterio-arterial anastomosis. If pregnancies were complicated by one death, a veno-venous anastomosis was more likely to be present. The above mentioned arguments provide evidence that the arterio-arterial anastomosis represents a functional collateral artery which outgrowth is driven by an increased shear-stress caused by an increased flow to a lower pressure vascular bed in the placenta of the recipient. The lower arterial pressure occurs from the moment that a chorionic artery which is connected to the anastomosis develops a significant stenosis. The resulting collateral flow through the anastomosis maintains blood supply to the lower pressure placental bed, the beneficial function of collaterals, but also results in an increasing net inter-twin transfusion which triggers the onset of severe TTTS [3]. The same phenomena was observed in our study.

**Key words:** twin pregnancy, monochorionic, anastomosis, twin-to-twin transfusion syndrome, arterio-arterial

**Introduction**

The twin-to-twin transfusion syndrome (TTTS) is a severe complication of monochorionic (MA) twin pregnancies, caused by a net inter-twin transfusion of blood from one fetus (the donor) towards the other fetus (the recipient) through placental anastomoses. Arterio-arterial (AA), veno-venous (VV) and arterio-venous (AV) anastomoses are detected in 98%, 43% and 91% of MA placentas, respectively [1]. TTTS is most often driven by unidirectional arterio-venous anastomoses, and mitigated by bidirectional arterio-arterial or veno-venous anastomoses which reduce the net inter-twin transfusion. Although AA net flows are modest, chronic unbalanced counterflow of this magnitude in the absence of compensatory superficial anastomoses can lead to significant haemodynamic compromise [6]. As a result, many studies revealed that the incidence of twin-twin transfusion syndrome was higher in the group with no AAA detected in vivo compared to the group with AAA found with Doppler (28.5 vs. 16.6%), but the difference was not statistically significant (p = 0.5) [4]. It is a well known fact that antenatal detection of artery-to-artery anastomosis predicts higher perinatal and double survival in twin-twin transfusion syndrome, independently of disease stage [7].

In contrast to these accepted concepts, cases have been described paradoxically devoid of arterio-venous anastomoses but including arterio-arterial anastomoses [3]. In this case we also suggest that TTTS may develop as a consequence of the arterio-arterial anastomosis with a bidirectional blood flow.

**Case presentation**

The patient was admitted to the hospital in the 29th week of the first pregnancy. The diagnosis of the twin-to-twin transfusion syndrome was established in the 26th week of the gestation during control scanning. The second twin, breech, was already found to be compromised, with absent end diastolic flow (AEDF) in the umbilical artery (periodically reversed end diastolic flow – REDF). The first twin was weighting 1136 g while the second twin was weighting 820 g. On admission the RBC was 3,61 T/l, Hb 6,58, WBC 7,23 G/l, PLT 195 G/l, US scan confirmed that the second twin was compromised – FHR 180/min, temporarily absent end diastolic flow in umbilical artery. The first twin was weighting 1320 g, while the second 1070 g. The cervix was short with the external os closed. The CTG traces within the following week were normal. The control scan on the 20th of August (29th + 5 week) showed nearly no progress in fetuses’ weights. Both fetuses in cephalic presentation, females, the second twin being hypotrophic – the discordance between fetuses was 22%. In doppler velocimetry in the second twin there was increased resistance in umbilical artery (UA), temporarily absent end diastolic flow, single pulsation in umbilical vein (UV), decreased resistance...
in middle cerebral artery (MCA) (signs of centralization of the circulation – brain sparing effect), ductus venosus (DV) – normal blood flow. In the placenta there was one huge arterio-arterial anastomosis with bilateral blood flow, resulting in hemodynamic disturbances.

The control scan done five days later (30+3 gestational week) showed moderate growth of the fetuses, with the first fetus weighting 1670 g, and the second 1120 g. The second twin was showing brain sparing effect in MCA, increased resistance in umbilical artery. FHR of the first twin was 150/min, the second twin’s FHR was 180/min. In next control scan done on the 1st of September (31+3 g.w.) the first twin was 1910 g, while the second – 1330 g. The second twin was compromised – increased resistance in UA with temporary absent end diastolic flow (AEDF), decreased resistance in MCA. The second twin turned into breech position. CTG traces was within the normal range.

On the 8th of September (32+3 g.w.) contractions appeared in the CTG traces thus the tocolysis was introduced. Treatment included fenoterol 8 times 1/2 tablet orally, and werapamil 1 tablet b.i.d. The contractions vanished in subsequent days. The examination on the same day revealed the cervix to be shortened, directed towards the sacral bone, with nearly no dilation. The vaginal culture was taken – III degree. The scan performed on the same day showed the discordance between fetuses reaching 35% (1973 g versus 1291 g). Fetal weight of the twin B was below the range. Doppler velocimetry showed the same phenomena in the twin B as before: brain sparing effect in MCA and temporary AEDF in UA. No other signs of
fetal distress was noted. Five days later another Doppler scan was performed confirming previous findings, with nearly constant AEDF in UA in twin B. On the 17th of September (33+5 g.w.) the complete US scan was done showing the discordance between the fetuses reaching 44% (2337 g versus 1304 g, twin B far below normal range, with nearly no progress in weight) with normal Doppler velocimetry in twin A and brain sparing in MCA, AEDF (temporary REDF) in UA in twin B. The placenta of twin B was IIIrd degree according to the rannum’s scale. Other measurements were normal. Intensive fetal monitoring was recommended (CTG 4 times a day) and doppler scan control in 2 days. Ctg traces of both fetuses were normal. The control scan performed five days later (34+3 g.w.) revealed no other findings as already stated. With signs of fetal distress in US, and lack of fetal growth of the twin B the decision of the caesarean section was made.

The patient delivered by a cesarean section in the 34th week plus 5 day. The indication to the caesarean section were the signs of the fetal distress (TTTS). The first baby girl was delivered weighing 1880 g, Ap 4,6,8, pH 7,25, BE (-4,5), pH 7,24, BE (-4,9). The second baby girl was delivered weighing 1270 g, Ap 6, 8, pH 7,16, BE(-8,8), pH 7,25, BE (-5,0). The first twin presented green amniotic fluid, the second’s fluid was clear. The second twin was send to NICU (neonatal intensive care unit). The prognosis of the second twin was uncertain. The first twin was released after couple of weeks’ observation and treatment from Neonatology Department, while treatment of the second twin took longer period of time. After surfactant, NO and respirator treatment the second twin was transferred from NICU to Neonatology Ward, where after total 9 weeks of treatment and observation was released home.

Discussion

Unidirectional arterio-venous (AV) anastomoses often result in twin-twin transfusion syndrome (TTTS). Additional, oppositely directed anastomoses may compensate for the circulatory imbalance and either prevent, delay the onset, or moderate the severity of TTTS. Intuitively, higher pressure gradient, oppositely-directed AV anastomoses (indicated as VA) would be expected to compensate better for TTTS than lower pressure gradient arterio-arterial (AA) anastomoses. However, clinical evidence suggests AA anastomoses compensate more efficaciously, because virtually all non-TTTS monochorionic twin placentas have AAs (84 per cent), contrary to TTTS placentas, where only 30 per cent have an AA. In one of the studies researchers sought to explain this observation by comparing the capabilities of various size VA and AA anastomoses to compensate for the effects of the primary AV. As study design they used a previously developed mathematical computer model of TTTS to determine ranges of anastomotic vascular resistances which cause varying fetal and amniotic fluid discordances. The results were as follows. An AA anastomosis of equal size as the feeding artery of an AV or VA had a significantly smaller resistance. The primary AV anastomosis might have been compensated by both VA as well as AA anastomoses. However, VA transfusion adequately compensated AV flow only for a small range of VA to AV vascular radius ratios. In contrast, AA transfusion compensated the AV flow for a much wider range of AA to AV vascular radius ratios. In conclusion, the wider range of AA than VA radii for adequate compensation of the AV explained the finding that an AA protected more frequently than a VA of similar size against the manifestations of TTTS [9].

But the other available data are controversial. Some researchers suggest that perinatal mortality in MA twins is not related to placental vascular anatomy. According to them the almost ubiquitous presence of compensating AA-anastomoses in MA placentas appears to prevent occurrence of TTTS [1]. In other study the angioarchitecture of 395 monochorionic twin placentas was studied. Mortality was highest in the absence of an arterio-arterial anastomosis (42%) and lowest in the presence of an arterio-arterial anastomosis (15%). But if mortality occurred, pregnancies with double mortality usually had an arterio-arterial anastomosis. If pregnancies were complicated by one death, a veno-venous anastomosis was more likely to be present. In conclusion of this study, monochorionic twin pregnancies are a high risk pregnancy with a high chance of both mortality and morbidity; placental characteristics were a major contributor to adverse outcome in these pregnancies [2].

Many in vivo, ex vivo and modelling studies suggest that arterio-arterial anastomoses (AAAs) protect against haemodynamic imbalance in monochorionic twins and thus the development of TTTS. There is a report of acute onset of severe TTTS at 34 weeks’ gestation in a patient with an antenatally visualized AAA which was shown at injection studies to have been obliterated, presumably by thrombosis. Computer modelling with the relevant clinical data confirmed that occlusion of the AAA alone was sufficient to reproduce the clinical manifestations. A study of the vascular configuration of AAA in the fixed placenta suggested that its small diameter and turbulent flow may have contributed to its occlusion. This case report showed that the unmasking of unbalanced AVA configurations by occlusion of a protective AAA can manifest as TTTS [8].

There is also another interesting phenomenon concerning severe onset of the TTTS. As one of the studies describes, the reciprocating flow is not unique to AAAs. It also occurs in the chorionic arteries of any cotyledon deprived of its venous outflow, in a similar manner to that in which reverse end-diastolic flow occurs in umbilical arteries when whole placental resistance is high. If venous return from the common chorionic vein in the recipient (draining the venous end of an AVA) is blocked as might happen after laser or embolism, there can be bidirectional flow from one umbilical artery insertion, through two cotyledons to the other insertion. We define this phenomenon as a pseudo-AAA (PAAA). The inclusion of two cotyledons in this path means that its resistance cannot match the low flow resistance of a true AAA, and transmission of the contralateral pulsatile pattern is absorbed in the cotyledons.
Thus, PAAA Doppler patterns differ from true AAA patterns in that two sets of systolic peaks, one forward and one reverse, can be discerned in true AAAs but only one in PAAAs. Therefore, visual observation of reciprocating flow (as observed in fetoscopy) is not sufficient to define a vessel as a true AAA which instead requires ultrasonical identification of two systolic patterns [5].

As a conclusion, the above mentioned arguments provide evidence that the arterio-arterial anastomosis represents a functional collateral artery whose outgrowth is driven by an increased shear-stress caused by an increased flow to a lower pressure vascular bed in the placenta of the recipient. The lower arterial pressure occurs from the moment that a chorionic artery which is connected to the anastomosis develops a significant stenosis. The resulting collateral flow through the anastomosis maintains blood supply to the lower pressure placental bed, the beneficial function of collaterals, but also results in an increasing net inter-twin transfusion which triggers the onset of severe TTTS [3]. The same phenomena was observed in our study. The bidirectional blood flow, as shown in picture 5, was the consequence of the changes mentioned above. It resulted in onset of the TTTS that forced us to deliver the babies prematurely, with all complications that assist such condition, but thanks to close fetal surveillance the postnatal development of both babies seems to be as undisturbed as was possible to achieve.

Bibliography


Michał Szuber
Department of Perinatology and Gynecology
Medical University in Poznań
Polna 33, 60-535 Poznań, Poland
e-mail: chejron74@wp.pl