

## **D-Transposition of the great arteries with restrictive foramen ovale in the fetus**

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### **Objective**

Restrictive foramen ovale (FO) in dextro-transposition of the great arteries (d-TGA) with intact ventricular septum may lead to severe life-threatening hypoxia within the first hours of life, making urgent balloon atrial septostomy (BAS) inevitable. Reliable prenatal prediction of restrictive FO is crucial in these cases. However, current prenatal echocardiographic markers show low predictive value and prenatal prediction often fails with fatal consequences for a subset of newborns. In this study we described our experience and aimed to identify reliable predictive markers for BAS.

### **Methods**

We included 45 fetuses with isolated d-TGA that were diagnosed and delivered between 2010 and 2022 in two large German tertiary referral centers. Inclusion criteria were the availability of former prenatal ultrasound reports, of stored echocardiographic videos and still images, that had to be obtained within the last 14 days prior to delivery and that were of sufficient quality for retrospective re-analysis. Cardiac parameters were retrospectively assessed and their predictive value was evaluated.

### **Results**

Among the 45 included fetuses with d-TGA, 22 neonates had restricted FO postnatally and required urgent BAS within the first 24 hours of life. In contrast, 23 neonates had normal FO anatomy, but 4 of them unexpectedly showed inadequate interatrial mixing despite their normal FO anatomy, rapidly developed hypoxia and also required urgent BAS ('bad mixer'). Overall, 26 (58%) neonates required urgent BAS, whereas 19 (42%) achieved good O<sub>2</sub> -saturation and did not undergo urgent BAS. In the former prenatal ultrasound reports, restrictive FO with subsequent urgent BAS was correctly predicted in 11 of 22 cases (50% sensitivity) whereas a normal FO anatomy was correctly predicted in 19 of 23 cases (83% specificity). After current re-analysis of the stored videos and images, we identified three highly significant markers for restrictive FO: a FO diameter <7mm ( $p < 0.01$ ), a fixed ( $p = 0.035$ ) and a hypermobile ( $p = 0.014$ ) FO flap. The maximum systolic flow velocities in the pulmonary veins were also significantly increased in restrictive FO ( $p = 0.021$ ), but no cut-off value to reliably predict restrictive FO could be identified. If the above markers are applied, all 22 cases with restrictive FO and all 23 cases with normal FO anatomy could correctly be predicted (100% positive predictive value). Correct prediction of urgent BAS also succeeded in all 22 cases with restrictive FO (100% PPV), but naturally failed in 4 of the 23 cases with correctly predicted normal FO ('bad mixer') (82.6% negative predictive value).

### **Conclusion**

Precise assessment of FO size and FO flap motility allows a reliable prenatal prediction of both restrictive and normal FO anatomy postnatally. Prediction of likelihood of urgent BAS also succeeds reliably in all fetuses with restrictive FO, but identification of the small subset of fetuses that also requires urgent BAS despite their normal FO anatomy fails, because the ability of sufficient postnatal interatrial mixing cannot be predicted prenatally. Therefore, all fetuses with prenatally diagnosed d-TGA should always be delivered in a tertiary center with cardiac catheter stand-by, allowing BAS within the first 24 hours after birth, regardless of their predicted FO anatomy.