

Tetralogy of Fallot: the use of three-dimensional (3D) ultrasound imaging and 3D model printing in the early prenatal diagnosis

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Introduction

Congenital heart defects (CHD) are common fetal malformations and remain a major cause of perinatal morbidity and mortality. Although detailed fetal cardiac assessment is usually performed during the 2nd trimester anomaly scan, advances in prenatal ultrasound technology have enabled accurate evaluation of cardiac anatomy during 1st trimester screening. Modern imaging techniques, including three-dimensional (3D) reconstruction and spatiotemporal image correlation (STIC), provide improved visualization of fetal cardiac structures and are particularly valuable in congenital heart defects with abnormal spatial relationships of great vessels.

Case Report

We report a case of a 29-year-old primigravida who conceived via in vitro fertilization following frozen embryo transfer. Patient had no significant medical history and no family history of CHD. 1st trimester screening showed normal fetal growth and low risk for common chromosomal abnormalities; however, detailed cardiac evaluation raised suspicion of abnormal anatomy.

Follow-up ultrasound demonstrated abnormal cardiac axis (~60°), dextroposition of aorta, ventricular septal defect, and narrowing of pulmonary trunk with preserved antegrade flow to pulmonary arteries, suggesting tetralogy of Fallot. Advanced imaging techniques, including 3D reconstruction and STIC, enabled detailed spatial visualization of the cardiac outflow tracts and supported the diagnostic process. Fetal echocardiography subsequently confirmed tetralogy of Fallot. Serial prenatal imaging was performed throughout pregnancy. To further enhance the diagnostic process, a 3D model of the fetal heart was printed based on ultrasound datasets.

Conclusion

This physical model accurately represented the spatial relationship between the "overriding" aorta and the pulmonary stenosis, which are characteristic features of TOF. First-trimester cardiac assessment using 3D ultrasound and printed models improves understanding, diagnosis, and timely referral for specialized care.

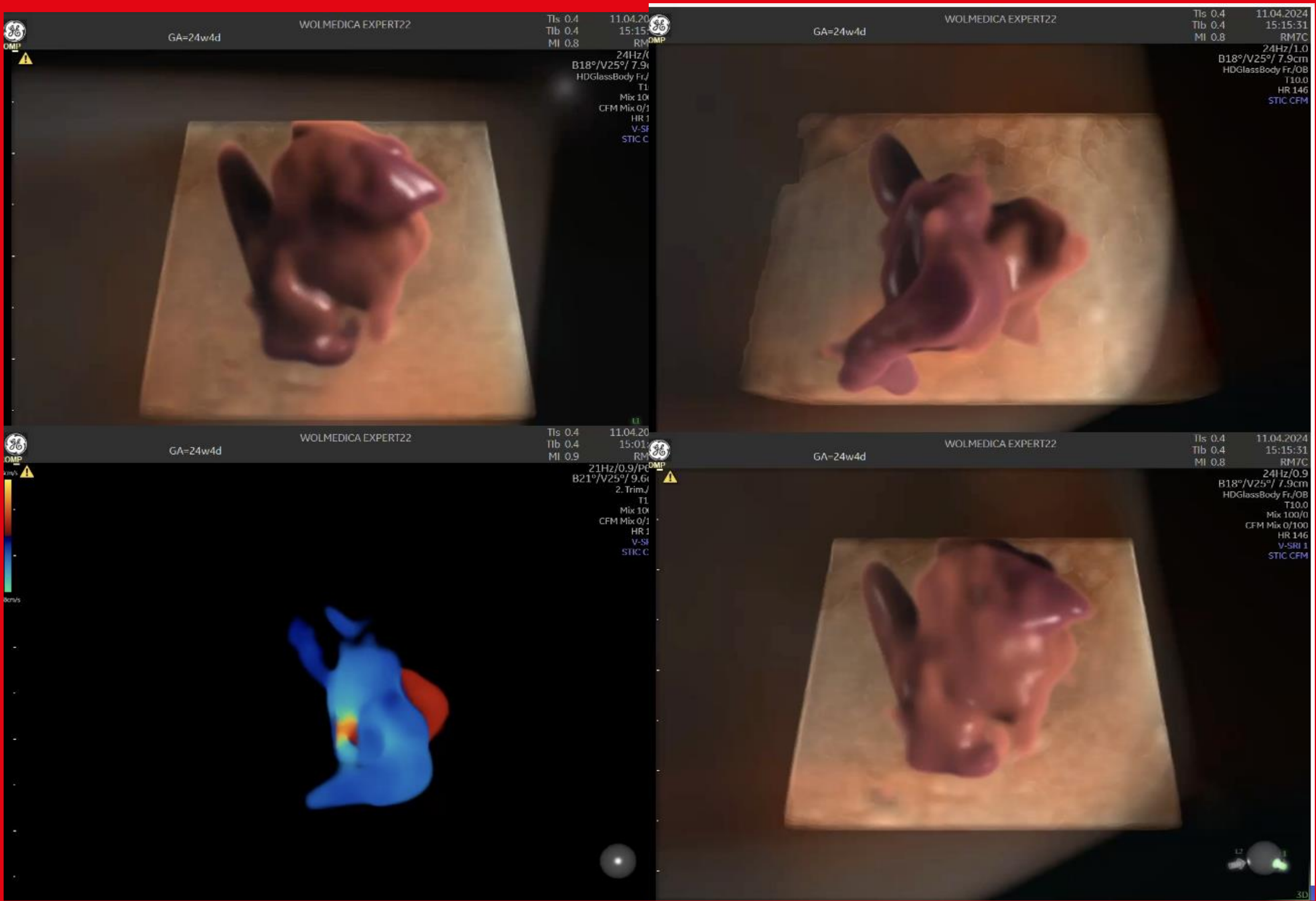


Figure 1. STIC examination

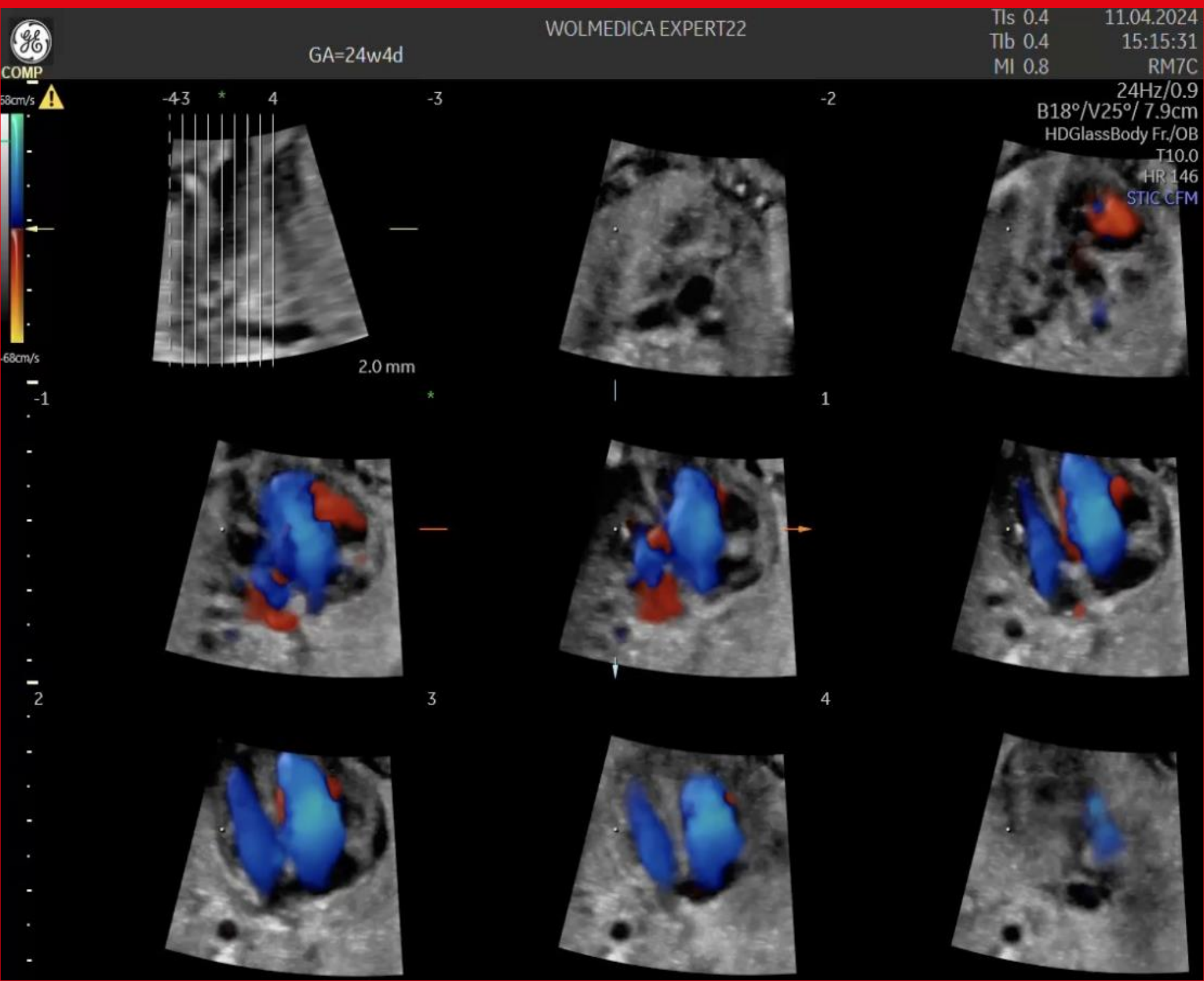


Figure 2. Tomographic Ultrasound Imaging



Figure 3. 3D model