Ultrasound in Med. & Biol., Vol. 38, No. 9, pp. 1502–1507, 2012

0301-5629/$ - see front matter

ELSEVIER

doi:10.1016/j.ultrasmedbio.2012.05.009

● *Original Contribution*

ASSESSMENT OF RIGHT VENTRICULAR FUNCTION IN RECIPIENT TWIN OF TWIN TO TWIN TRANSFUSION SYNDROME WITH SPECKLE TRACKING ECHOCARDIOGRAPHY

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(*Received* 19 *December* 2011; *revised* 2 *May* 2012; *in final form* 11 *May* 2012)

Abstract—This study was undertaken to evaluate the right ventricular myocardial systolic function and its relation to the fetal volume and pressure overload in recipient twin of twin to twin transfusion syndrome with speckle tracking echocardiography. Longitudinal peak systolic strains of the right ventricle were measured by speckle tracking echocardiography in 17 patients with twin-to-twin transfusion syndrome (TTTS) and 19 normal monochorionic diamniotic pregnancies. The right ventricular free wall thickness in recipient twin (0.43 ± 0.14 cm) was significantly larger than that in the donor (0.21 ± 0.04 cm, $p < 0.05$) and the control group (0.18 ± 0.03 cm, $p < 0.05$ for larger twin and 0.17 ± 0.02 cm, $p < 0.05$ for smaller twin). Although there were no significant differences in the right ventricular fractional shortening and cavity area percent change among control and the TTTS groups, the absolute value of peak systolic strains of ventricular septum, right ventricular free wall and global right ventricle in recipients were all significantly lower than those of the donors and the control group. Besides, the global right ventricular peak systolic strain correlated well with gestational age adjusted right ventricular free wall thickness ($r = 0.65$, $p = 0.04$) but not with gestational age adjusted right ventricular end-diastolic dimension ($r = 0.38$, $p = 0.28$) and cavity area percent change ($r = 0.33$, $p = 0.35$). Right ventricular systolic dysfunction measured with decreased right ventricular peak systolic longitudinal strain exists despite the absence of diminished fractional shortening and cavity area percent change and this reduced systolic function correlates with the right ventricular pressure overload as shown by increased right ventricular free wall thickness. (E-mail: ybdeng2007@hotmail.com) © **2012 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Cardiac function, Speckle tracking echocardiography, Two-dimensional strain, Monochorionic twins, Twin to twin transfusion syndrome.**

INTRODUCTION

Twin-to-twin transfusion syndrome (TTTS) is a gestational condition restricted to monochorionic twin pregnancies (Cincotta and Fisk 1997). Many studies have shown that the cardiac function decreased and right ventricular function seemed to be affected much more commonly than left ventricular function in recipient twin (Barrea et al. 2005; Michelfelder et al. 2007; Raboisson et al. 2004; Rychik et al. 2007). It was indicated that in TTTS, the fetal cardiac function decreased because of chronic volume overload as a consequence of the net transfer of blood from the donor twin to the recipient through placental vascular anastomoses and/or subsequent pressure overload as a consequence of elevated concentration of endothelin in the recipient and upregulation of the rennin-angiotension system in the donor twin (Bajoria et al. 1995; Bajoria et al. 1999; Mahieu-Caputo et al. 2000). Although the myocardial diastolic function has been demonstrated to be impaired by measuring the isovolume relaxation time and myocardial performance index with pulsed Doppler flow recording in recipient twin, the systolic function evaluated with fractional shortening is preserved in all or diminished only in a small number of recipient twin (Barrea et al. 2005; Raboisson et al. 2004). In addition, it is not known whether fetal cardiac function in TTTS is related to the volume or pressure overload.

Speckle tracking echocardiography is a novel technique for analyzing myocardial motion (Amundsen et al. 2006). The method uses B-mode images for speckle tracking analysis and allows calculation of myocardial

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displacement and strain (Deng et al. 2010). Regional myocardial strain measured by speckle tracking echocardiography has been demonstrated to be a sensitive parameter for the evaluation of regional myocardial systolic function in patients with preserved global left ventricular systolic function, including those with diastolic heart failure, hypertension and coronary heart disease without visual regional wall motion abnormality (Deng et al. 2010; Liang et al. 2006; Yip et al. 2002; Wang et al. 2008). Recent studies have shown that speckle tracking echocardiography is feasible in assessing fetal cardiac function in fetuses with and without heart disease (Mieghem et al. 2010; Younoszai et al. 2008). Therefore, the present study was undertaken to evaluate the right ventricular myocardial systolic function and its relation to the fetal volume and pressure overload in recipient twin of twin to twin transfusion syndrome with speckle tracking echocardiography.

MATERIALS AND METHODS

Study population

Study population consisted of 17 patients with TTTS. TTTS was diagnosed as the presence of oligohydramnios in the donor twin with a deepest vertical amniotic fluid pocket <2 cm and polyhydramnios in the recipient twin with a deepest amniotic fluid >8 cm prior to 20 weeks and >10 cm after 20 weeks in a monochorionic twin pregnancy (Senat et al. 2004). Patients were staged based on Quintero's staging system (Quintero et al. 1999). Nineteen subjects with normal monochorionic diamniotic pregnancies were recruited as the control group at a gestational age between 16.5 and 26.6 weeks. Monochorionicity was identified by the presence of "T" sign between 10 and 14 weeks, or twins of the same sex with a single placenta. Pathologic examination of the placenta after birth confirmed chorionicity in all cases. Those fetuses with pathologies that could lead to abnormal cardiac function (intrauterine growth restriction, gestational diabetes, fetal arrhythmia, fetal malformations and chromosomal defects) were excluded from this study. The study was approved by the local ethics committee and informed consent was obtained from all of the mothers.

Fetal echocardiographic and speckle tracking recording and analysis

Fetal echocardiography was performed according to the recommendations of the International Society of Ultrasound in Obstetrics & Gynecology (ISUOG 2006) with a 6C2 probe on Siemens Acuson Sequoia 512 (Siemens Medical Solutions, Mountain View, CA, USA). The following parameters were measured in all fetuses according to methods described previously: cardiothoracic ratio (Paladini et al. 1990), peak systolic velocity of middle cerebral artery (Mari and Deter 1992), pulsatility indexes of umbilical artery (Sonesson et al. 1993), middle cerebral artery and ductus venousus, end-diastolic and end-systolic dimensions of right ventricle and end-diastolic thickness of right ventricular free wall (Schiller et al. 1989). End-diastolic and end-systolic right ventricular cavity areas were measured on four-chamber view by tracing the endocardium manually. The right ventricular fractional shortening was calculated by dividing the difference of the right ventricular end-diastolic and end-systolic dimensions with the end-diastolic dimension. Similarly, right ventricular cavity area percent change was calculated by dividing the difference of the right ventricular end-diastolic and end-systolic cavity areas with the end-diastolic cavity area. Right ventricular myocardial performance index was also measured on pulsed Doppler velocity waveforms as described before (Raboisson et al. 2004). The right ventricular dimension and cavity area and thickness of right ventricular free wall at end-diastole were adjusted with the gestational age. Fetal weight and gestational age were determined by the earliest second-trimester ultrasound measurements of head and abdominal circumferences and femur length (Hadlock et al. 1984). The fetal weight discordance was calculated by dividing the difference of the weight between larger and smaller twin with fetal weight of larger twin.

Syngo VVI software (Siemens Medical Solutions) was used for speckle tracking analysis. First, a digital clip of zoomed fetal four-chamber view was recorded and then transferred to the offline workstation. Second, the beginning and end of a cardiac cycle was defined with M-mode tracing of ventricular wall or atrioventricular valve motion. Third, the endocardium of the right ventricle was traced manually from a single end-systolic frame with clear endocardial border. After the tracking quality was verified for each segment (with subsequent manual adjustment of the region-of-interest if necessary), myocardial motion was analyzed by speckle-tracking within the region-of-interest bound by endocardial and epicardial borders. Myocardial longitudinal strain profile was obtained and peak systolic strain value was measured (Fig. 1). Peak systolic longitudinal strain of the ventricular septum and right ventricular free wall were calculated by averaging the segmental strain values (Fig. 1).

Interobserver and intraobserver reproducibility

To assess the reproducibility of the strain measurements, peak systolic longitudinal strain in five recipient twins and five control twins were measured by two independent observers on the same day and by one observer twice, 1 week apart. The interobserver and intraobserver variability is calculated as a percentage of the absolute difference between the two measurements divided by the mean value of the measurements.