2D Speckle Tracking Echocardiography in fetuses with critical aortic stenosis before and after intrauterine aortic valvuloplasty

Justus G. Reitz, Johanna M. Meier, Christoph Berg, Ivonne Bedei, Viktoria A. Kuhn, Roland Axt-Fliedner

Introduction

Critical aortic stenosis (CAS) in fetuses often progresses to hypoplastic left heart syndrome (HLHS) with postnatal uni-ventricular palliation. Therefore, fetal aortic valvuloplasty (FAV) is performed to improve left ventricular (LV) function and prevent LV remodeling and hypoplasia in order to achieve postnatal biventricular (BV) circulation. However, the impact of FAV on myocardial function is difficult to measure with conventional echocardiographic parameters. It is still challenging to predict which fetuses benefit from FAV and have postnatal BV circulation whereas others continue to progress to HLHS.

Therefore, the aim of this study was to analyze the impact of FAV in fetuses with critical AS on global longitudinal peak systolic strain (GLPSS) of the LV using two-dimensional Speckle Tracking Echocardiography (2D STE). Secondary, the predictive value of STE parameters on postnatal outcome was assessed.

Methods

In this retrospective study fetuses with critical AS underwent FAV between 2011 and 2020 in University Hospital Bonn and had pre- and postinterventional ultrasound four-chamber views (4CV) stored. Global Longitudinal Peak Systolic Strain (GLPSS) of the LV and right ventricle (RV) were retrospectively analyzed.

Results

23 fetuses with critical AS were included. The mean gestational age at FAV was 26 weeks. Median time between pre-interventional 4CV loop and intervention was 3 days, median time between intervention and post-interventional 4CV loop was 5 days.

Fetuses after intervention demonstrated significantly better LV-GLPSS mean values post- vs. pre-intervention (-5.36% vs. -1.57%; $p<0.001$). There was no change in RV function.

20 fetuses were born alive. Postnatal, 10 had biventricular circulation and 10 underwent single ventricular palliation. Of those 10 children with postnatal biventricular circulation, 9 had better LV-GLPSS values after intervention than before intervention (difference strain values >3%) whereas of the 10 children with postnatal single ventricular palliation, only one had post-intervention >3% better strain values and 9 had not. Improved post-interventional LV-GLPSS strain values were correlated with biventricular outcome ($p<0.05$).

Furthermore, both pre- and post-interventional LV- and RV-GLPSS were correlated with postnatal outcome ($p<0.05$). Of the conventional fetal echocardiographic parameters only ACI PI correlated with postnatal outcome. There was a trend in LV length and TV/MV ratio to correlate with postnatal outcome but it was not significant.

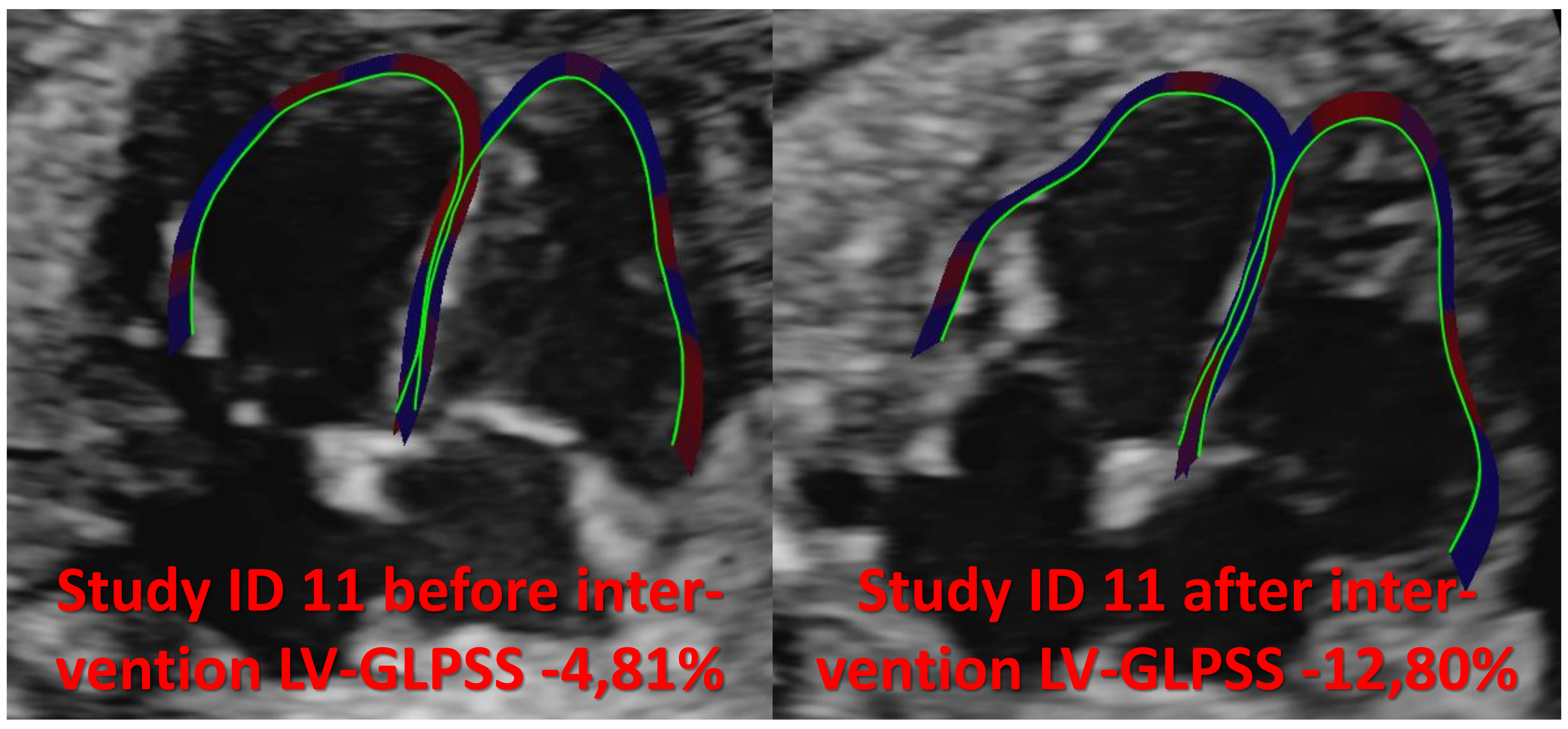
Conclusion

FAV in fetuses with critical AS seeks to improve fetal LV function in order to prevent progression from aortic stenosis (AS) to hypoplastic left heart syndrome (HLHS) and postnatal single ventricular palliation.

This study shows that LV myocardial function analyzed by 2D STE is significantly better after intervention. In addition, improved post-interventional strain values were correlated with biventricular postnatal outcome.

Furthermore, pre-interventional STE parameters might be an additional predictor for postnatal outcome of FAV.

Further studies are needed to investigate the reliability of STE parameters as a predictor for postnatal outcome after FAV.



Variable	all	born alive	SV	BV
cohort n=	23	20	10	10
maternal age in years (mean)	31	31	31	31
LV-length pre-intervention in mm (mean)	19.5	20	22	18.16
LV-length pre-intervention z-score (mean)	0.87	1	1.79	0.22
RV-length pre-intervention in mm (mean)	17.6	18.25	20.23	16.26
RV/LV ratio pre-intervention (mean)	0.93	0.94	0.99	0.89
MV-diameter pre-intervention in mm (mean)	5.33	5.48	5.86	5.13
MV-diameter pre-intervention z-score (mean)	-1.55	-1.46	-1.05	-1.83
AV-diameter pre-intervention in mm (mean)	2.56	2.58	2.7	2.49
AV-diameter pre-intervention z-score (mean)	-3.49	-3.54	-3.38	-3.67
TV-diameter pre-intervention in mm (mean)	8.2	8.4	9.54	7.27
TV/MV ratio pre intervention (mean)	1.6	1.62	1.88	1.36
aortic root pre-intervention in mm (mean)	3.65	3.64	3.4	3.87
ACM PI in m/s (mean)	1.68	1.67	1.82	1.54
aortic valve v max in m/s (mean)	2.63	2.61	2.59	2.63
mitral valve v max in m/s (mean)	3.52	3.57	3.38	3.74
foramen ovale restrictiv n=	9	8	5	3
gestational age first intervention	26	26	26	26
more than one intervention	8	6	3	2
gestational age second intervention	27	28	29	27
RV-GLPSS pre-intervention in % (mean)	-10.4	-10.1	-7.5	-12.7
RV-GLPSS post-intervention in % (mean)	-11	-10.5	-8.7	-12.7
LV-GLPSS pre-intervention in % (mean)	-1.57	-1.86	-1.17	-2.6
LV-GLPSS post-intervention in % (mean)	-5.36	-5.76	-2.8	-8.7
difference LV-GLPSS pre- to postintervention in % (mean)	-3.79	-3.9	-1.69	-6.11
difference LV-GLPSS pre- to postintervention >3% n=	12	10	1	9
death prenatal n=	3	n/a	n/a	n/a
gestational age at birth in weeks (mean)		35	37	36
birth mode spontaneus vaginal/sectio cesaria		7 vs 13	4 vs. 6	3 vs. 7
weight at birth in kg (mean)		2.96	2.99	2.94
head circumference at birth in cm (mean)		32.8	32.55	33.05
APGAR 1 min/5 min/10 min (mean)		9/9/9.5	9/9/9.5	9/9/9.5
pH from umbilical cord blood (median)		7.26	7.26	7.27
death postnatal n=		6	3	3

Values marked red correlated significant with bi- vs. univentricular postnatal outcome. Comparison of continuous variables between the two sub-groups (BV vs SV) was performed using the exact Mann-Whitney-U Test and for comparison of dichotomous categorical variables Fisher's exact test was used. Bland-Altmann-Plots showed good interrater reliability.

MV, Mitral Valve; AV, Aortic Valve; TV, Tricuspid Valve; ACM PI, Arteria cerebri media pulsatily index

Prof. Dr. R. Axt-Fliedner
Division of Prenatal Diagnosis & Therapy,
Department of Obstetrics and Gynecology,
Justus-Liebig-University
Giessen, Germany

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

https://www.ukgm.de/ugm_2/deu/ugi_gyn/15451.html
Phone: +49 0641/985-45101
Fax: +49 0641/985-45279