Application of Knowledge-Based Reconstruction to Three Dimensional Echocardiography and Comparison with Semiautomatic Border Detection Method for Evaluating Ventricular Function in Tetralogy of Fallot

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Background

- The Knowledge-Based Reconstruction (KBR) technology has conventionally used 2D echocardiograms and positional data for processing into 3D representations and surface rendering for functional assessment
- KBR utilizes anatomic cardiac landmarks and databases without border tracing
- Our goals were (1) to investigate a new KBR system and algorithm (VMS+, Ventripoint) in conjunction with 3DE, and (2) compare results of ventricular function between VMS+ and semiautomatic 3DE contour detection methods: 4DLV 3.0 and 4DRV 2.0 (TomTec)

Methods

- 3DE was prospectively performed in 50 subjects including 25 repaired tetralogy of Fallot (TOF) and 25 age and body surface area (BSA) matched controls (iE33, Philips)
- Full-volume acquisitions of left and right ventricles (LV, RV) were made from focused apical views
- After importing raw cartesian 3DE datasets, borders and specific anatomical structures of LV and RV were defined by placing points on standard VMS 2D scan planes
- The anatomical landmarks included LV apex, endocardium, interventricular septum (IVS), mitral and aortic annulus (LV); RV apex, free wall, basal bulge, IVS, tricuspid and pulmonic annulus and conal septum (RV). Using VMS+, an initial abstract model of 3D shape was generated, refined by blending and scaling to best fit, and 3D volume derived by processing through VMS-CMR libraries (Figure)
- The resultant 3D model was used to calculate end-diastolic, end-systolic, stroke volume (EDV, ESV, SV), and ejection fraction (EF). Comparisons were made to TomTec measurements

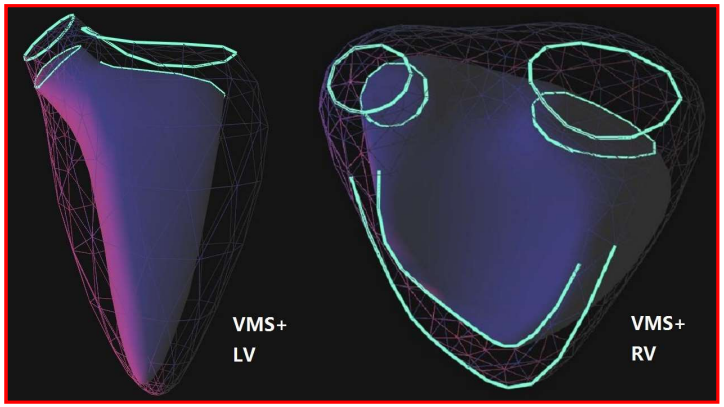

Figure: 3DE derived VMS+ KBR reconstructed LV model in TOF (left); 3DE derived VMS+ KBR reconstructed RV model in TOF (right)

Results

- For TOF, age was 15.8±10 yrs, BSA was 1.4±0.5 m2, and for normals, age was 15.1±9 yrs, and BSA 1.4±0.5 m2
- LV and RV volumes, function and analysis times by both methods are shown (Table)
- LV volumes showed excellent agreement between VMS+ and TomTec, while agreement was lower for RV volumes

		TOF group (n=25)				Normal (n=25)			
		VMS+	TomTec	r value	p value	VMS+	TomTec	r value	p value
LV	EDV (ml)	100±46	97±47	0.90	<0.001	87±36	84±36	0.91	<0.001
	ESV (ml)	44±20	41±22	0.91	<0.001	39±16	36±15	0.91	<0.001
	SV (ml)	56±25	54±26	0.92	<0.001	48±20	46±21	0.92	<0.001
	EF (%)	55±3	54±4	0.93	<0.001	57±2	56±3	0.93	<0.001
RV	EDV (ml)	133±53	123±54	0.8	<0.001	110±43	102±41	0.82	<0.001
	ESV (ml)	72±31	66±31	0.83	<0.001	43±19	39±18	0.83	<0.001
	SV (ml)	62±8	58±8	0.88	<0.001	67±25	64±23	0.89	<0.001
	EF (%)	46±8	48±8	0.92	<0.001	60±4	62±5	0.92	<0.001

Conclusions

- This study demonstrates feasibility of quantifying biventricular volumes and function using VMS+ on native 3DE datasets in normal and repaired TOF hearts
- Analyses times with VMS+ were closer with semiautomatic border detection for the LV, however for the RV, VMS+ analysis times were longer
- RV volumes by VMS+ were greater than those by semiautomatic border detection, likely due to better outflow tract inclusion with VMS+

Authors have nothing to disclose