

# Early echocardiographic findings

## for cardiac chambers remodeling after congenital cardiac defects intervention

*Hallazgos ecocardiográficos tempranos para la remodelación de las cámaras cardíacas después de la intervención de defectos cardíacos congénitos*

 Salwa S. Kareem<sup>1</sup>,  Mohanad K. Shukur Al-Ghanimi<sup>2</sup>,  Talaat Ali AL-Jarrah<sup>3</sup>

<sup>1</sup>Babylon health director. [drsalwaalkafaji@gmail.com](mailto:drsalwaalkafaji@gmail.com).

<sup>2</sup>Assistant prof. Babylon University/Collage of Medicine. [dr.muhammadalghanimi@gmail.com](mailto:dr.muhammadalghanimi@gmail.com)

<sup>3</sup>Pediatric Cardiologist, Nasiriyah Heart. [talaataljarrah@gmail.com](mailto:talaataljarrah@gmail.com).

Received/Recibido: 12/28/2020 Accepted/Aceptado: 01/15/2021 Published/Publicado: 03/10/2021 DOI: <http://doi.org/10.5281/zenodo.4716146>

### Abstract

Echocardiography is one of the most significant features in hospital for patients with inherited cardiac illness to assess defects morphology, assessment of associated abnormalities and exclude additional lesions. We aim to assessment the cardiac function before cardiac catheterization and to detect the possible early change after intervention and to investigate the complications early following intervention. The type of study is a prospective study conducted for a period of four months duration from 1<sup>st</sup> January 2020 to 1<sup>st</sup> May 2020, at Shahid Al- Mihrab cardiac center, at Al-Hilla city and Al-Nasiriya Heart Center at AL-Nasiriya city, Iraq. All patients who undergone transcatheter intervention for congenital heart disease during data collection time were included in this study. Variables such as age, gender, weight and height were recorded. Echocardiography was done for every patient in day before and day after transcatheter intervention; Data was analyzed using SPSS version 23. 39 patients included, For patients with ASD, echocardiography shown improvement of systolic RV function by significant increase in TAPSE (P value =0.001). For VSD patients, echocardiographic study showed a significant increase in TAPSE and EF (P value = 0.050 & 0.0001 respectively). For patients with PDA, echocardiographic study of LA, LV, PAP there were reduction post operation but statistically non-significant. Regarding COA, showed non-significant improvement of LV systolic function evaluated by EF and there were no significant changes in other echocardiographic parameters. In patients with PS, there was significant improvement of RV systolic function by increase in TAPSE (P value=0.004). Regarding AS there was reduction of PG across the AV with improvement of LV systolic function by increment of EF and there was a reduction of PAP. Echocardiography in the peri interventional situation can enable presentation of interference and vital for recurrent follow-up.

**Keywords:** Early Echocardiographic findings, cardiac chambers remodeling, congenital cardiac defects.

### Resumen

La ecocardiografía es una de las características más importantes en el hospital para los pacientes con enfermedades cardíacas hereditarias para evaluar la morfología de los defectos, evaluar las anomalías asociadas y excluir lesiones adicionales. Nuestro objetivo es evaluar la función cardíaca antes del cateterismo cardíaco y detectar el posible cambio temprano después de la intervención e investigar las complicaciones después de la intervención. El tipo de estudio es un estudio prospectivo realizado por un período de cuatro meses de duración desde el 1 de enero de 2020 hasta el 1 de mayo de 2020, en el centro cardíaco Shahid Al-Mihrab, en la ciudad de Al-Hilla y el Centro cardíaco Al-Nasiriya en la ciudad de AL-Nasiriya, Irak. Todos los pacientes que se sometieron a una intervención transcáteter por cardiopatía congénita durante el tiempo de recopilación de datos se incluyeron en este estudio. Se registraron variables como edad, sexo, peso y talla. Se realizó una ecocardiografía a todos los pacientes el día anterior y el día posterior a la intervención transcáteter; Los datos se analizaron utilizando SPSS versión 23. Se incluyeron 39 pacientes. Para los pacientes con TEA, la ecocardiografía mostró una mejora de la función sistólica del VD mediante un aumento significativo de TAPSE (valor de  $p = 0,001$ ). Para los pacientes con CIV, el estudio ecocardiográfico mostró un aumento significativo en TAPSE y FE (valor de  $P = 0,050$  y  $0,0001$  respectivamente). Para los pacientes con CAP, estudio ecocardiográfico de AI, LV, PAP hubo reducción posoperatoria pero estadísticamente no significativa. En cuanto a la COA, mostró una mejoría no significativa de la función sistólica del VI evaluada por FE y no hubo cambios significativos en otros parámetros ecocardiográficos. En los pacientes con EP, hubo una mejora significativa de la función sistólica del VD mediante el aumento de TAPSE (valor de  $p = 0,004$ ). En cuanto a la EA, hubo reducción de PG a través de la AV con mejoría de la función sistólica del VI por incremento de la FE y hubo una reducción de la PAP. La ecocardiografía en la situación peri intervencionista puede permitir la presentación de interferencias y es vital para el seguimiento recurrente.

**Palabras clave:** Hallazgos ecocardiográficos precoces, remodelación de las cámaras cardíacas, defectos cardíacos congénitos.

## Introduction

Congenital heart disease (CHD) makes up nearly one third of all significant congenital anomalies<sup>1</sup>. According to the CDC, the incidence of CHD in the US is about 1% or 10 per 1,000 live births<sup>2</sup>. A systematic review and meta-analysis report showed the incidence in Asia about 9.3/1,000 live birth<sup>3</sup>. Inherited cardiac illness found as wide congenital heart disease represents a broad range of circumstances, from humble faults with a well scenario, to the compound and severe, which need numerous and processes and have undefined long-term consequences<sup>4</sup>. Non compound defect describe as (VSD), atrial septal defect (ASD), pulmonary stenosis (PS), patent ductus arteriosus (PDA), aortic stenosis (AS) and aortic coarctation in older children<sup>5</sup>. Numerous simple procedures of CHD, existence has been supposed to be usual<sup>6</sup>. Subsequently the 1980s, echocardiography has been the non-interference imaging procedure in diagnosis and determined CHD in kids and adults, with main analytic mistakes happening in only 0.2% to 2% infants<sup>7</sup>. Echocardiography has substituted catheterization as the main diagnostic and it is nowadays unusual for newborn infants to experience catheterization for virtuously indicative determinations. There are no similar studies in Iraq that deals with the role of echocardiography in evaluate and follow up the patients with noncomplex congenital heart diseases after trans catheter interventions, so this study was justify that roles.

## Patients and Methods

A prospective study that carried out in Shahid Al- Mihrab cardiac center, Al-Hilla city and Al-Nasirih Heart Center at AL-Nasirih city, Iraq between the 1st January 2020 to 1st May 2020, the period of study was limited due to catheter centers stopped working because of pandemic of COVID -19. All patients who undergone trans catheter intervention for congenital heart disease during data collection time were included in this study after excluded patients with history of severe pulmonary vascular disease, ASD with absent of inferior or superior rim, VSD with no aortic rim, AS with moderate aortic regurgitation. A selected variable like sex and age in years, weight and height to measured body surface area (BSA) were recorded. Preintervention all participant patients undergone full echocardiographic assessment to the required parameters at rest, parasternal long and short axis view and then the apical view imaged were stored for all the patients for offline analysis , these parameters include assessment of left ventricle end diastolic volume (LVDD), ejection fraction(EF) by Teichholz method , left atrium (LA) diameter, right atrium (RA) and right ventricle (RV) diameters with TAPSE, , inter-ventricular septal thickness (IVST) & posterior wall thickness (PWT) , in addition to aortic size parameters , pulmonary size parameters with pulmonary artery pressure, Function of diastole of LV was determined by using pulse wave (PW) and TDI.

Pulse wave Doppler included the following:

- E-wave velocity.
- A- wave velocity.

E/A ratio. while the tissue Doppler imaging included:

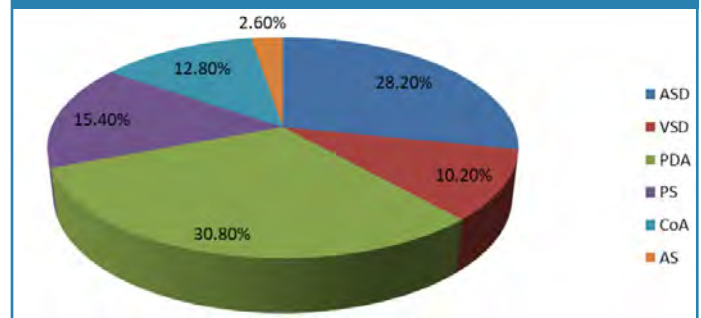
- $e^{\wedge}$
- $E/e^{\wedge}$  ratio

Pulmonary artery pressure (PAP) estimation obtained by measuring peak tricuspid pressure gradient from the right ventricle to the right atrium by using Bernoulli equation ( $\Delta P = 4V^2$ )<sup>(8)</sup>. where V is the maximum TR jet velocity, and by adding the right atrial pressure where estimated by inferior vena cava diameter and its change during respiration, this was representing the RV pressure and will equal the SPAP, then all these variables reassessed first day post trans catheter interventions.

## Result

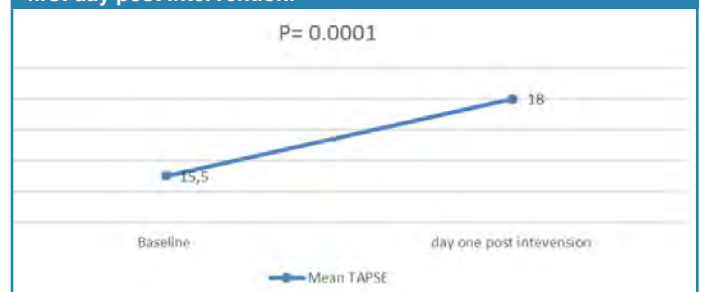
A total of 39 patients with CHD were enrolled in this study, with mean $\pm$ SD was 9.1 $\pm$ 13.6 years, ranging between 43 days to 49 years, the male to female ratio was 1: 1.4. The mean $\pm$ SD body surface area was 0.79 $\pm$ 0.66, ranging between 0.2 to 2.8. Type of congenital heart defect for studied patients were 11(28.2%) patients had ASD, 4(10.1%) patients had VSD, 12(30.8%) patients had PDA, 6(15.4%) patients had PS, 5(12.8%) had CoA and only patient had AS (2.6%), figure -1-.

Figure 1. Type of congenital heart defect.



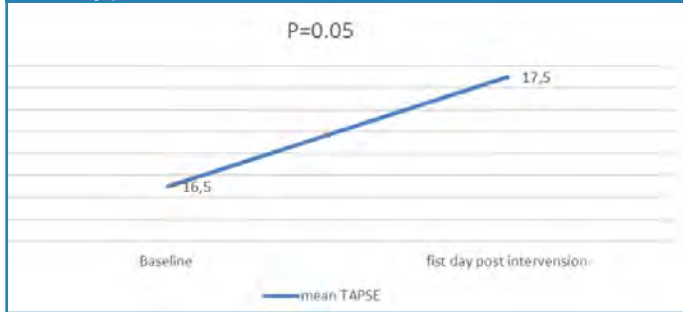
**Echocardiographic changes for patients with ASD:** For patients with ASD, the mean ( $\pm$ SD) size defect was 12.8( $\pm$ 5.7) mm ranging between 7-28mm and direction of shunt was left to right, Echocardiographic parameters of RA, RV and PAP were shown a non-significant reduction post intervention with improvement of systolic RV function by significant increase in TAPSE from 15.5mm at baseline to 18mm at first post intervention day (P value =0.001). figure -2-.

Figure 2. Difference in the mean TAPSE between baseline and first day post intervention.



**Echocardiographic changes for patients with VSD:** The mean ( $\pm$ SD) size defect was 7.5( $\pm$ 0.5) mm ranging between 7-8mm and direction of shunt was left to right. echocardiographic study showed statistically non-significant reduction in LA, LV size parameters and PAP. But there were a significant increase in TAPSE between baseline (16.5mm) and first day post intervention (17.5mm) ( $p=0.050$ ), figure -3-.

**Figure 3. Difference in the mean TAPSE between baseline and first day post intervention.**



Regarding the systolic function, there was an increase in the mean EF% from 58.7% in baseline to 65.7% in first day post intervention and that increment was significant ( $p=0.0001$ ). Approximately the diastolic function has shown no change in their parameters, table -1-.

**Table 1. Difference in systolic and diastolic function between baseline and first day post intervention for VSD patients.**

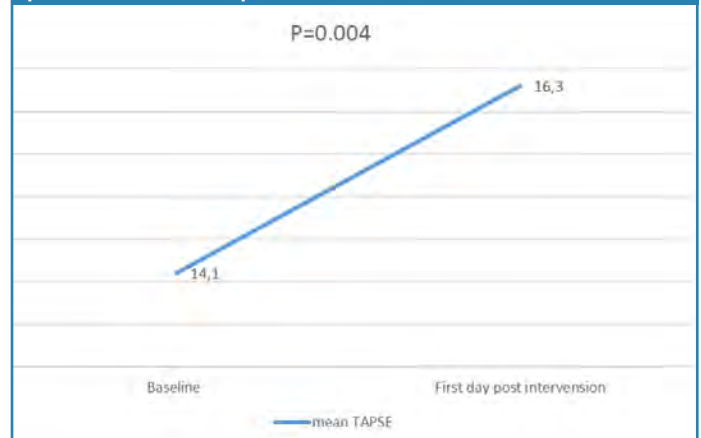
Parameters		Mean	SD	P value	
Systolic function EF	Baseline	58.7	1.5	0.0001	
	first day post intervention	65.7	1.2		
Diastolic function	EIA	Baseline	1.1	0.09	0.7
		first day post intervention	1.1	0.08	
	Ele <sup>^</sup>	Baseline	9.7	2.6	0.67
		first day post intervention	9	2.1	
	PCWP	Baseline	13.7	2.6	0.67
		first day post intervention	13	2.1	

EF=ejection fraction, PCWP =pulmonary capillary wedge pressure, Student T test, significant  $\leq 0.05$ .

**Echocardiographic changes for patients with PDA:** For patients with PDA echocardiographic study of LA, LV, PAP there was reduction post operation but statistically non-significant.

**Echocardiographic changes for patients with PS:** For patients with PS, there was improvement of RV systolic function by increase in TAPSE ( $P$  value= $0.004$ ) with no significant changes in other echocardiographic parameters figure -4-.

**Figure 4. Difference in TAPSE between baseline and first day post intervention for patients with PS.**



**Echocardiographic changes for patients with CoA:** Patients with CoA, the PG showed a significant reduction between baseline (59.8) and first day post intervention (16.4)  $p=0.0001$ , with non-significant improvement of LV systolic function evaluated by EF and there were no significant changes in other echocardiographic parameters table -2-.

**Table 2. Difference in AO parameters between baseline and first day post intervention for patients with CoA.**

AO by 2D		Mean	SD	P Value
Annulus (mm)	Baseline	13.2	8.5	0.94
	First day post intervention	12.8	8.3	
SV (mm)	Baseline	17.6	9	0.97
	First day post intervention	17.4	9.2	
STJ (mm)	Baseline	12.8	6.6	1
	First day post intervention	12.8	6.6	
Ascending Ao (mm)	Baseline	14.4	6.8	1
	First day post intervention	14.4	6.8	
Descending Ao	Size (mm)	11	4	0.67
	PG (mmHg)	59.8	13.5	
	First day post intervention	16.4	4.3	

SV=sinus of valsalva, STJ=sinotubular junction, PG= pressure gradient, Student T test, significant  $\leq 0.05$ .

Only one male patient age was 5 months and had AS where enrolled in this study, echocardiography shown a reduction of PG across the AV with improvement of LV systolic function by increment of EF from 57% at baseline to 65% at first day post intervention and there was a reduction of PAP from 48 mmHg at baseline to 27 mmHg.

## Discussion

For ASD patients, Atrial septal defect closure has been shown to result in a reduction in RV size with improvement of RV systolic function evaluated by TAPSE and this in agreement with other studies like Schussler et al study and Teo et al study<sup>9,10</sup>. The improvement RV function has been reported Humenberger et al. study<sup>11</sup> and Salehian et al. study<sup>12</sup>. This study demonstrated that decrease in RV size, although that reduction was not significant that may be due to small sample size and inclusion wide age range.

Regarding VSD patients, though VSDs can occur in any part of the interventricular septum, the majority are perimembranous. The remainder are muscular; in this study, all patients had perimembranous VSD except one supracristal. Early VSD pathophysiology of induced RV pressure excess consequences in right ventricular hypertrophy. Ventricular hypertrophy in right side and volume excess results in pulmonary hypertension, LA dilation with related arrhythmias, besides mitral valve regurgitation, all VSDs were effectively closed and there were no shunt and there were a decreased interventricular flow by echocardiography, a similar finding was noticed by Wang et al study<sup>13</sup> and there was a reduction in LA and LV diameters with significant improvement in LV and RV function evaluated by EF and TAPSE respectively with a noticeable reduction in PAP although statistically non-significant.

Regarding patients with PDA, the left to right shunting through hemodynamically significant patent ductus arteriosus (PDA) causes pulmonary over circulation with resultant left ventricle (LV) volume overload and remodeling. The current study demonstrated an early decrease in LVEDD following successful trans catheter ductal closure with improvement of LV systolic function evaluated by EF this is due to PDA closure is supposed to alter the LV volume overload and remodeling with improvement of systolic and diastolic heart function gradually this concordance to other study by El-Khuffash et al,<sup>14</sup> Jeong et al<sup>15</sup> and Zhang et al. Other parameters showed reduction in the mean between baseline and first post intervention day reading but that reduction was not significant as it may need more time.

For the patients with PS, Following the procedure, the dramatic fall of PG across the PV and right ventricular peak systolic pressure along with a slight increase in pulmonary artery flow occurs while the cardiac output remains unchanged or it may improve. The PV leaflets open more freely with less doming, and the width of blood jet flowing through PV increases. Right ventricular function is improved significantly with the reduction of tricuspid regurge and right-to-left shunt. This result was in line of Talukder et al study<sup>16</sup> For CoA patients, after intervention there were an improvement of LV functions with significant reduction of PG, this result was in line of Lam et al study<sup>17</sup>.

Regarding AS, echocardiography plays a vital role in the per interventional assessment of the aortic valve and surrounding apparatus<sup>18</sup>. There was a reduction of PG across the AV with improvement of LV systolic function by increment of EF

and there was a reduction of PAP which reflects good sign postoperatively.

## Conclusion

Echocardiography suggestions significant compensations when managing patients with inherited cardiac illness. Aside from founding starting point heart presentation, Echocardiography in the peri interventional situation can enable presentation of interference and vital for recurrent follow-up. In addition to establishing the presentation of the heart as the starting point, echocardiography in the peri-interventional setting can allow the presentation of interferences and is vital for recurrent follow-up.

## References

1. Van Der Linde D, Konings E, Slager M. a., Witsenburg, M., Helbing, W. a., Takkenberg, JJM & Roos-Hesselink, JW Birth prevalence of congenital heart disease worldwide: A systematic review and meta-analysis. *J Am Coll Cardiol.* 2011; 58:2241-7.
2. CDC. "Data and Statistics | Congenital Heart Defects | NCBDDD | CDC." *Centers for Disease Control and Prevention* 2018. *Centers for Disease Control and Prevention.* Web.
3. Mocumbi AO, Lameira E, Yaksh A, Paul L, Ferreira MB, Sidi D. Challenges on the management of congenital heart disease in developing countries. *International journal of cardiology.* 2011;148(3):285-8.
4. Buratto E, Ye X-T, Konstantinov IE. Simple congenital heart disease: a complex challenge for public health. *Journal of thoracic disease.* 2016;8(11):2994.
5. Hoffman JI, Kaplan S, Liberthson RR. Prevalence of congenital heart disease. *American heart journal.* 2004;147(3):425-39.
6. Baumgartner H. The Task Force on the Management of Grown-up Congenital Heart Disease of the European Society of Cardiology (ESC): ESC Guidelines for the management of grown-up congenital heart disease (new version 2010). *Eur Heart J.* 2010;31:2915-57.
7. Dorfman AL, Levine JC, Colan SD, Geva T. Accuracy of echocardiography in low birth weight infants with congenital heart disease. *Pediatrics.* 2005;115(1):102-7.
8. DeGroot C, Shandas R, Kwon J, Valdes-Cruz L. Accuracy of the Bernoulli equation for estimation of pressure gradient across stenotic Blalock-Taussig shunts: an in vitro and numerical study. *Pediatric cardiology.* 2000;21(5):439-47.
9. Teo KS, Dundon BK, Molae P, Williams KF, Carbone A, Brown MA, et al. Percutaneous closure of atrial septal defects leads to normalization of atrial and ventricular volumes. *Journal of Cardiovascular Magnetic Resonance.* 2008;10(1):1-8.
10. Schussler JM, Anwar A, Phillips SD, Roberts BJ, Vallabhan RC, Grayburn PA. Effect on right ventricular volume of percutaneous Amplatzer closure of atrial septal defect in adults. *The American journal of cardiology.* 2005;95(8):993-5.
11. Humenberger M, Rosenhek R, Gabriel H, Rader F, Heger M, Klaar U, et al. Benefit of atrial septal defect closure in adults: impact of age. *European heart journal.* 2011;32(5):553-60.
12. Salehian O, Horlick E, Schwerzmann M, Haberer K, McLaughlin P,



- Siu SC, et al. Improvements in cardiac form and function after transcatheter closure of secundum atrial septal defects. *Journal of the American College of Cardiology*. 2005;45(4):499-504.
13. Wang L, Cao S, Li J, Yang L, Liu Y, Ren J, et al. Transcatheter closure of congenital perimembranous ventricular septal defect in children using symmetric occluders: an 8-year multiinstitutional experience. *The Annals of thoracic surgery*. 2012;94(2):592-8.
  14. El-Khuffash AF, Jain A, Dragulescu A, McNamara PJ, Mertens L. Acute changes in myocardial systolic function in preterm infants undergoing patent ductus arteriosus ligation: a tissue Doppler and myocardial deformation study. *Journal of the American Society of Echocardiography*. 2012;25(10):1058-67.
  15. Jeong Y-H, Yun T-J, Song J-M, Park J-J, Seo D-M, Koh J-K, et al. Left ventricular remodeling and change of systolic function after closure of patent ductus arteriosus in adults: device and surgical closure. *American heart journal*. 2007;154(3):436-40.
  16. Talukder MF, Hongxin L, Fei L, Khashru MBB. Percutaneous balloon valvuloplasty of pulmonary valve stenosis: state of the art and future prospects. *International Surgery Journal*. 2020;7(2):609-16.
  17. Lam Y-Y, Mullen MJ, Kaya MG, Gatzoulis MA, Li W, Henein MY. Left ventricular and ascending aortic function after stenting of native coarctation of aorta. *The American journal of cardiology*. 2010;105(9):1343-7.
  18. Kitai T, Tsutsui RS. The contemporary role of echocardiography in the assessment and management of aortic stenosis. *Journal of Medical Ultrasonics*. 2020;47(1):71-80.



[www.revhipertension.com](http://www.revhipertension.com)  
[www.revdiabetes.com](http://www.revdiabetes.com)  
[www.revsindrome.com](http://www.revsindrome.com)  
[www.revistaavft.com](http://www.revistaavft.com)

#### Indices y Bases de Datos:

ZENODO, OPENAIRE, OPEN JOURNAL SYSTEMS

REDALYC (Red de Revistas Científicas de América Latina, el Caribe, España y Portugal)

SCOPUS de Excerpta Medica

GOOGLE SCHOLAR

Scielo

BIREME (Centro Latinoamericano y del Caribe de Información en Ciencias de la Salud)

LATINDEX (Sistema Regional de Información en Línea para Revistas Científicas de América Latina, el Caribe, España y Portugal)

Índice de Revistas Latinoamericanas en Ciencias (Universidad Nacional Autónoma de México)

LIVECS (Literatura Venezolana de Ciencias de la Salud)

LILACS (Literatura Latinoamericana y del Caribe en Ciencias de la Salud)

PERIÓDICA (Índices de Revistas Latinoamericanas en Ciencias)

REVENCYT (Índice y Biblioteca Electrónica de Revistas Venezolanas de Ciencias y Tecnología)

SABER - UCV

EBSCO Publishing

PROQUEST