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The Echocardiography Follow Up Imaging in Transposition of the Great Artery after Lecompte Maneuver Procedure Arterial Switch

Uthen Bunmee*

*Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand.

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ABSTRACT

Echocardiography was cardiac imaging tool for evaluating screening problem and follow up in transposition of the great artery. It's has properties of non-invasive, inexpensive, non-radiation, and convenient portability. especially when after LeCompte maneuver procedure of arterial switch, it's has several parameters. But we divide into group of parameters from the common problem after repair TGA consist of PA branches size and anatomy, Outflow tract and semilunar valve, Ventricular function and valvular function. The estimated right ventricular pressure was necessary parameter in case of right outflow tract narrow or obstruction may be considered pulmonary pressure elevated. However, the standard view and special view for demonstrated pulmonary structure was challenged to practice in TGA after repair by LeCompte maneuver procedure.

Keyword: Echocardiography, Transposition of the great artery, LeCompte maneuver, Arterial switch

GENERAL CHARACTERISTIC

The transposition of the great artery was the rare condition of severe congenital heart disease group. The incidence in upper central region in Thailand occurs about 2.8% [1]. Although, many factors induce and etiology. But, it's having several reported describe the correlation between organic solvents and the incidence of congenital heart disease (CHD) consist of Coarctation of aorta (CoA), Hypoplastic left heart syndrome (HLHS), and transposition of the great artery (TGA). This finding is supported by those of others who found that organic solvents and other chemicals are associated with cases of CHD overall [2,3]. The pulmonary artery took of left ventricle and the aorta took of right ventricle. This character, the major ventricle was created pumping with high pressure to both lungs associated with congestion and high pulmonary pressure and minor ventricle was poor power to supply systemic associated with cyanosis signs. The any communication shunt was necessary forgive the deoxygenated blood and oxygenated blood able to mixing, consist of atrial septal defect, patent foramen ovale, ventricular septal defect, ductus arteriosus, or other extra-cardiac shunt communication was needed. The echocardiography has the role of imaging for examination screen especially for preparing and guided the balloon atrial septostomy procedure for palliative treatment in in TGA intact septum [4]. In another way, ventricular septal defect (VSD) or Atrial septal defect (ASD) may be produced increase pulmonary blood flow due to the left ventricle (LV) generate high pressure to the lung. Surgeon will protect a complication of increase pulmonary blood flow by pulmonary artery banding surgery (PA banding) and this procedure able train right ventricle pumping and developed to thicken of muscle too [5].

CARDIAC IMAGING MODALITY

The comprehensive transthoracic echocardiography has been necessary imaging since first diagnosis screening until post treatment period. The way of echocardiography in TGA consist of pre-operative study period, peri-operative study period, post-operative study period and follow up [6]. Although the golden standard evaluation of extra cardiac vessel and function after arterial switch was the computed tomography (CT) [7]. In another way, CT was an important role for coronary pattern identified and influenced to predicted risk of surgery [8,9]. The angiogram has benefit in case of complicated coronary abnormality type and role of intervention. In the case of high body weight and low risk of surgery, arterial switch may be a choice for treatment. In the after that, cardiologist will follow up yearly for physical

Corresponding author: Uthen Bunmee, Faculty of Medicine Ramathibodi Hospital, Mahidol University, 270, RAMA 6 road, Ratchathewi, Bangkok, Thailand, Tel: +66 876850708; E-mail: Utan_bunmee@hotmail.com

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examination and request imaging for evaluating heart function and peripheral pulmonary stenosis (PPS) [10].

SURGERY TREATMENT INFLUENCE TO PULMONARY ARTERY ANATOMY

The supravalvular and peripheral pulmonary stenosis was common problem in post-repair TGA approximately 39% [10]. Especially history of PA banding either main PA banding or bilateral PA banding. This reason was the indication for follow up imaging. However, the LeCompte maneuver procedure has associate airway compress and PPS because of direction of main pulmonary artery more anterior under sternum and PA branches pull stretch and aortic pulsatile compress [11]. This reason was difficult and limited to demonstrate long segment of main trunk and branches of pulmonary artery by echocardiography. The CT or MRI has golden equipment for evaluating anatomy of pulmonary system. However, the risk of radiation and expensively must be considered. In TGA, the Echocardiography has the role of basic tool has good correlation of another modality [12].

ECHOCARDIOGRAPHY AND PARAMETERS

PA branches size and anatomy: The American society of echocardiography was recommended in post-operative TGA use standard view comprehensive echocardiography imaging. Especially, the suprasternal short axis or high parasternal view had the benefit of demonstrating the anatomy and anterior relationship of the branch pulmonary arteries to the aorta after the LeCompte maneuver. Because of the PA branches was straddling the aorta difference normal anatomy pattern (**Figures 1 & 2**). In addition to size, pressure gradient is also important for evaluation. Although McGoon ratio had a benefit in tetralogy of Fallot and other congenital heart disease of describing abnormal size pulmonary artery. The McGoon ratio able to apply to assessment PA size compares with abdominal descending aorta (DAo) from equation McGoon ratio = RPA+LPA/DAo. (Normal > 1.8) [13]. The Z score of pulmonary artery size was popular in CT or the MRI. But several cases in TGA after repair by LeCompte maneuver procedure, the PA branches will stretch and slightly undersize,if we compare with the pulmonary artery Z-score from normal population group may be extremely under the size of the body surface area, this limitation of interpretation must be concerned. (Normal range of Z score -2 to 2).

Figure 1. The anteroposterior (AP) view of Angiogram shows narrowing of origin part pulmonary artery branches and visualized catheter to inject contrast media in main pulmonary artery.

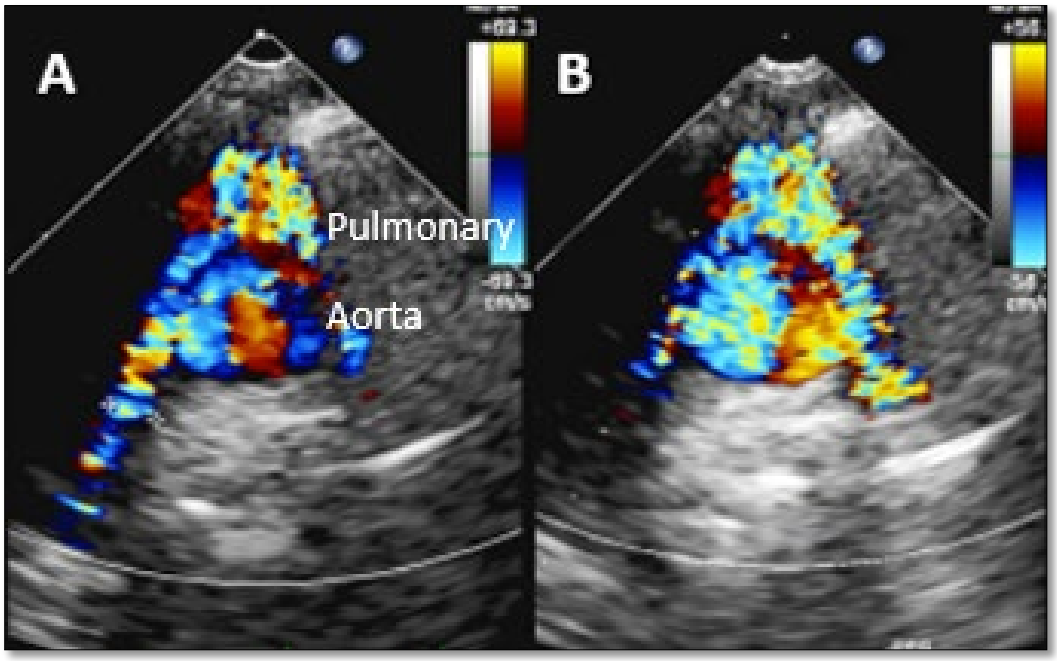

Figure 2. Two Dimension with color mode Echocardiogram in high parasternal window or suprasternal short axis adjust marker transducer to lateral left sided of patient shows turbulent flow in RPA (A) and LPA with bifurcation (B). The pulmonary artery was anterior of aorta anteroposterior relationship under sternum reason of difficult for demonstrated. The supine Trendelenburg position of the patient was provided.

OUT FLOW TRACT AND SEMILUNAR VALVE

The outflow tract and semilunar valve function both aortic and pulmonic valves used the parasternal long axis view (**Figure 2**) and modified parasternal long axis view with anterior angulation of transducer. Because of aortic root dilated and valve regurgitation was common occur approximately 22% in ten years follow up [15]. The parasternal short axis view was a limitation for demonstrating both semilunar valve in same view (**Figures 2 & 3**). The overriding aorta may be considering the cause of obstruction the outflow tract after closure septal defect [16].

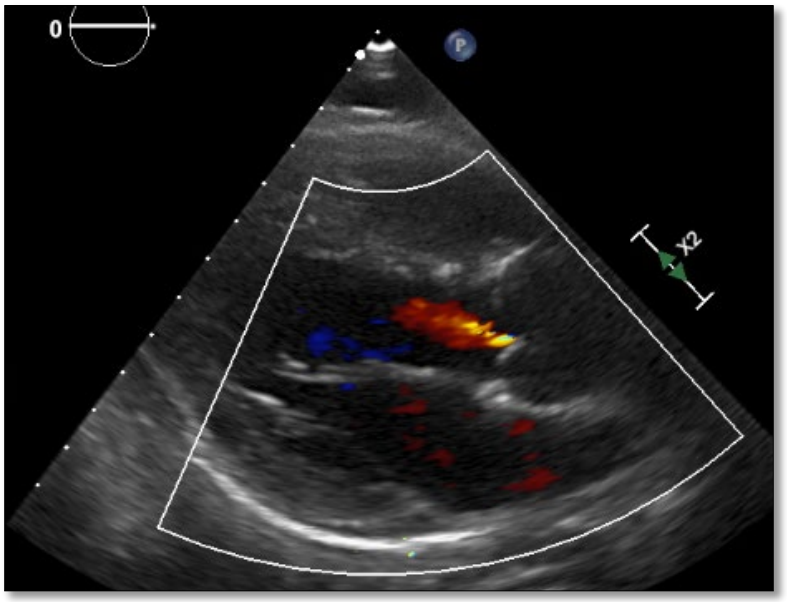

Figure 3. Two dimensions with color mode of Echocardiogram in parasternal long axis view adjust marker transducer to left shoulder of patient shows turbulent flow at aortic valve in closure phase evidence of mild aortic valve regurgitation.

ESTIMATED RIGHT VENTRICULAR PRESSURE

The modified parasternal long axis view with anterior angulated transducer was the use of the demonstrated pulmonic valve and infundibular part. The overriding aorta may be considering outflow tract obstruction leading of increase pulmonary pressure and right-side cardiac pressure able to push blood from the right ventricle insufficient to right atrium chamber (**Figure 4**). Tricuspid regurgitation pressure gradient (Normal TRPG < 35 mm Hg) [17] and pulmonary end diastolic pressure (PREDP), It's able to estimate right atrium pressure (RAP) about 5-10 mm Hg if inferior vene cava size < 2.1 cm. And collapsing signs >50%. [18] The formula for calculating RVSP = TRPG + RAP (mmHg.) (RVSP; right ventricular systolic pressure, RAP; Right atrial pressure). The RVSP will equal systolic PAP when without pulmonary valve stenosis. But the PS or PPS evidence must be reported and the calculation method may be using another formula.

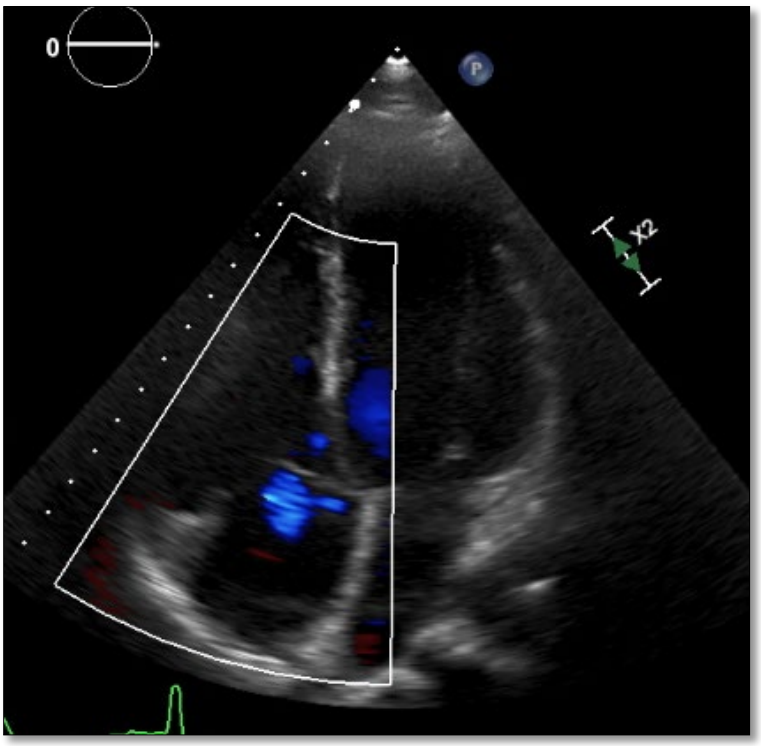

Figure 4. Two Dimension with color mode of Echocardiogram in Apical 4 chambers view shows tricuspid regurgitation jet in right atrium at closure phase. This view was a standard view for measure tricuspid valve pressure gradients by continuous wave Doppler.

VENTRICULAR FUNCTION

The reason for coronary artery relocalization procedure has influence to the coronary supply and regional wall motion of LV Although the main of pumping was the left sided ventricle (after repair). But in several cases the morphology of main ventricle was more trabeculation or noncompacted. This point was considered evidence of reducing ventricular pumping and related to impair ventricular function. The left ventricular ejection fraction (normal LVEF > 55%) in systolic function, the circumferential or longitudinal strain was important parameter for described neo-left ventricular function [10]. (Normal global longitudinal strain -15% to -22%) [19]. After some report use -20% cut off point for considering normal [20]. However, the right ventricular function was also necessary, in addition the tricuspid annulus plane exertion which is a parameter for evaluating RV function and many cut points in several main diseases such as in pulmonary hypertension if TAPSE < 1.6 cm. (since 1.5 cm. below) It's being able to detect elevated pulmonary pressure in patients with interstitial lung disease who underwent cardiac catheterization [21]. (Accept rang > 1.5 cm.) There is also tissue Doppler velocity of S' wave at lateral wall beside leaflet of the tricuspid valve that can be a parameter used to evaluate RV function. (Normal > 11.5 cm/s) [22]. About the diastolic function E/E' at mitral valve inflow able to reflect the filling pressure of LV and LA contraction. The peak velocity of E wave of mitral valve inflow by pulse wave Doppler (**Figures 5-8**) and the peak velocity of E' wave of tissue pulse wave Doppler able to ratio E/E' if greater than 15 may be related to elevate left atrial pressure, such as mitral stenosis or regurgitation and pulmonary vein stenosis or pulmonary hypertension. (Normal < 15) [23].

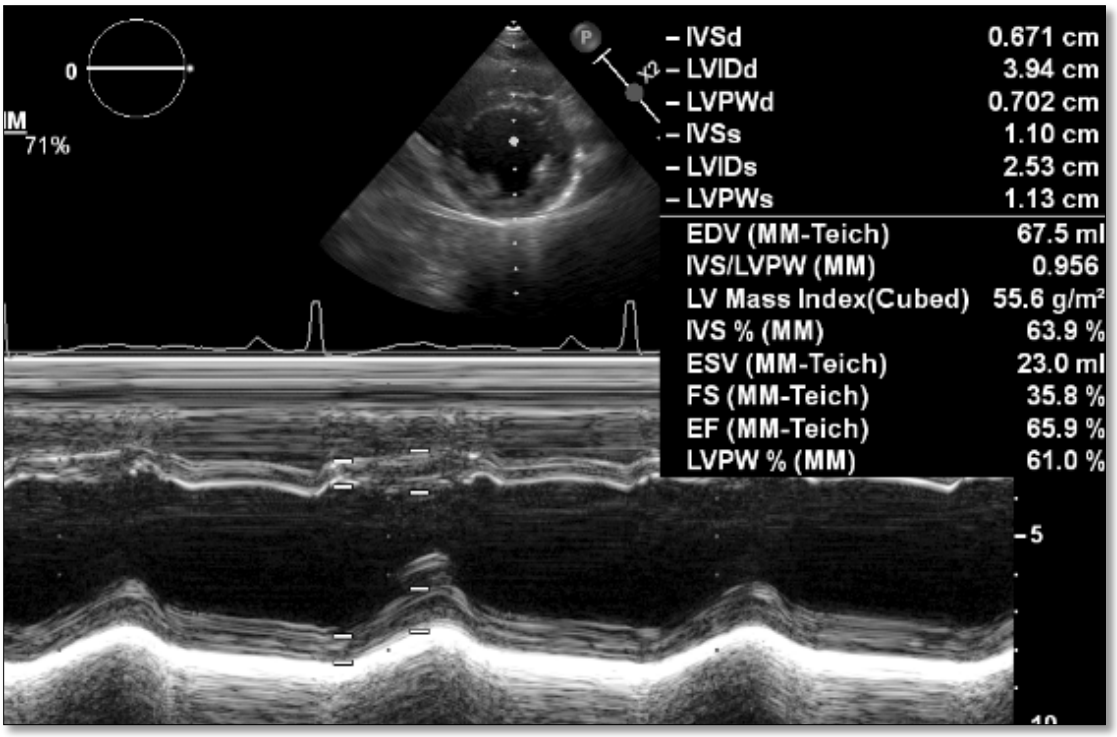

Figure 5. The echocardiogram in motion mode via cross section of the left ventricle shows the pattern movement, LV dimension, LV wall thickness, LVEF in LV systolic function.

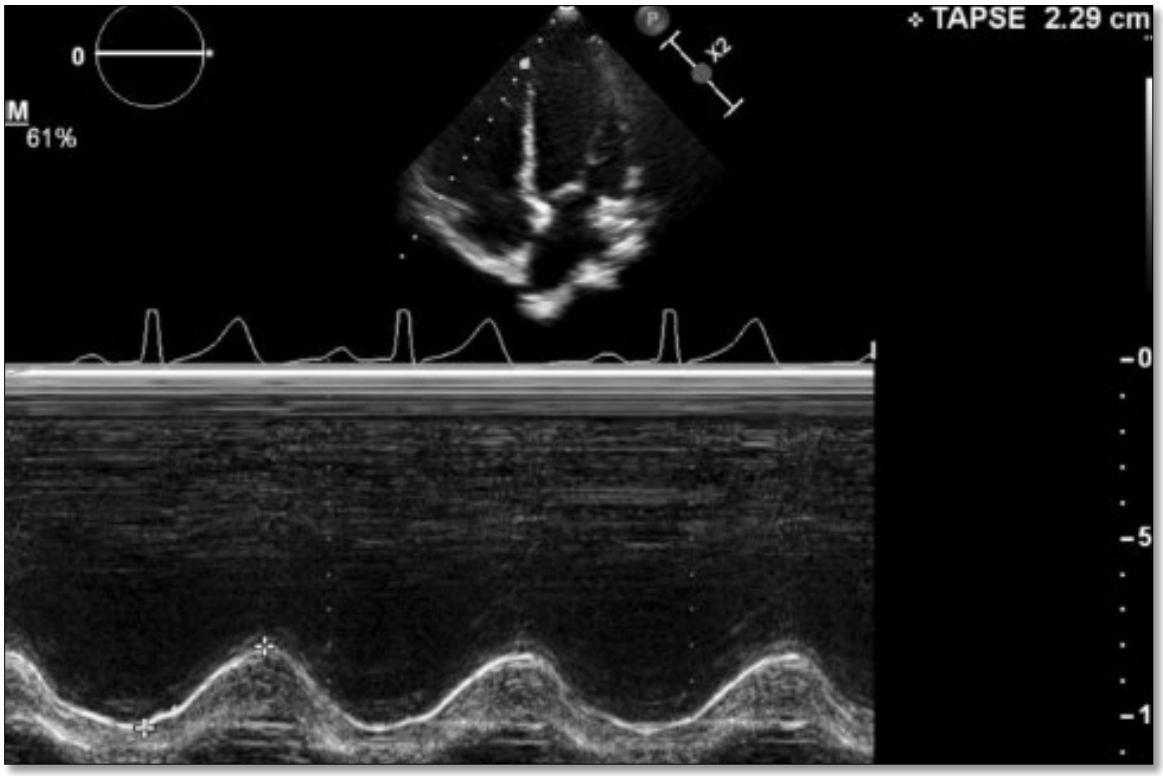

Figure 6. The echocardiogram in motion mode via lateral wall beside TV leaflet in apical 4 chambers view shows TAPSE in RV systolic function.

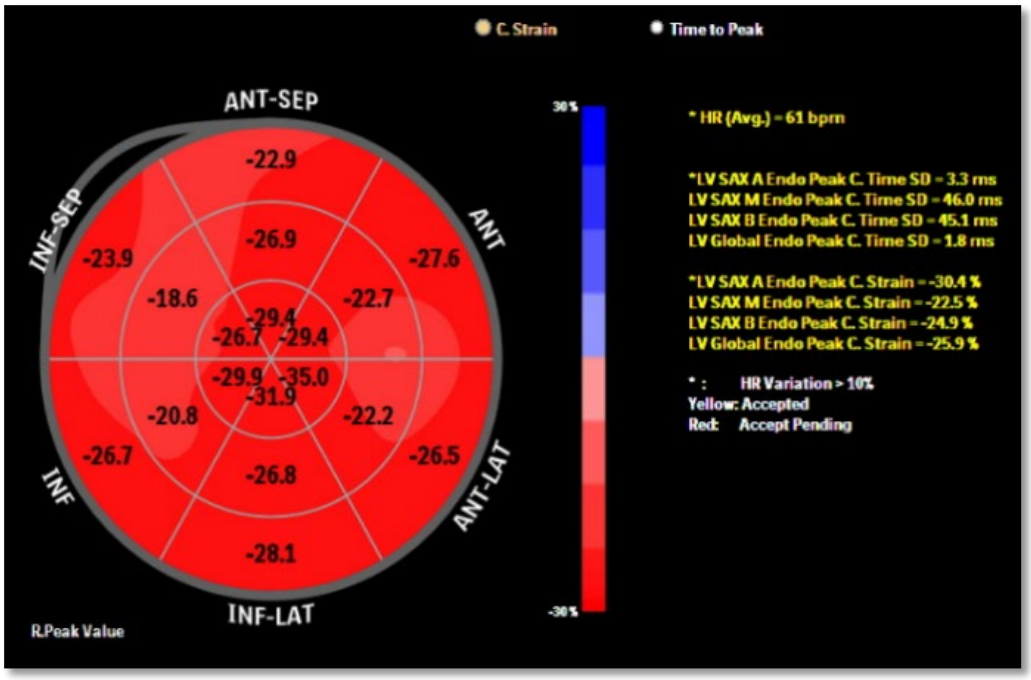

Figure 7. The echocardiogram in strain mode of left ventricular function had the benefit of describing the percentage strain property of myocardial all 18 segments and global value.

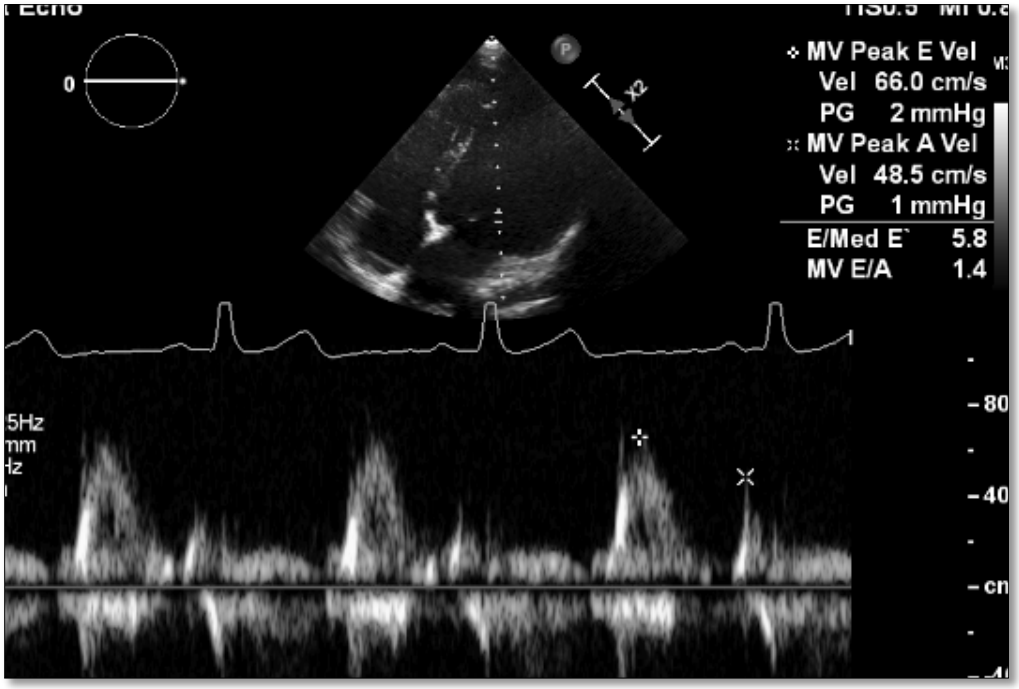

Figure 8. The apical four chambers view echocardiogram in pulse wave Doppler mode of mitral valve inflow shows the velocity wave pattern of early filling (E wave), atrial contraction (A wave), represent left ventricular diastolic function.

ATRIOVENTRICULAR VALVES FUNCTION

The atrio-ventricular valve (AV valve) both mitral valve and tricuspid was necessary for assessment in echocardiography. Because of both AV valves had a function and influence of volume or load in the chambers. The impair ventricular function was shown chamber dilated, this sign may lead to atrio-ventricular valve annulus dilated with regurgitate and be a burden of atrial from reason of increase volume [24].

However, the impairment of AV valve may be related to a congenital abnormality and coronary artery problem which must be analyzed and finding causes [25].

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