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Validity of Color Coded Tissue Doppler Imaging in the Assessment of Interventricular Septal Motion in Adult Patients with Atrial Septal Defect

[1*]Ghazi F. Haji, [2]Amal Noori Al Marayati, [3]Sabah Saleh Hussein, [4]Alaa Abdulhussein Alenbari
[1*]MBCh.B, MD., FIBMS (Med) FIBMS (Cardiol), College of Medicine, University of Baghdad, Iraq.
E-mail: ghazi_haji@yahoo.com
[2] MBCh.B., FRCP., CABM., FICMS., Consultant Cardiologist, Iraqi Centre of Heart Disease, Iraq.
[3] MBCh.B., M.Sci, H.D., Medicine, H.D., Echocardiography, Kirkuk General Hospital, Iraq.
[4] MBCh.B., D.C.H-CABP(Pediat), FICMS(Cardio) Ibn-AL-Nafess Teaching Hospital, Iraq.
Corresponding author: Ghazi F. Haji, ghazi_haji@yahoo.com

ABSTRACT

Background: Atrial septal defect (ASD) is one of the most widely recognized cardiac congenital abnormalities in adulthood. Atrial septal defect is characterized by an inter-atrial septum defect that allows the pulmonary venous return from the left atrium to pass directly to the right atrium. Paradoxical septal motion is mainly detected by two-dimensional and M-mode echocardiography. The recently introduced Doppler tissue imaging (TDI) echocardiographic modality has been used in many clinical situations, including ventricle wall movement determination.

Objective: To investigate the validity of Tissue Doppler imagery (TDI) coded in color as one of the parameters in ASD assessment.

Patients and methods: A cross-sectional retrospective study was performed from June 2018 to June 2019 in multi-teaching centers in Iraq. This study involved adult patients with ASD (confirmed with transthoracic TTE and transesophageal echocardiography TEE), patients with other congenital or pathological cardiac defects were removed from the research. TEE was conducted in just 6 patients (Diagnostic only), whereas TTE obtained all the measurements. The echocardiographic analysis included two-dimensional imagery from the long and short parastern axis view, apical and subcostal view with Doppler color demonstration of interatrial shunt, Doppler color coded tissue to determine interventricularseptal motion Results: There are 40 patients and 40 controls in this sample. The mean case patient age was 30.4 (SD ± 8.42) and the controls age was 33.5 (SD± 9.74). Among the case and control groups there were 33 females (83%) and 7 males (17%), the mean BSA (body surface area) of the case population was 1.88 m2 (SD ± 0.14) and that of the control was 1.81 m2 (SD ± 0.12).), these were not statistically significant differences. There was 36 (90 percent) ASD secondum, and 4 (10 percent) of sinus venosus type. Parameters (Qp / Qs, RA. Area, and RV., basal diameter) were significantly different between case and control groups. There were no significant differences in the SL between case and control groups in colour-coded tissue Doppler image parameter Standardized septal length as follows (68.2± 2.162), (36.7± 2.944) and (66.6± 1.700), respectively (36.8± 2.122); There were significant differences in color change point distance (CCP), standardized color change point distance, and the ratio of CCP to SL between case and control groups as follows (28.12± 3.114), (15.24± 2.359), (40.9± 3.532) and (16.975± 1.765), (9.29± 0.99), (25.54± 2.513) respectively.

Conclusions: TDI has been found to be a reliable tool to assess wall movement anomalies in adult ASD patients and can be used as additional criteria to support ASD diagnosis.

Key words: Atrial Septal Defect, Doppler Fabric Color Coded, Wall Movement, Transthoracic Echo.

Correspondence:
Ghazi F. Haji
MBCh.B, MD., FIBMS (Med)
FIBMS (Cardiol),
College of Medicine,
University of Baghdad,
Iraq.
E-mail Address:
ghazi_haji@yahoo.com

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INTRODUCTION

Atrial septal defect (ASD) is one of the most frequently known cardiac anomalies in adulthood(1) Shunting around the interatrial septum is typically left-to-right and occurs mainly in late ventricular systole and early diastole(2) ASD types; Ostiumsecondum, Ostiumprimum and sinus venosus. ASD occurs with a female-to - male ratio of approximately 2:1, ASD patients may be asymptomatic through infancy and adolescence, (3) The most common symptoms are atrial arrhythmia-related palpitations(4) ASD is an acyanotic lesion, atrial shunt reversal (Eisenmenger syndrome) may occur, leading to cyanosis and clubbing(5) Chest X-rays most commonly display cardiomegaly (6) 2-dimensional echocardiography, which offers direct non-invasive visualization of most forms of ASDs, TEE may provide excellent atrial septum identification. (7) MRI has been used successfully to classify the ASD size and location (8). Electrography can assist in defining ASD forms (9 Paradoxical septal movement is characterized as the movement of the interventricular septum away from the left ventricular, which can be divided into ischemic and non-ischemic wall movement abnormalities(10) The cardinal sign of ischemia is the intermittent, regional wall movement abnormality – the diagnostic cornerstone(11) The left branch block of the bundle changes the electrical activation sequence and thus the left ventricle contraction sequence (11). Developed in 1983, the color coded Doppler fluid imaging technique was commonly used for two-dimensional echocardiographic visualization of valvular regurgitation, stenotic fluid, shunt flow, and other irregular flows (8) TDI, the wall moving towards the probe is red, while the wall moving away from the probe is blue (12)

Study Objective

To determine changes in IVS movement in adult ASD patients using TDI colour, and to determine whether there is a relationship between these changes and the other parameters used in ASD assessment, and to investigate the validity of Tissue Doppler imaging (TDI) color coded as one of the parameters in ASD assessment.

PATIENTS & METHODS

A cross-sectional prospective study was conducted from June 2018 to June 2019 in multi-teaching centers in Iraq. This study included adult patients with ASD (confirmed with transthoracic and transesophageal echocardiography), patients with other congenital or structural cardiac abnormalities were excluded from the study. The same number was included as the control group, Transthoracic echocardiography examination using the general electric vivid E9 equipped with a 3.5 MHZ frequency phase array transducer with TDI activated, TEE was performed in only 6 patients (diagnosis only), whereas all measurements were performed by TTE; In each patient and control group, the echocardiographic analysis included two-dimensional imagery from the long and short parastern axis view, apical and subcostal view with color Doppler demonstration of interatrial shunt, Color coded tissue Doppler to test interventriclarseptal motion, The following parameters were assessed: Form and size of defect, interventricular septum length in long parastern axis view during systole, and distance between apex and aortic valve attachment site after color coded tissue activation Doppler imaging, area of interest was changed to cover septum and aortic valve. The point of change of colour (CCP) – The IVS point at which the color changes from red (motion to probe) to blue (motion away from the probe) was determined by framing the view from an early systole. The distance from the CCP to the aoric valve was measured, taking into account the fact that the rear wall was considered as colored red (indicating anterior movement). CCP distance and SL have been calculated and expressed as a percentage of normalized values for body surface area, and the CCP distance to SL ratio has been calculated.

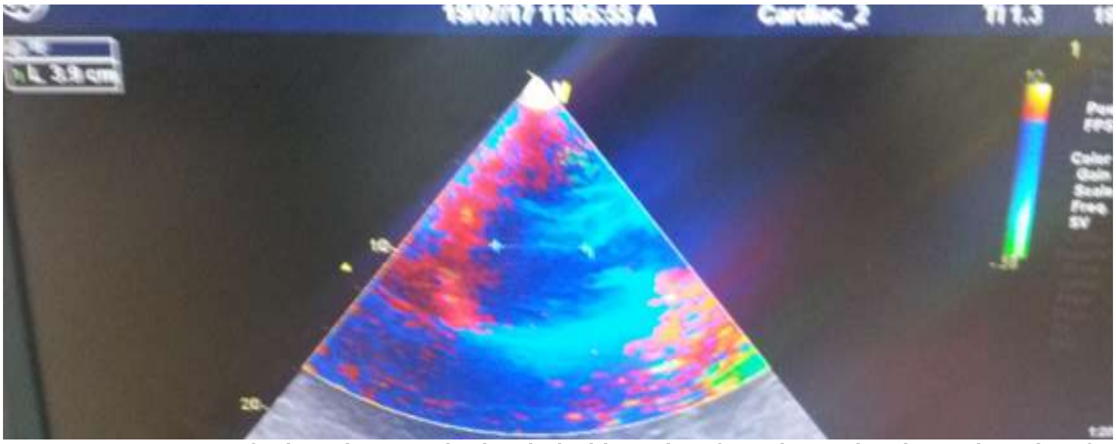

Figure 1: Measurement of colour change point (CCP), the blue colour from the aortic valve to the point of red colour

The determination of the pulmonary to systemic flow ratio or Qp: Qs is the main way to quantify the size of the shunt Right atrium area and the right basal ventricular diameter, the approval of the Institutional Ethics Committee and the written consent of all patients included in this study.

Statistical Analysis: Statistical assessment was performed using windows using the SPSS 19.0. This used unpaired t-test when comparing mean values between classes. The chi-square method was used when measuring frequency differences. A P-value significance rating < 0.05 was selected.

RESULTS

This study included 40 patients and 40 controls. The mean age of patients group was 30.4years (SD ± 8.42) and that of the controls was 33.5 years (SD± 9.74) In the patients and control groups there was 33 female (83%) and 7 men (17%), the mean BSA (body surface area) of the case patient was 1.88 m² (SD ± 0.14) and that of the control was 1.81 m² (SD ± 0.12), these differences were not statistically significant as shown in (table 1) There number of ASD secundum was 36 (90%), and was 4 of sinus venosus type (10%) as shown in figure 2

Table 1: No. and percentages of ASD patient and mean of BSA in patient and control groups

Groups	Age (years) Mean± SD	BMI m² Mean± SD	Female No. %	Male No. %
ASD	30.4 ±8.4	1.88 ±.0.14	33 (83%)	7 (17%)
Control	33.5 ±97.4	1.81 ± 0.12	33 (83%)	(17%) 7
P value	>0.05	>0.05	>0.05	>0.05

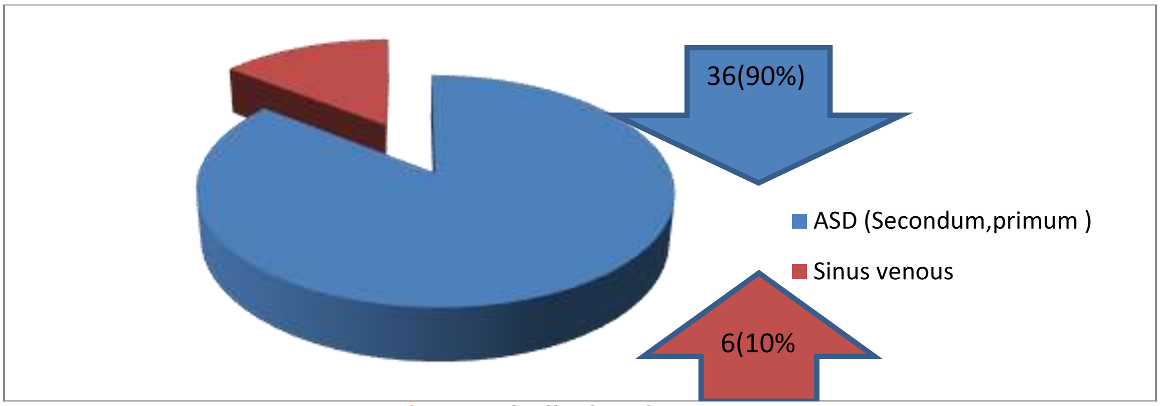

Figure 2: **Distribution of ASD types**

There were a significant differences between patient and control groups in parameters (Qp/Qs, RA. Area, and RV., basal diameter), as shown in table 2

Table 2: **Echocardiographic Mean, std. Deviation, and std. Error Mean parameters in patient and control groups**

Groups	Qp/Qs	Normalize Qp/Qs	RA.area cm^2	Normalize RA.area cm^2/m^2	RV. Basal diameter mm	Normalizd RV basal diameter mm/m^2
ASD	2.2±0.282	1.2±0.177	24.2±2.224	13.2±1.735	46.8±3.627	25.3±2.692
	S.E:0.045	S.E:0.028	S.E:0.351	S.E:0.274	S.E:0.573	S.E:0.425
Control	1.06±0.133	0.58±0.078	14.5±1.095	8.1±0.800	31.5±1.761	17.5±1.640
	S.E:0.021	S.E:0.012	S.E:0.176	S.E:0.126	S.E:278	S.E:0.259
P value	0.037*	0.023*	0.041*	0.033*	0.029*	0.044*

* Significant

In colour coded tissue Doppler imaging parameters there was no significant differences between case and control groups in the SL (septal length) , normalized septal length as follows (68.2± 2.162), (36.7 ± 2.944) and (66.6± 1.700), (36.8± 2.122) respectively . In colour change point distance (CCP), normalized colour change point distance , and the ratio of CCP to SL, there were a significant differences between case and control groups as follows (28.12± 3.114), (15.24± 2.359) , (40.9± 3.532) and (16.975± 1.765), (9.29± 0.99), (25.54± 2.513) respectively as shown in table 3

Table 3: **Correlation between SL, normalized SL, CCP, normalized CCP and CCP/SL ratio in case and control groups**

Groups	SL mm	Normalize SL mm/m^2	CCP mm	Normalize CCP mm/m^2	CCP/SL %
ASD	68.2±2.162	36.7±2.944	28.12±3.114	15.2±2.359	40.9±3.532
	S.E:0.341	S.E:0.465	S.E:0.492	S.E:0.373	S.E:0.565
Control	66.6±1.700	36.8±2.122	16.9±1.765	9.2±0.995	25.5±2.513
	S.E:0.268	S.E:0.335	S.E:0.279	S.E:0.159	S.E:0.397
P value	0.672	0.784	0.035*	0.052*	0.039*

Significant *

The colour coded tissue Doppler results of CCP distance, normalized CCP distance, and CCP to SL ratio comparing to other echocardiographic parameters of ASD assessment (Qp/Qs, and normalized Qp/Qs) revealing that there was a significant correlation within case group as follows in table 4, 5, and 6 respectively

Table 4: **Correlation between CCP distance and Qp/Qs**

Parameter	Mean ±	Std.Error mean	P value
CCP	28.1±3.114	0.492	0.012**
Qp/Qs	2.20±0.286	0.0452	0.012**

** Highly significant

Table 5: **Correlation between normalized CCP distance and normalized Qp/Qs**

Parameter	Mean ±	Std .Error mean	P value
Normalize CCP	15.2±2.359	0.373	0.036*
Normalize Qp/Qs	1.2±0.177	0.274	0.036*

*Significant

Table 6: **Correlation between CCP/SL ratio to normalized Qp/Qs**

Parameter	Mean ±	Std.Error mean	P value
CCP/SL	40.9±3.532	0.539	0.041*
Qp/Qs	1.2±0.177	0.274	0.041*

*significant

There was no significant correlation between colour coded tissue Doppler parameters (CCP, and normalized CCP) with RA. area and normalized RA. area (table 7, 8), but there was a significant correlation between CCP/SL ratio and normalized RA. area (table 9)

Table 7: Correlation between CCP distance and RA. Area

Parameter	Mean ±	Std.Error mean	P value
CCP	28.1±3.114	0.492	0.092
RA.area	24.4±2.224	0.351	

Table 8: Correlation between normalized CCP distance and normalized RA. area

Parameter	Mean ±	Std.Error mean	P value
Normalized CCP	15.2±2.359	0.373	0.098
Normalize RA.Area	13.2±1.735	0.274	0.098

Table 9: Correlation between CCP/SL ratio and normalized RA. Area

Parameter	Mean ±	Std.Error mean	P value
CCP/SL	40.9±3.532	0.565	0.024*
Normalize RA.area	13.2±1.735	0.274	0.024*

*Significant

The correlation of colour coded tissue Doppler parameters of ASD patients with RV. basal diameter shows that there was no significant correlation between CCP distance, normalized CCP distance and RV. basal diameter and normalized RV. basal diameter respectively, but there was a significant correlation between CCP/SL and normalized RV. basal diameter as shown in table 10, 11, and 12 respectively.

Table 10: Correlation between CCP distance and RV. basal diameter

Parameter	Mean ±	Std.Error mean	P value
CCP	28.1±3.114	0.492	0.087
RV.basal diameter	46.8±3.627	0.573	

Table 11: Correlation between normalized CCP distance and normalized RV. basal diameter

Parameter	Mean ±	Std. Error mean	P value
Normalize CCP	15.2±2.359	0. 373	0.067
Normalize RV.basal diameter	25.3±2.692	0.425	0.076

Table 12: Correlation between CCP/SL ratio and normalized RV. basal diameter

Parameter	Mean ±	Std.Error mean	P value
CCP/SL ratio	40.9±3.532	0.565	0.046*
Normalized RV basal diameter	25.3±2.692	0.425	0.046*

Significant *

DISCUSSION

For this research, we developed a modality of Doppler tissue imaging to assess ventricular wall motion by changing the traditional Doppler color flow imaging system. Different studies have shown that color coded Tissue Doppler TDI imagery is a reliable method of detecting ventricular wall movement (13, 14)

Our study showed that the female patient ratio in ASD was 83 percent, and the male ratio was 17 percent, 90 percent was the rate of ASD secondum, and 10 percent was approved for Sinus venosus relative to previous research.

Compared to the control group, the CCP distance was moved towards the top, the change was observed proximally at a distance of 28.125 ±3.114 mm 40.9 percent from the Aortic valve, this finding was consistent with that stated by Iwaski et al (15), and was not consistent with Kardesoglu et al. This change of IVS could be due to the volume overload on the right ventricle, the key haemodynamic effect of ASD, but the explanation why an increased volume load may lead to a shift of CCP to the apex and its physical basis needs further study. In our analysis we tested the association between echocardiographic measurements obtained by color coded Tissue Doppler imagery TDI and other echocardiographic parameters in control and ASD classes, there was a important association between CCP, normalized CCP / SL ratio, right atrium area (RA area), normalized right atrium region, right basal ventricle diameter (RV. basal diameter), And uniform rv. Basal diameter, agreed with Iwaski et al., who found a strong link between TDI parameters and Qp / QS, the key parameters of ASD assessment, in our analysis we added the right atrium region and right basal ventricle diameter to Qp / Qs, making TDI parameters one of the main parameters of ASD assessment (16)

According to Kardesoglu et al. there was no substantial association between Qp / Qs value and standardized CCP size, this can be explained as a limited number of patients were taken in this study(1) (17) found that a ventricular septal motion was frankly paradoxical in patients with an atrial septal defect (81 percent), flat in three (7 percent) and regular in (12 percent). Nevertheless, when septal motion was quantified as a change in septal location from end-diastole to systole and measured as a percentage of diastolic cardiac diameter, there was a spectrum in the magnitude of septal motion rather than a distinct distinction between regular, flat, and paradoxical motion. Regular patients include those with irregular septal activity. Consequently, each patient in whom the septum was relatively anterior (as defined by a septal position ratio of 0.40 or less) had regular septal motion, while each patient in whom the septum was relatively posterior (as defined by a septalposition ratio greater than 0.40) had irregular flat or anterior motion. In addition the correlation between the ratio of the end-diastolic septal position and the magnitude of the systolic septal motion was strong. By contrast, septal motion magnitude and direction were weakly associated with the RVDD index and negatively correlated with shunt magnitude (expressed as Qp: Qs) and right systolic ventricular pressure. In general the ASD patients with regular septal motion were those with smaller shunts, though not necessarily. (Contrast, except for patients with Eisenmenger reactions, each flat or paradoxically moving ASD patient had Qp: Qs greater than 1.5:1. However, four out of five patients with normal septal motion had right ventricular diastolic diameter (RVDD) index greater than 1.4, It was slightly higher than average (mean 1.0 ± SD 0.2 cm / m2) and not substantially different from flat or paradoxically moving ASD patients, which is consistent with our study findings, but we took basal RV in our sample. Diameter over RVDD. Although McDicken, Moran and Groundstroem and their colleagues reported that tissue movement could be estimated by modified color Doppler imaging, the validity and accuracy of this method for clinical assessment have not been systematically studied.

CONCLUSIONS

Color Coded TDI has been found to be a reliable tool for the identification of wall movement disorders in adult ASD patients.

CONFLICT OF INTEREST

None

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