Tricusped Annular Plane Systolic Excursion in Children with ASD

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ABSTRACT:
Background: the complexity of estimating RV geometry and function was well documented and Tricusped Annular Plane Systolic Excursion (TAPSE) is one of the assessment tools of right ventricle in adults. **Aim Of the work:** this study aimed to evaluate right ventricular (RV) function in children with atrial septal defect (ASD) and to determine whether TAPSE is an accurate marker of right ventricular (RV) systolic function in patients with atrial septal defect (ASD).
Patients and methods: this retrospective study was conducted on 30 Egyptian children with age ranged from 2 months to 18 years of both sexes and they were categorized into two groups, 20 patients group with ASD and 10 control group; they were referred to Cardiology Unit of Al-Azhar University Hospitals in the period from December 2016 to December 2018. The ethics committee of Faculty of Medicine, Al-Azhar University approved this study after verbal and written consents from the parents of these children. All children were subjected to the clinical history, general examination, local examination, chest radiograph, electrocardiogram (ECG) and trans-thorathic echocardiography examination. **Results:** there was statistical significant difference in TAPSE results between ASD and non-ASD children, statistical significant difference in ECG finding between ASD and non-ASD children, there was a statistical significant positive correlation between TAPSE and right ventricular fractional area changes (RVFAC) in the control group and a statistical significant negative correlation between TAPSE and left ventricle ejection fraction (LVEF). **Conclusion:** TAPSE is a good indicator for the right ventricular function in children with ASD and a good predictor for development of complications.
Key words: Tricusped Annular Plane Systolic Excursion, atrial septal defects, right ventricular function.

INTRODUCTION

The complexity of estimating RV geometry and function was well documented. The main problems were: complex, three-dimensional RV shape impossible to describe the known geometric figures, specific myocardial fibres orientation (different from LV) and their various participation in RV contraction. Both interventricular septum and RV free wall contribute approximately equally to the right ventricular function [1]. Tricuspid Annular Plane Systolic Excursion (TAPSE) and Tricuspid Annular Peak Systolic Velocity (TAPSV) are from the recently published indices for assessment of right ventricular function [2].

The TAPSE is an indicator of ventricular contractile function that correlates well with RVEF in adults and can also be used as a reference of systolic RV function in pediatrics [3].

Atrial Septal Defect (ASD) is one of the more common congenital cardiac anomalies presenting in childhood. Atrial septal defect is characterized by a defect in the inter-atrial septum allowing left to right shunt. Depending on the size of the defect, size of the shunt and associated anomalies, this can result in a spectrum of disease affecting the right ventricular function ranging from no significant cardiac sequelae to right ventricular dysfunction, pulmonary arterial hypertension, and even atrial arrhythmias [4].

AIM of the WORK:

The purposes of this study were to evaluate right ventricular (RV) function in patients with atrial septal defect (ASD) and to determine whether TAPSE is an accurate marker of right ventricular (RV) systolic function in patients with atrial septal defect (ASD).

PATIENTS and METHODS

This retrospective study was performed on 30 Egyptian children with age ranged from 2 months to 18 years of both sexes; they were referred to Cardiology Unit of Al-Azhar University Hospitals and found to be normal by clinical examination and by investigations in the period from December 2016 to December 2018.

The ethics committee of faculty of medicine Al-Azhar University approved this study.

The children in this study were classified according to the ASD to two groups:
*   Group 1 patients with ASD.
*   Group 2 healthy children as the control group
- **Inclusion criteria**:
The criteria for inclusion in this study were clinical and/or echocardiographic evidence of a significant left-to-right shunt through a ASD.
- **Exclusion criteria**:
1- Weight less than 5 kg.
2- Other significant congenital cardiac anomalies.

3- Multiple complex congenital anomalies of the heart.

4- Symptoms and signs of sepsis and shock.

All children under the study were subjected to the following:

• **Written consent** was obtained from parents of these children participating in this study.

• **Detailed history** with special emphasis on the family history of cardiac diseases.

• **Through clinical examination**: including general examination and local examination.

• Chest radiograph and electrocardiograph.

• Echocardiography with special emphasis on asd size, RVFAC, LVEF and TAPSE.

Statistical analysis:

Data were analyzed by using Statistical Program for Social Science (SPSS) version 15.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

☐ Independent-samples t-test of significance: was used when comparing between two means.

☐ Chi-square test: was used when comparing between non-parametric data.

☐ A one-way analysis of variance (ANOVA): when comparing between more than two means.

☐ Pearson's correlation coefficient (r): test was used for correlating data.

☐ Probability (P-value)

P-value < 0.05 was considered significant.

P-value < 0.001 was considered as highly significant.

P-value > 0.05 was considered insignificant.

RESULTS:

Table 1 : comparison between patients and the control as regard personal data

Variables		Patients (N = 20)	Control (N = 10)	P-value
Age (months)	**Mean**	78.3	78.0	0.9
	±SD	42.6	39.3	
Sex	**Male**	9 (45%)	5 (50%)	0.8
	Female	11 (55%)	5(50%)	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001:highly significant.

In this study, the mean age of patients group was 78.3±42.6 months and 78±39.3 months with a statistical significant difference (P-value 0.9) between the two groups.

As regard the sex distribution, in patients group male were 45% and female were 55% while, in the control group male to female ratio was 1:1 and there was also no statistical significant difference (p-value > 0.8) between the patients and the control groups.

Table 2 : comparison between the patients and control as regard present history of cardiac diseases

Variables		Patients (N = 20)	Control (N = 10)	P-value
present history of cardiac diseases	**Asymptomatic**	10 (50%)	7 (70%)	0.09
	Repeated chest infection	3 (15%)	1 (10%)	
	Dyspnea on exertion	6 (30%)	0 (0%)	
	Tachycardia	0 (0%)	2 (20%)	
	Feeding difficulty	1 (5%)	0 (0%)	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001:highly significant.

From all subjected children, 10 children (50%) of patients group were asymptomatic, 3 children (15%) presented by repeated chest infection, 3 children (30%) presented by dyspnea on exertion, one child (5%) presented by feeding difficulty, while in the control group, 7 children (70%) were asymptomatic, two children (20%) presented by tachycardia and only one child presented by repeated chest infection.There was no

statistical significant difference (p-value > 0.05) between the patients and the control as regard present history of cardiac diseases.

Table 3: comparison between patients and control as regard body measurements

Variables		Patients (N = 20)	Control (N = 10)	P-value
Weight (Kg)	Mean	20.1	22.3	0.6
	±SD	8.6	11.2	
Weight percentile	Mean	23.6	34.6	0.3
	±SD	26.3	21.6	
BSA	Mean	0.7	0.8	0.3
	±SD	0.2	0.3	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001: highly significant

In this table, the mean weight of patients group was 20.1±8.6 kg while, in the control group was 22.3±11.2 kg and there was statistical significant difference (p-value > 0.6) between both groups.

The mean body surface area of patient group was 0.7±0.2 m³ while, in the control group it was 0.8±0.3 m³ and also there was no statistical significant difference (p-value > 0.05) between both groups.

Table 4 : comparison between the patients and control as regard vital data

Variables		Patients (N = 20)	Control (N = 10)	P-value
HR (beat / min)	Mean	103.9	94.8	0.2
	±SD	12.3	21.3	
RR (cycle / min)	Mean	26.8	24.8	0.6
	±SD	9.4	8.5	
Temp. (cº)	Mean	37.09	37.2	0.4
	±SD	0.3	0.4	
Systolic BP (mmHg)	Mean	94.4	102.7	0.05
	±SD	11.5	7.9	
Diastolic BP (mmHg)	Mean	56.9	63.6	0.07
	±SD	8.5	10.5	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001: highly significant

This table showed no statistical significant difference **(p-value > 0.05)** between the patients and control as regard vital data (HR, RR, Temp., systolic BP and diastolic BP).

Table 5: comparison between patients and control as regard ECG

Variables		Patients (N = 20)	Control (N = 10)	P-value
ECG	Normal	11 (55%)	10 (100%)	0.01*
	RVD RVH	9 (45%)	0 (0%)	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001:highly significant

This table shows statistically significant difference **(p-value < 0.01)** between the patients and control as regard ECG.

Table 6: comparison between patients and control as regard echocardiography

Variables		Patients (N = 20)	Control (N = 10)	P-value
ASD size (mm)	Mean	16.08	0.0	< 0.001**
	±SD	6.9	0.0	
MR	No	17 (85%)	10 (100%)	0.6
	Grade I	1 (5%)	0 (0%)	
	Grade II	1 (5%)	0 (0%)	
	Travial	1 (5%)	0 (0%)	
EF	Mean	65.3	69.2	0.2
	±SD	5.6	10.4	
TAPSE	Mean	16.2	19.5	0.009*
	±SD	4.4	2.3	

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001:highly significant

This table showed:

•   Highly statistical significant difference (p-value < 0.001) between the patients and the control as regard ASD size.

•   Statistically significant difference (p-value < 0.05) between patients and control as regard TAPSE.

•   No statistical significant difference (p-value > 0.05) between patients and control as regard MR and EF.

Table 7 : correlation study between TAPSE and other studied parameters (age, ASD size, EF and RVFAC) in patients group

Variables	Patients group (r)	p-value
TAPSE vs age	0.2	0.3
TAPSE vs ASD size	0.03	0.9
TAPSE vs EF	- 0.5	0.04*
TAPSE vs RVFAC	- 0.9	0.9

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001:highly significant

This table showed:

•   Statistically significant (p-value < 0.05) negative correlation (n = - 0.5) between TAPSE and EF in the patients group.

•   No statistical significant (p-value > 0.05) correlation between TAPSE and other studied parameters (age, ASD size and RVFAC) in the patients group.
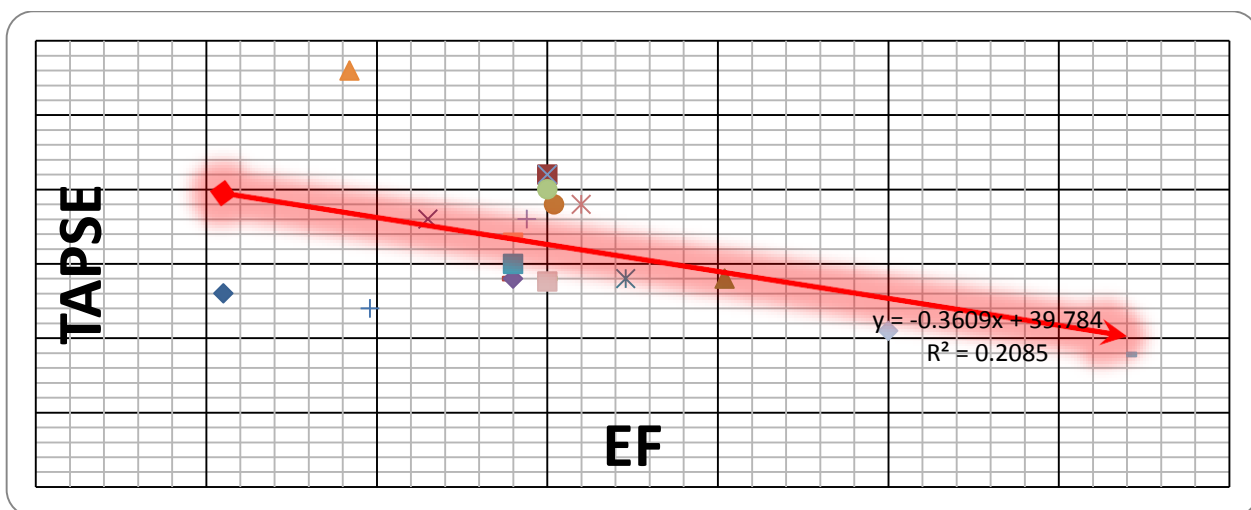

$y = -0.3609x + 39.784$
$R^2 = 0.2085$

Figure 1: negative correlation between TAPSE and EF in patients group

Table 8: correlation study between TAPSE and other studied parameters (age, EF and RVFAC) in control group

Variables	Control group	(r)	p-value
TAPSE vs age		0.6	0.05
TAPSE vs EF		0.6	0.06
TAPSE vs RVFAC		0.8	**0.01***

P-value .0.05: no significant   P-value > 0.05: insignificant   P-value < 0.001: highly significant
This table showed:
•   Statistically significant (**p-value < 0.01**) positive correlation (**n = 0.8**) between TAPSE and RVFAC in the control group.
•   No statistical significant (**p-value > 0.05**) correlation between TAPSE and other studied parameters (age and EF) in the control group.
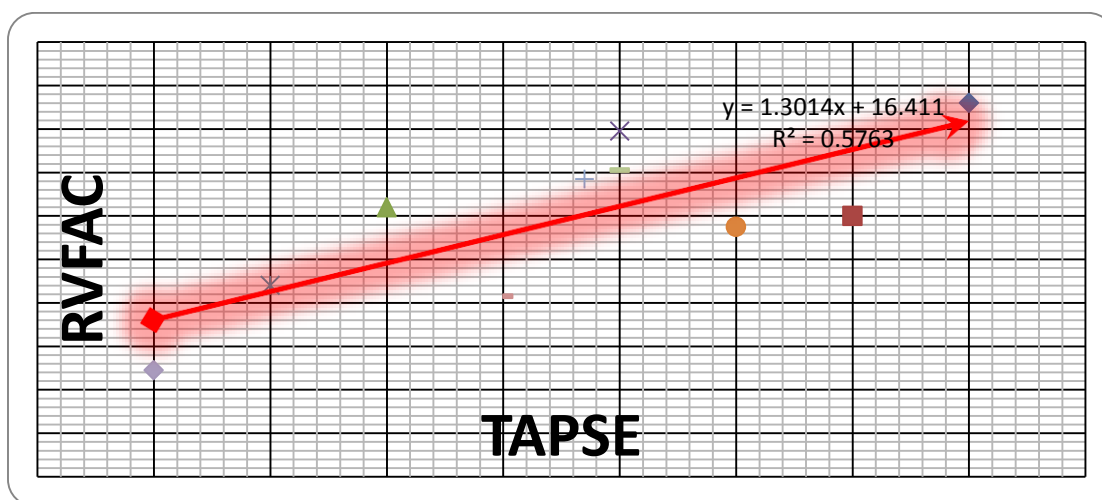
Figure 2: positive correlation between TAPSE and RVFAC in control group

DISCUSSION:
This study was performed on 30 Egyptian children referred to Cardiology Unit of Al-Azhar University Hospitals. These children were categorized into two groups, group A 20 children with ASD and group B 10 normal healthy children to evaluate the right ventricular function using TAPSE. The demographic features of total children of the study were demonstrated. In the control group, the mean age of the studied children was 78±39.3 months in control group, the mean weight in kg was 22.3±11.2 in the control group and the mean body surface area in m² was .8±.3 in the control group while, in study performed by **Fahrettin *et al*.** [5] on Turkish children, the mean age in months was 86.98±60.62 the mean weight in kg was 27.64±18.47, while the mean BSA in m2 was 0.91±0.44 and in study performed by **Ivan *et al*.** [6] on Spanish children the mean age in years was 4.12±4.29, the mean weigh in kg was 18.05±16.07 and mean BSA was 0.67±0.39 m2. This can be explained by the fact that anthropometric measurements differ among children of different countries due to the difference in nutritional, racial and environmental factors.

In the patients group, the mean age of the studied children was 78.3±42.6 months, the mean weight in kg was 20.1±8.6 and the mean body surface area in m² was 0.7±0.2 with no statistically significant difference between that of the control group (P value <0.05) as the control group were age and sex matched with patient group.In our study, there was no statistical significant difference in the demographic features included weight and BSA between males and females in both patient and control groups where p value was > 0.05 . These results agree with results of **Fahrettin *et al*.** [5] and **Ivan *et al*.** [6] In our study, there was a statistically significant difference (**p-value < 0.05**) between the patients and control as

regard ECG which showed right ventricular enlargement in the patients group. These results agree with those of **Santos et al.**[7] who demonstrated that electrocardiographic anomalies can help in diagnosing atrial septal defects. An rSr' or rsR' QRS configuration that could be seen on the ECG in right precordial leads likely reflecting right ventricular dysfunction.

In our study, the mean value of TAPSE for the control group in relation to their age was 19.5±2.3 mm, this agrees with the study performed by **Fahrettin et al.** [5], in which the mean TAPSE value was 19.56±5.54mm. While, in another study performed by **Ivan et al.** [6] , they showed that the mean TAPSE value was 17.09±5.09mm.This proved that TAPSE is influenced by both racial and environmental factors.

On the other hand, the mean value of TAPSE in the patients group was 16.2±4.4mm with a statistically significant difference between patient and control group (p value <0.009). These results agree with results of **Kassem et al.** [8] , they found that tricuspid annular motion in children with CHD including ASD especially if there is pulmonary hypertension have shown reduced tricuspid annular plane systolic excursion values when compared with age-matched and children.

In this study, there was no statistical significant difference (p-value > 0.05) between patients and control as regard RVFAC. This result agree with those of **Andrews et al.**[9] , they showed that ASD in infancy, childhood and adolescence even with large ASD, impaired right ventricular function occur later on in life.

In our study, there was a statistically significant (p-value < 0.05) positive correlation (n = 0.8) between TAPSE and RVFAC in the control group. This result come in agreement with the study performed by **Sato et al.** [10] which approved the relation between TAPSE and RVFAC compared to cardiac magnetic resonance derived measurements.

On the other hand, there was a statistically significant (p-value 0.04) negative correlation (n = - 0.5) between TAPSE and EF in patients group. As regard the diagnostic and prognostic value of TAPSE in the congenital heart diseases, a study performed by **Levy et al.** [11] , they found that the value of TAPSE was unchanged in ASD children only without pulmonary hypertension, but this value was lower than normal in children with ASD associated pulmonary hypertension. Also, this study showed the importance of assessment of right ventricular function by TAPSE to predict prognosis.

CONCLUSION:

In this study we concluded that assessment of right ventricle systolic function is not easy by Echocardiography due to its complex geometry, and it has both diagnostic and prognostic values in pediatric diseases. Tricuspid annular plane systolic excursion (TAPSE) is a simple, reliable, easy and reproducible measure done by M-mode echocardiography for assessment of R.V. systolic function. Reference value of TAPSE in adults is known but in pediatrics, TAPSE value differ according to anthropometric measurements, racial and environmental factors, accordingly each country should use its specific reference values and percentile charts while evaluating TAPSE. TAPSE correlates positively with RVFAC and negatively with LVEF. value of TAPSE was lower in ASD children than non-ASD children. Value of TAPSE was unchanged in patients with only ASD without pulmonary hypertension.

RECOMMENDATIONS:
- Assessment of right ventricle systolic function should be done routinely by echocardiography.
- Tricuspid annular plane systolic excursion (TAPSE) should be used routinely as a simple, reliable, reproducible echocardiographic measure for assessment of R.V. systolic function.
- Each country should use its specific percentile charts for reference values of TAPSE as TAPSE differs according to anthropometric measurements, racial and environmental factors.
- Further studies should include larger number children with other structural heart diseases and should be done in multiple centers of Egypt.
- TAPSE can be used as a follow up measure in children with ASD to predict development of complication like pulmonary artery hypertension.

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