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Predictors of Improvement After Device Closure of Atrial Septal Defect in Patients Above 30 Years

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Abstract

Background: Atrial septal defects constitute around 25–30% of recent diagnoses of congenital heart defects in adults and the most common a cyanotic shunt lesion in adult as well.

Aim of work: Assessment of enhancement of heart performance after device closure Assessment of symptomatic improvement after device closure.

Patients and methods: This study was involved 30 cases with atrial septal defect (ASD) who underwent closure of ASD with device closure.

Results: Comparison among pre- and post-ASD device closure regarding echocardiogram data. There were significant statistical alterations in comparison amongst the pre- and post-ASD device closure regarding LVESV ($P < 0.001$), EF ($P = 0.038$), MAPSE ($P = 0.005$) LV MPI ($P < 0.001$), deceleration time ($P < 0.001$), E/A ratio ($P = 0.022$) and E/e' ratio ($P = 0.015$). There were also a significant statistical difference regarding, RV MPI ($P < 0.001$), TAPSE ($P < 0.001$), s' ($P < 0.001$), IVRT ($P < 0.001$), RV FAC ($P < 0.001$) and LA volume ($P = 0.022$). There were no significant statistical change regarding LVEDD ($P = 0.293$) also RA volume ($P = 0.065$).

Conclusion: Device closure of ASDs result in an enhancement of RV, LV function and LA volume besides a non-significant reduction in RA volume.

Keywords: Atrial septal defect, Pulmonary arterial hypertension, Transcatheter closure

1. Introduction

ASD constitute approximately 25% to thirty percent of recent detects of congenital heart problems in adults and the most common a cyanotic shunt lesion in adult as well.¹

The left-to-right shunt through the interatrial septal defect result in chronic overload of the right heart.² If it is not treated, it may lead to atrial arrhythmias, pulmonary hypertension, right heart failure, systemic embolism, atrioventricular valve regurgitation.³

Transcatheter closure of ostium secundum (ASDs) has evolved from its initial use by Mills and King in

1976 to become a viable alternative to operating correction.⁴

The employment of the transcatheter closure of atrial septal defect has been highly successful, accompanied by comparable rate of complication compared with the surgical intervention.⁵ In spite of extraordinary outcomes, the available information about the improvement of Cardiac performance after elective percutaneous closure of the atrial septal defect is limited.⁶

Moreover, the mechanisms that intervene in determining cardiac performance improvement after Transcatheter closure remain to be identified.⁷ Our present study aimed to Assess of enhancement

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of heart performance after device closure and Assess of symptomatic improvement after device closure.

2. Patients and methods

This study was involved 30 cases with atrial septal defect (ASD) who underwent closure of ASD with device closure.

2.1. Inclusion criteria

Age was above 30 years, Symptomatic Secundum atrial septal defect with a left-to-right shunt.

2.2. Exclusion criteria

ASD was >38 mm or inadequate rims for device closure, Concomitant congenital heart illness and Pulmonary hypertension not fit for percutaneous closure, Patients with AF, and individuals who failed an exercise test.

Table 1. Demographic data of the patients.

	(Number = 30)
Sex	
Male	10 (33.3%)
Female	20 (66.7%)
Age (years)	
Mean ± SD	41.16 ± 7.63
Range	30–57
Weight (kg)	
Mean ± SD	70.28 ± 6.83
Range	59–85.5
Height (cm)	
Mean ± SD	167.23 ± 6.26
Range	159–183
Body Mass Index (kg/m ²)	
Mean ± SD	25.08 ± 1.46
Range	22.2–27.7
Diabetes mellitus	
Yes	6 (20.0%)
No	24 (80.0%)
Hypertension	
Yes	3 (10.0%)
No	27 (90.0%)
Dyslipidemia	
Yes	8 (26.7%)
No	22 (73.3%)
Thyroid disorders	
Yes	2 (6.7%)
No	28 (93.3%)
Symptoms	
No	2 (6.7%)
Dyspnea	6 (20.0%)
Fatigability	6 (20.0%)
Palpitation	3 (10.0%)
> one symptom	13 (43.3%)

2.3. Operation design

1-History taking, 2-Clinical examination 3-Laboratory investigations 4-Standard 12-leads ECG5. Echocardiography: Left ventricular systolic function, LV diastolic function, RV systolic function.

3. Results

Table 1 showed that demographic data of the cases. The mean age was 41.16 ± 7.63 years. Twenty patients (66.7%) were female and 10 patients (33.3%) were males. The mean weight was 70.28 ± 6.83 Kg,

Table 2. Preprocedural echocardiogram data of the patients.

LVEDV (ml)	
Mean ± SD	64.89 ± 7.30
Range	49.1–79.5
LVESV (ml)	
Mean ± SD	24.51 ± 3.50
Range	18.2–29.9
EF (%)	
Mean ± SD	58.57 ± 2.87
Range	53.5–65.2
MAPSE (cm)	
Mean ± SD	1.87 ± 0.21
Range	1.5–2.2
LV MPI	
Mean ± SD	0.28 ± 0.14
Range	0.11–0.80
Deceleration time (ms)	
Mean ± SD	221.36 ± 49.86
Range	130–379
E/A ratio	
Mean ± SD	1.68 ± 0.44
Range	1.0–2.4
E/e' ratio (lateral)	
Mean ± SD	7.05 ± 2.21
Range	2.5–10.4
RV MPI	
Mean ± SD	0.59 ± 0.07
Range	0.45–0.76
TAPSE (cm)	
Mean ± SD	1.91 ± 0.38
Range	1.2–2.7
IVRT (mm/s)	
Mean ± SD	128.26 ± 12.72
Range	87–142
RV FAC (%)	
Mean ± SD	67.50 ± 6.14
Range	57.2–79.4
S' (lateral) (cm/s)	
Mean ± SD	16.09 ± 2.76
Range	11.4–20.5
LA volume (ml)	
Mean ± SD	31.35 ± 5.52
Range	18.6–39.6
RA Volume (ml)	
Mean ± SD	38.68 ± 2.71
Range	34.9–45.0
ASD size (mm) (by TEE)	
Mean ± SD	22.96 ± 4.24
Range	15–28

Table 3. Post-procedural echocardiogram data of the patients.

LVEDV (ml)	
Mean \pm SD	66.84 \pm 6.95
Range	55.4–79.5
LVESV (ml)	
Mean \pm SD	29.29 \pm 3.77
Range	20.9–35.1
EF (%)	
Mean \pm SD	60.00 \pm 2.34
Range	56.6–64.2
MAPSE (cm)	
Mean \pm SD	2.03 \pm 0.22
Range	1.6–2.5
LV MPI	
Mean \pm SD	0.40 \pm 0.08
Range	0.31–0.67
Deceleration time (ms)	
Mean \pm SD	127.67 \pm 26.20
Range	99–212
E/A ratio	
Mean \pm SD	1.41 \pm 0.45
Range	0.6–2.1
E/e' ratio (lateral)	
Mean \pm SD	5.62 \pm 2.21
Range	1.6–10
RV MPI	
Mean \pm SD	0.38 \pm 0.02
Range	0.31–0.45
TAPSE (cm)	
Mean \pm SD	2.43 \pm 0.43
Range	1.7–3.2
IVRT (mm/s)	
Mean \pm SD	86.23 \pm 13.04
Range	65–109
RV FAC (%)	
Mean \pm SD	42.55 \pm 6.69
Range	30.7–53.1
S' (lateral) (cm/s)	
Mean \pm SD	13.15 \pm 3.37
Range	6.5–18.4
LA volume (ml)	
Mean \pm SD	34.35 \pm 4.28
Range	24.5–40.4
RA volume (ml)	
Mean \pm SD	27.54 \pm 2.35
Range	24–32

the mean height was 167.23 ± 6.26 cm and the mean body mass index was 25.08 ± 1.46 kg/m².

Regarding the comorbidities, 6 patients (20%) were diabetic, 3 participants (10%) were hypertensive, 8 participants (26.7%) were dyslipidemic and 2 participants (6.7%) had thyroid disorders. The main symptom of the patients were dyspnea in 6 patients (20%), fatigability in 6 patients (20%), palpitation in 3 patients (10%), and combinations of the previous symptoms in 13 patient (43.3%). On the other hand, there were 2 patients who were asymptomatic (Table 2).

Our results showed that the pre-procedural echocardiogram data of the patient. The mean LVEDV was 64.89 ± 7.30 ml, and the mean LVESV was 24.51 ± 3.50 ml.

Regarding the assessment of the LV systolic function, the mean EF was $58.57 \pm 2.87\%$, the mean MAPSE was 1.87 ± 0.21 cm, the mean LV MPI was 0.28 ± 0.14 . Regarding the assessment of the LV diastolic function, the mean deceleration time was 221.36 ± 49.86 ms, the mean E/A ratio was 1.68 ± 0.44 , and E/e' ratio was 7.05 ± 2.21 . Regarding the assessment of the RV systolic function, the mean RV MPI was 0.59 ± 0.07 , the mean TAPSE was 1.91 ± 0.38 cm, the mean IVRT was 128.26 ± 12.72 mm/s, the mean RV FAC was $67.50 \pm 6.14\%$ and the mean tissue doppler velocity (s') was 16.09 ± 2.76 cm/s. The mean LA volume was 31.35 ± 5.52 ml and the mean RA volume was 38.68 ± 2.71 ml. The mean size of ASD, which was measured by TEE, was 22.96 ± 4.24 mm (Table 3, Fig. 1).

Our results showed that the post-procedural echocardiogram data of the patient. The mean LVEDV was 66.84 ± 6.95 ml and the mean LVESV was 29.29 ± 3.77 ml.

Regarding the assessment of the LV systolic function, the mean EF was $60.00 \pm 2.34\%$, the mean MAPSE was 2.03 ± 0.22 cm, the mean LV MPI was 0.40 ± 0.08 . Regarding the assessment of the LV

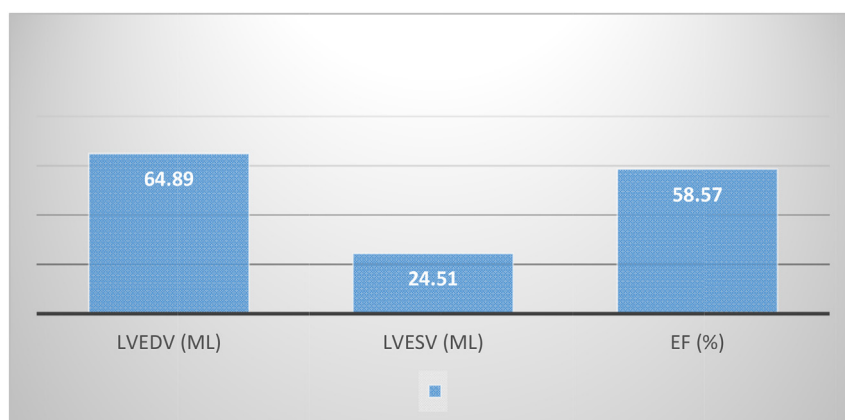


Fig. 1. Shows preprocedural LVEDV, LVESV and EF of the patients.

Table 4. Comparison among pre & post ASD device closure regarding echocardiogram data.

	Pre- (Number = 30)	Post- (Number = 30)	P value
LVEDV (mm)	64.89 ± 7.30	66.84 ± 6.95	0.293
LVESV (mm)	24.51 ± 3.50	29.29 ± 3.77	<0.001*
EF (%)	58.57 ± 2.87	60.00 ± 2.34	0.038*
MAPSE (cm)	1.87 ± 0.21	2.03 ± 0.22	0.005*
LV MPI	0.28 ± 0.14	0.40 ± 0.08	<0.001*
Deceation time (ms)	221.36 ± 49.86	127.67 ± 26.20	<0.001*
E/A ratio	1.68 ± 0.44	1.41 ± 0.45	0.022*
E/e'ratio (lateral)	7.05 ± 2.21	5.62 ± 2.21	0.015*
RV MPI	0.59 ± 0.07	0.38 ± 0.02	<0.001*
TAPSE (cm)	1.91 ± 0.38	2.43 ± 0.43	<0.001*
IVRT (mm/s)	128.26 ± 12.72	86.23 ± 13.04	<0.001*
RV FAC (%)	67.50 ± 6.14	42.55 ± 6.69	<0.001*
S' (lateral) (cm/s)	16.09 ± 2.76	13.15 ± 3.37	<0.001*
LA volume (ml)	31.35 ± 5.52	34.35 ± 4.28	0.022*
RA volume (ml)	38.68 ± 2.71	27.54 ± 2.35	0.065

* Increase volume after closure with significant P value.

diastolic function, the mean deceleration time was 127.67 ± 26.20 ms, the mean E/A ratio was 1.41 ± 0.45 and the E/e' ratio was 5.62 ± 2.21.

Regarding the assessment of the RV systolic function, the mean RV MPI was 0.38 ± 0.02, the mean TAPSE was 2.43 ± 0.43 cm, the mean IVRT was 86.23 ± 13.04 mm/s, the mean RV FAC was 42.55 ± 6.69% and the mean tissue doppler velocity (s') was 16.09 ± 2.76 cm/s. The mean LA volume was 34.35 ± 4.28 ml and the mean RA volume was 27.54 ± 2.35 ml (Table 4, Fig. 2).

Our results showed that comparison amongst pre- and post-ASD device closure regarding echocardiogram data. There were significant statistical variances in comparison among the pre- and post-atrial septal defects device closure regarding LVESV (P < 0.001), EF (P = 0.038), MAPSE

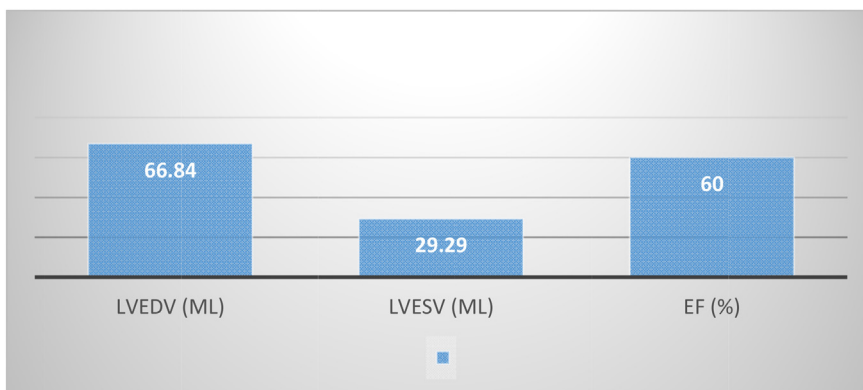


Fig. 2. Shows postprocedural LVEDV, LVESV and EF of the patients.

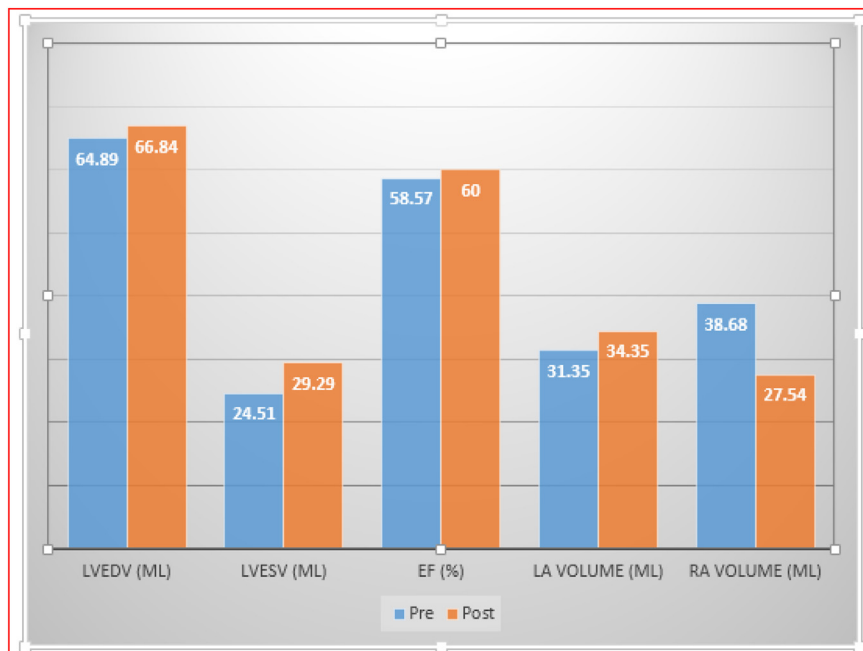


Fig. 3. Shows comparison between pre and post ASD device closure retarding LVEDV, LVESV, LA volume and RA volume.

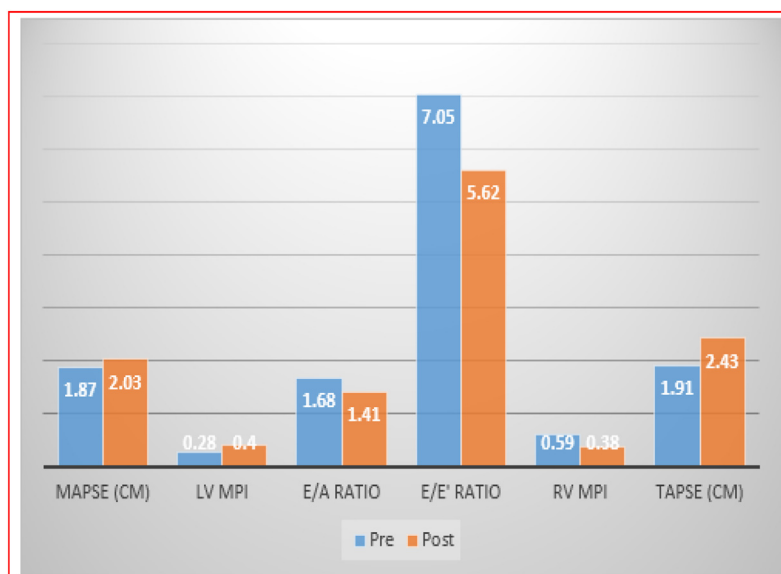


Fig. 4. Shows comparison between pre and post ASD device closure regarding MAPSE, LV MPI, E/A ratio, E/e' ratio, RV MPI and TAPSE.

($P = 0.005$) LV MPI ($P < 0.001$), deceleration time ($P < 0.001$), E/A ratio ($P = 0.022$) and E/e' ratio ($P = 0.015$) There were also significant statistical difference regarding, RV MPI ($P < 0.001$), TAPSE ($P < 0.001$), s' ($P < 0.001$), IVRT ($P < 0.001$), RV FAC ($P < 0.001$) and LA volume ($P = 0.022$). There were no significant statistical difference regarding LVEDD ($P = 0.293$) and RA volume ($P = 0.065$) (Figs. 3 and 4).

4. Discussion

An atrial septal defect accounts for approximately ten percent of all congenital cardiac problems and is one of the most frequent kinds of congenital heart illness in adults. Without treatment, atrial arrhythmias, right heart failure, pulmonary hypertension and/or a systemic embolism can develop as a result of the chronic volume overload of the right heart caused by the left-to-right shunt through an ASD.⁸ Both surgical and device closure of ASDs have been found to enhance hemodynamic and functional right ventricular performance in previous investigations. Closure of (ASDs) via Medical Device for Patients with PAH (pulmonary arterial hypertension) increased cardiac function, decreased atrial arrhythmias and decreased severity of PAH.⁹

Our results showed that the mean age was 41.16 ± 7.63 years. 20 cases (66.7%) were female & 10 patients (33.3%) were males. The mean weight was 70.28 ± 6.83 Kg, the mean height was 167.23 ± 6.26 cm and the mean body mass index was 25.08 ± 1.46 kg/

m^2 . regarding the comorbidities, 6 cases (20%) were diabetic, 3 cases (10%) were hypertensive, 8 cases (26.7%) were dyslipidemic and 2 cases (6.7%) had thyroid disorders. The main symptom of the patients were dyspnea in 6 patients (20%), fatigability in 6 patients (20%), palpitation in 3 patients (10%) and combinations of the previous symptoms in 13 patient (43.3%). On the other hand, there were 2 patients who were asymptomatic.

Our results agreement with Ermis *et al.*¹⁰ who found that there were a total of 19 participants (17 females and 2 males). Mean age was 47.2 years (± 12.7) with an average body mass index of 25.8 (± 6.3). Of the 19 patients, 6 individuals had a medical history of hypertension, 2 individuals had hyperlipidemia, 1 person had history of stroke, 1 individual with hypothyroidism and 1 individual had a history of coronary artery disease with previous percutaneous coronary intervention to the left anterior descending. No additional comorbid medical conditions were present.

Our results Showed that the pre-procedural echocardiogram data of the patient. The mean LVEDV was 64.89 ± 7.30 ml and the mean LVESV was 24.51 ± 3.50 ml. regarding the assessment of the LV systolic function, the mean EF was $58.57 \pm 2.87\%$, the mean MAPSE was 1.87 ± 0.21 cm, the mean LV MPI was 0.28 ± 0.14 . Regarding the assessment of the LV diastolic function, the mean deceleration time was 221.36 ± 49.86 ms, the mean E/A ratio was 1.68 ± 0.44 and E/e' ratio was 7.05 ± 2.21 . regarding the assessment of the RV systolic function, the mean RV MPI was 0.59 ± 0.07 , the mean TAPSE was

1.91 ± 0.38 cm, the mean IVRT was 128.26 ± 12.72 mm/s, the mean RV FAC was 67.50 ± 6.14% and the mean tissue doppler velocity (s') was 16.09 ± 2.76 cm/s. The mean LA volume was 31.35 ± 5.52 ml and the mean RA volume was 38.68 ± 2.71 ml. The mean size of ASD, which was measured by TEE, was 22.96 ± 4.24 mm.

Our results proposed with El Sherbiny *et al.*¹¹ who found that the mean LVED was 40.74 ± 2, the mean LVESD was 26.53 ± 1.22, the mean LVEDV was 73.33 ± 8.7, the mean LA diameter was 31.96 ± 2.75, the mean MAPSE was 23.16 ± 2.15, the mean RV area was 21.13 ± 4.3 and the mean RA area was 17.61 ± 4.21. Similarly, Our results agreement with Stephensen *et al.*¹² who found that the mean LVEDVi (ml/m²) was 83 ± 13, the mean LVESVi (ml/m²) was 36 ± 1, the mean LVSVi (ml/m²) was 47 ± 6, the mean LVEF (%) was 58 ± 8, the mean RVEDVi (ml/m²) was 171 ± 53, the mean RVESVi (ml/m²) was 82 ± 27, The mean RVEF (%) was 52 ± 6. The mean LAVi (ml/m²) was 61 ± 17 and The mean RAVi (ml/m²) was 103 ± 42.

Our results showed that the postprocedural echocardiogram data of the patient. The mean LVEDV was 66.84 ± 6.95 ml and the mean LVESV was 29.29 ± 3.77 ml. regarding the assessment of the LV systolic function, the mean EF was 60.00 ± 2.34%, the mean MAPSE was 2.03 ± 0.22 cm, the mean LV MPI was 0.40 ± 0.08. Regarding the assessment of the LV diastolic function, the mean deceleration time was 127.67 ± 26.20 ms, the mean E/A ratio was 1.41 ± 0.45 and E/e' ratio was 5.62 ± 2.21. Regarding the assessment of the RV systolic function, the mean RV MPI was 0.38 ± 0.02, the mean TAPSE was 2.43 ± 0.43 cm, the mean IVRT was 86.23 ± 13.04 mm/s, the mean RV FAC was 42.55 ± 6.69% and the mean tissue doppler velocity (s') was 16.09 ± 2.76 cm/s. The mean LA volume was 34.35 ± 4.28 ml and the mean RA volume was 27.54 ± 2.35 ml.

Our results agreement with El Sherbiny *et al.*¹¹ who found that the mean LVEDV was 79.24 ± 9.2 ml, the mean LVESD was 26.76 ± 1.41, the mean TAPSE was 19.66 ± 2.18, the mean MAPSE was 21.99 ± 2.75 the mean RA volume was 16.51 ± 3.6 and the mean LA diameter was 31.99 ± 2.77.

Our results showed that comparison between pre and post ASD device closure regarding echocardiogram data. There were significant statistical differences in comparison between the pre and post ASD device closure regarding LVESV ($P < 0.001$), EF ($P = 0.038$), MAPSE ($P = 0.005$) LV MPI ($P < 0.001$), deceleration time ($P < 0.001$), E/A ratio ($P = 0.022$) and E/e' ratio ($P = 0.015$). There were also

significant statistical difference regarding, RV MPI ($P < 0.001$), TAPSE ($P < 0.001$), s' ($P < 0.001$), IVRT ($P < 0.001$), RV FAC ($P < 0.001$) & LA volume ($P = 0.022$). There were no significant statistical difference regarding LVEDD ($P = 0.293$) and RA volume ($P = 0.065$). Our results agreement with EL-SISI *et al.*¹³ who found that LVEDD (cm) the mean pre ASD device closure was 2.9 ± 0.2 the mean after ASD closure was 3.2 ± 0.5 P value = 0.012*EF (%) the mean pre ASD device closure was 66.7 ± 5.1 the mean after ASD closure was 70.7 ± 8 P value = 0.033, the mean E/A ratio pre ASD device closure was 1.6 ± 0.3 P value = 0.039, TAPSE (mm) the mean pre ASD device closure was 22.9 ± 4.9 after ASD closure was 20.1 ± 4.3 P value = 0.003MAPSE (mm) pre ASD device closure was 15.3 ± 2.8 after ASD closure was 17.5 ± 2 P value = 0.026. all there were high statistically significant difference.

4.1. Conclusion

Device closure of ASDs leads to enhancement of RV, LV function and LA volume in addition to non-significant reduction in RA volume. These hemodynamic improvements provide insights into the symptomatic benefits gained in closure of ASDs using the device.

Conflicts of interest

Authors declare that there is no conflict of interest, no financial issues to be declared.

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