Role of Transthoracic Echocardiography in Pre-Intervention Sizing of ASD Secundum and Interventional Guidance for Transcatheter Closure of ASD Secundum

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Abstract

Transcatheter closure of atrial septal defect secundum become an alternative method for surgery, sizing of defect with device closure is routinely done under transesophageal echocardiography which are expensive technique and not easily affordable in many center, some center start to using of transthoracic echocardiography with limitation for age ,weight and size complexity of defect

To determine the role transthoracic echocardiography in pre-intervention sizing of ASD secundum and guidance during transcatheter closure of ASD secundum together with fluoroscopy in cardiac catheterization laboratory. In order to reduce the cost and simplify the procedure

One hundred eight patients with ASD secundum were selected by TTE for transcatheter closure with ASO in Iraqi center for heart disease in Baghdad city of them 64% female and 36%male ,age was rang form (1-65) yrs mean +/- SD(20.41-14.68) years and weight range from (9-103)kg mean (45.08-27.04) Defect size range from (7-35) mm mean (19.76-8-24) and ASO occluder size range (10.5-40) mm mean (23.53-9.07), the success rate was 94.5%. In 13% of cases were complex cases either complex type of defect or complex anatomy of heart and we use procedure that help to increase the success rate of occluder implantation in 19 case (17.59%) like balloon assistance or dilator method, we found positive relationship between size of defect and size of device There was no significance for gender, age or weight in success or failure of procedure but the only significance is the size of defect and device

The TTE is good way for detect the accurate sizing of ASD secundum and guiding the ASD intervention procedure with no limitation for age weight of patient or defect size or complexity of defect.

Keywords: Transthoracic echocardiography, sizing of ASD, echocardiography guidance of intervention, ASD occlude

دور فحص الايكو عن طريق الصدر في تحديد حجم الفتحة الاذينية قبل التداخل القسطاري والمساعدة في أغلاق الفتحة الاذينية أثناء التداخل القسطاري

الخلاصة:

عملية أغلاق الفتحه بواسطة الغلاقه أصبحت اللأن طريقه بديله لعمليات القلب المفتوح,وتعتبر طريقة تحديد حجم الفتحه الاذينيه بواسطة ناظور الايكو هي الطريقه الروتينيه المستخدمه وهي طريقه مكلفه وغير متوفره في كل مراكز القلب وهناك بعض المراكز تستخدم الايكو مع وجود صعوبه في أستخدامه للفتحات المعقده وأعمار واوزان المرضى لغرض تعيين دور الايكو في تحديد الحجم الحقيقي للفتحه الاذينيه مع المساعده في عملية اغلاق الفتحه الاذينيه بواسطة السداده وبالتداخل القسطاري لغرض تسهيل العمليه وتقليل وقتها دراسه أجريت في المركز العراقي لامراض القلب في بغداد وللمرضى تم أختيار ١٠٨ مريض لديهم فتحه أذينيه تمتلك مواصفات الأغلاق بواسطة الغلاقه ,كان أغلب المرضى من النساء وبنسبة٦٤% أما بالنسبه لاعمار المرضى يتراوح من(١-٦٥) سنه أما وزن المرضي المشاركين بالبحث هو (٩-١٠٣)كغم أما حجم الفتحات فقد كان يتراح بين (٧-٣٥)ملم وحجم السدادات المختاره هو مابين(١٠.٥-٤٠)ملم,لقد كانت نسبة نجاح أغلاق الفتحات هي ٩٤.٥% في حوالي ١٣% من الفتحات

كانت فتحات معقده لذلكاستخدمنا طرق مساعده لغرض زيادة نسبة نجاح أغلاق الفتحات وقد أستخدمت في ١٩ حاله أي بنسبة ١٧.٥٩% مثل طرقة الاسناد بالبالون او الدعامه ,وتم أيجاد علاقه طرديه بين حجم لفتحه وحجم الغلاقه وقد وجد بأنه لاتأثير لعمر ووزن المريض او جنسه لنجاح وفشل الاغلاق وانما حجم الفتحه وحجم السداده هو المحدد الوحيد للنجاح أو الفشل لأغلاق الفتحات بواسة الغلاقه أن الاو طريقه جيده جدا في تحديد حجم الفتحه الاذينيه الحقيقي قبل التداخل القسطاري كما يساعد في عملية الاغلاق أثناء التداخل القسطاري بدون التقيد بحجم الفتحه أو صعوبتها أو عمر المريض ووزنه.

Introduction

Transcatheter closure of atrial septal defect (ASD) first described by King et al 1976[1] now is an accepted method of therapy for this disease. Although this method of therapy may be more expensive, it is preferable over surgery due to less traumatic burden and better cosmetic results [2, 3].

In addition to fluoroscopy, an echocardiographic imaging modality is necessary to guide the interventionist during this procedure. Transesophageal echocardiography (TEE) or intracardiac echocardiography (ICE) are standard method for this purpose, however, both methods are relatively inconvenient since they either require general anesthesia (TEE) or high cost catheter and special training. Many patients or pediatric cardiology center cannot afford high expenses of purchasing and maintaining these equipments.

On the other hand, transthoracic echocardiography (TTE) is convenient and accessible everywhere without additional cost. There is little evidence in the literature about ASD closure under TTE guidance [4-7].

Patients and Methods

We evaluated all transcatheter closure of ASD with ASO (atrial septal occluder) that have been attempted in the Iraqi center for heart disease in Baghdad from Jun 2012 to October 2013.

All procedure was performed under local anesthesia except for small children those cannot tolerate the procedure under local anesthesia where general anesthesia was use.

Inclusion criteria was significant left to right shunt and exclusion criteria were absent inferior and superior rims, un-reversible pulmonary hypertension, association with others congenital heart diseases that need surgery, anomalous pulmonary vein and large ASD secundum with their total atrial septum length less than the left disc of ASO.

Selections of cases were performed in outpatient clinic with TTE.

Two ultrasound system machine Vivid I9 with S3 transducer, GE healthcare, USA) and portable Philips machine S2-4 transducer using two-dimensional (2D) echocardiographic and color flow mapping studies. Before intervention, all patients underwent TTE for determination of ASD number, size, position and spatial relations with adjacent cardiac structure and during intervention procedure using the TTE for determination proper closure of defect without any residual shunt and the occluder catch all surrounding interatrial septum rims with no pressing on any surrounding structure and checking the right pulmonary vein, coronary sinus, SVC (superior vena cava), IVC (inferior vena cava) flow and aortic, mitral and tricuspid valve function and competence.

By using apical four chamber view to measure the distance between ASD and mitral valve annulus, atrium top and the total septum length, parasternal short axis view to measure the aortic rim and posterior-inferior side and subcostal view to measure the distance between the ASD the entrance of the superior vena cava and the inferior vena cava, the total length of atrial septum ,we chose the largest ASD diameter as indicator for determination the optimal size ASD occluder and the device then oversized by (3-

6)mm than the size measure by TTE. The following type of occluder use Amplatzer - type ASD occluder and Occlutech ASD occluder in different generation. Patient receive aspirin (3-5) mg /kg) three days before procedure and 6months after procedure. Antibiotic prophylaxis with ceftriaxone single dose (50-75mg /kg) was administered before procedure .Heparin (100mg/kg IV) administered during procedure. During ASD secundum closure procedure, fluoroscopy was used for help in guidance for closure of ASD and any residual shunt by angiographic injection after complete implantation of occluder before deployment in 35degree LAO (left anterior oblique) and 35 degree cranial and check the stability of occluder and document the occluder is attaching to all the rims by the aid of echocardiography and fluoroscopy. The device was inserted and deployed under fluoroscopic and TTE guidance, a secure and stable position of occluder within the defect was checked by a gentle pushing and pulling of the delivery cable. The device and adjacent structure were then examined by TTE to ensure that there was no encroachment of the device on the atrioventricular valves or the right pulmonary vein and document the occluder is attach to all the rims. After releasing of the device from the cable by unscrewing it, a final TTE examination was undertaken to demonstrate the position of the device and any residual shunting.

Some time we use balloon assistance technique by passing giudewire in pulmonary vein either above or below the occluder depend from which side the occluder is fall and pass Tyshak balloon (15 mm*3 or 2cm) or dilator method by handmade curved hard end of Amplatzer guideword the wire remain inside the dilator, these both technique help to correct the position of occluder until catch all rims and successful implantation. Patient were examined after the closing procedure on the 1st day, 1, 3, 6months and then yearly.

Results

This study has been carried out at Iraqi center of heart disease in Baghdad. One hundred sixty four patient with ASD secundum visited that centre at the time of data collection, from Jun 2012 to October 2013, (108) patients fulfill the inclusion criteria, data was collected using echocardiographic reports, from them 102(94.5%) patients were successful implantation and 6 patients (5.5%) failed including 2patients were embolized four patients the implantation was impossible due to very small inferior and superior rims and flobby or mal-alignment of rims

The intervention in this study involve wide range of age (1-65) years mean ± SD (20.41 ± 14.68) years and weight range from (9-103) kg, mean ± SD (45.08 ± 27.04) kg

In overall ASO procedure, size of occluder device used range from 10.5 to 40 mm, mean± SD (23.53 ± 9.07) mm and size of defect range from7-35mm, mean± SD (19.76 ± 8.24) mm .

Most cases 64% were female and 36% male. There is strong relationship between defect size to ASO size mean defect to device size =1.19

Fourteen patients with ASD secundum (13%) had complex anatomy by itself or another association make it complex including 2ASD secundum defect (2.8%) closed by 2 occluder in same session, 3patients (2.8%) with small left atrium, 7patients (6.5%) with large ASD secundum size and small inferior or superior rims <5mm , one patient (0.92%) with dextrocardia LTGA(congenitally corrected transposition of great artery) +severe pulmonary valve stenosis+ large ASD secundum(in same session defect closure with occluder and balloon dilation for severe PS with increase of Spao2 after intervention from 74% to 96%).

The distribution of complex ASD secundum was mentioned in figure 1

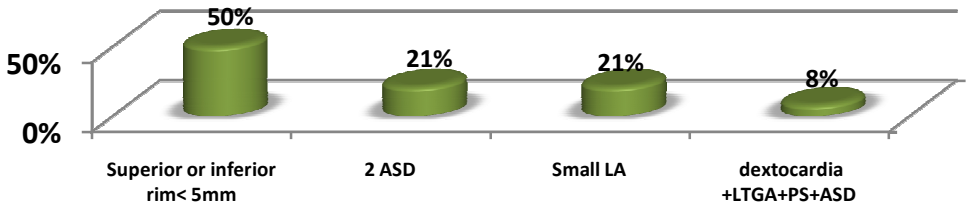

Figure 1: Distribution of patients with complex ASD by type

Significant positive linear correlation between defect to device size(r=0.994, p=<0.001) as shown in figure 2

Figure 4 shows the correlation between defect (ASD) size and device size there was significant positive linear correlation between these two variables. (r =0.994, P = **<0.001****)

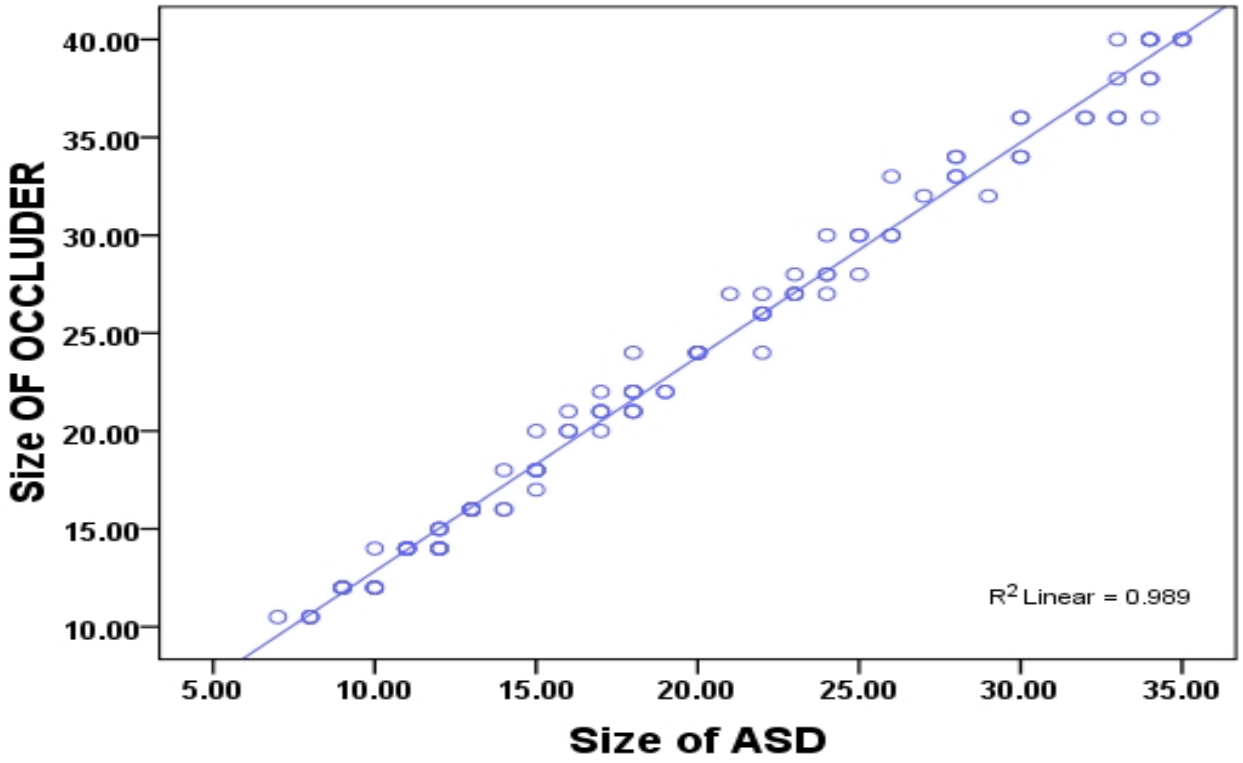

Figure2: The correlation between defect size and device size.

In 19 patients (17.59%) the implantation of occluder implantation were not so easy due to large ASD secundum size with small inferior, superior rim or mal-alignment of septum, that need assistance to change the direction of occluder and become with direction of septum and catch all rims of defect or to support the occluder from area of septum when the rim is small flobby, balloon assistance used in 17 patients (15.74%), 2 patients (1.85%) using the dilator method

Table 1: shows the distribution of patients according to method for closure of defect, where balloon assistance had been used in 17 patients (15.74%) and dilator method in 2 patients (1.85%)

Table 1: The distribution of patients according to method

Closure methods	N	Number of total cases	%
Balloon assistance	17	108	15.74%
Dilator methods	2	108	1.85%
Total	19	108	17.59%

Table 2: show the squeal of patients ASD closure under transthorasic echocardiography. Successful ASD closure were (94.5%), while it was failed in (5.5%).

Table 2: The squeal of patients with ASD closure under transthorasic echocardiography

Sequel of ASD Closure	N	Number of total cases	%
Successful closure	102	108	94.5%
Failed*	6	108	5.5%
Total	108	108	100%

There was no statistical association between outcome of case and gender regarding the failure in closure of ASD defect 5 (83%) were female and 1 (17%) was male, P-value=0.415

Table 3: shows the association of patients outcome (failure or successful ASD closures) by gender. There was no significant association between outcome of case and gender. (83%) of patients with failed ASD occlusion and 66% of successful procedure were female and 17% failed occlusion and 38% successful occlusion were male with p-value=0.415

Table 3: The association of outcome (failure or successful ASD closure) by gender

Variable	Failure	Success	Total	P-value
Gender				
Female	5 (83%)	64 (63%)	69 (64%)	0.415 [a]
Male	1 (17%)	38 (37%)	39 (36%)	

No statistical significant differences between means of age, weight of patients for outcome of procedure but the only variable that affect success and failure of closure are the size of defect and size of occluder with mean size for defect with failure closure was (30.83±6.52) mm, and mean size for occluder with high chance for failure of closure (35.66±6.97) mm as shown in table 4.

Table 4: the association of age weight, size of defect and size of occluder in outcome of procedure

Variable	Groups	N	Mean ± S.D	t-test	df	P value
Age (in years)	Failure	6	28.83 ± 20.11	1.453	106	0.149
	success	102	19.92±14.27			
Weight (in Kg)	Failure	6	56.66 ± 22.83	1.08	106	0.282
	success	102	44.4±27.21			
ASD size (in mm)	Failure	6	30.83 ± 6.52	3.55	109	0.001
	success	105	19.13 ± 7.89			
device size (in mm)	Failure	6	35.66 ± 6.97	3.54	109	0.001
	success	105	22.83±8.7			

The size of occluder and defect was only the variables affect on success of closure, the failure was for large defect and large ASO with mean size for defect with failure of closure (30.83±6.52)mm P-value=0.001, and mean size for occluder high chance for failure closure (35.66±6.97) with P-value=0.001

Discussion

In our study the procedures were successful in 94.5% and 6cases (5.5%) were failed two of them were embolized and removed by snaring.

This study goes with the study done in Iran in 2010 by Keyhan et al [9] where 30 procedures successful (94%) but this study done in children because of good window in such age group and our study had no age and weight limitation. Sergio et al study done from 2008 to 2012 in Rady Children's Hospital/University of California–San Diego institutional review board on children age 8-12yrs old found that TTE is efficacious and safe as TEE for assessment and guidance of ASD occlusion using ASO and found additional safety for TTE in reduce fluoroscopy exposure [10] Before the interventional therapy, we used TTE in multiple views to detect the largest size of defect and determine the size and shape of rims. The size of selected occluder increase by little larger than the size of defect because small defect had good rims , we increase the size of ASO by larger than the size of defect in state of large defect or those with flobby and small rims this goes by study did in China in 2008 by LI Gui-shuang[8] as by multiple view obtain the largest ASD diameter and use this diameter as reference for selecting ASO size and for small ASD ,because the rims intact ,an ASO size little larger than the ASD diameter TTE was sufficient. However, for large ASD, the rims were soft or not intact and large AO weight was also a negative factor for the ASO fixing, so the selected ASO size was much larger than the ASD diameter. We increase the size of occluder by 2-6mm than size of defect this finding compatible with a study done by Zhang et al [11] that showed the ASD device size is always 4-6 mm larger than the ASD diameter measured by TTE and found good correlation between the diameters of ASD measured by TTE &with the selected ASD device size.

In present study we do not use stretch balloon diameter because the use of balloon stretch may lead to laceration in ASD rims and may increase size of defect and change the case from occluder closure to surgical

closure and take long duration time of procedure and more radiographic exposure .The TTE was not only for detect the size of defect but for guiding the closure by occluder., it did not move greatly as same for what did by LI Gui-shuang study [8]. Some cases with complex anatomy as large defect, small or posterior mal-alignment of the septum from TTE study or to correct the perpendicular position of occluder so we used balloon assistance procedure to help in closure of ASD by using of balloon assistance or dilator method use the dilator method in two cases only because we afraid from perforation and the balloon method with less risk we use either sizing balloon or Tyshak balloon and site of balloon to support the device from weak site of defect mean either in pulmonary vein above or below the occluder(either left pulmonary vein or right pulmonary vein). Ajith et al [12] used balloon assisted device helps in controlled delivery and device alignment in very large ASD with posterior mal-alignment of the septum for closure of (≥35 mm) ASD had 90% success. This study was done with TEE help. In Kardon& colleagues study in 2004 where 74 patients involved in study; the procedure was successful only in 56 patients & failed in 18 patients (75.6%), the failure rate was explained by high percentage of patient with deficient rims & poor subcostal window in the remainders. Kardon and colleagues [5] demonstrated that although TTE is certainly more comfortable &less costly to the patient than either TEE or ICE, but there is some limitation or difficulty especially in patients with deficient rims & in performing transthoracic imaging while biplane fluoroscopic imaging is being performed. The rotating gantries may be hazardous to the echo cardiographer, and some patients have poor subcostal window "especially in obese patients and the subcostal region may be inaccessible due to sterile draper. In our study there is no limitation for age or weight or complexity of ASD anatomy for closure under TTE guidance, that depend on good selection for cases and using of more developing TTE machine with good resolution image, and no identified case with infection.

Conclusion

Transthoracic echocardiography, used to measure ASD diameter, can accurately direct the selection of the ASO needed for successfully closure of ASD, TTE is safe and effective as an imagining guide for ASD transcatheter closure with no limitation for age, weight, complexity or size of defect the more sophisticated echocardiographic modalities (TEE, ICE) are not available or affordable by the hospital or patients. TTE guidance and sizing of ASD need physician with experience in echocardiography and interventional therapy.

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