ASD Closure in Small Children

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Introduction

- Transcatheter closure of ASD 2^{O} has been accepted as a standard tx option in adults and children
- Optimal timing of known ASD closure: 1(2)~5yrs
  → Device closure : 3(4)-5yrs (?)

  Rao PS. Indian J Pediatr 2013;80:32, Petit CJ et al. Pediatr Cardiol 2013;34:220
- There may be a substantial resistance against a clinical decision for device closure in very young children,
  probably because of the paucity of data and/or lacking of individual experience in this group of patients

→ ***Is device closure safe & effective in young children?***

Symptomatic ASD in Small Children

- **About 5% of pts develop symptoms in early infancy**

  Am Heart J 1973;85:601, Am Heart J 1962;64:467, Pediatrics 1964;34:101

- **Surgical ASD closure in young children**

  - *Bull C et al. 1981 Arch Dis Child*

    → **some of the infants c ASD require early surgery**

  - *Parvathy U et al. 2004 Asian Cardiovasc Thorac Ann*

    → **18pts < 2yrs; early surgery in symptomatic pts**

  - *Lammers A et al. 2005 JTCS* - 24 symptomatic infants

    → **early surgery should be performed in symptomatic infants with compromised lungs**

ASD closure in small children

The need for early intervention in small children

- ✓ **Special clinical setting for an early closure;**
  - ***Chronic lung disease in premature infants***
  - ***Chr'some anomaly with compromised CPF***
  - ***Recurrent resp. infection* +/- airway problem**
  - ***Planed liver transplantation, etc..***
- ✓ **Secundun ASD may "outgrow"** *(≈30% of large ASD)*

  → ***a "suitable" ASD for device closure may be changed to an "unsuitable" ASD***

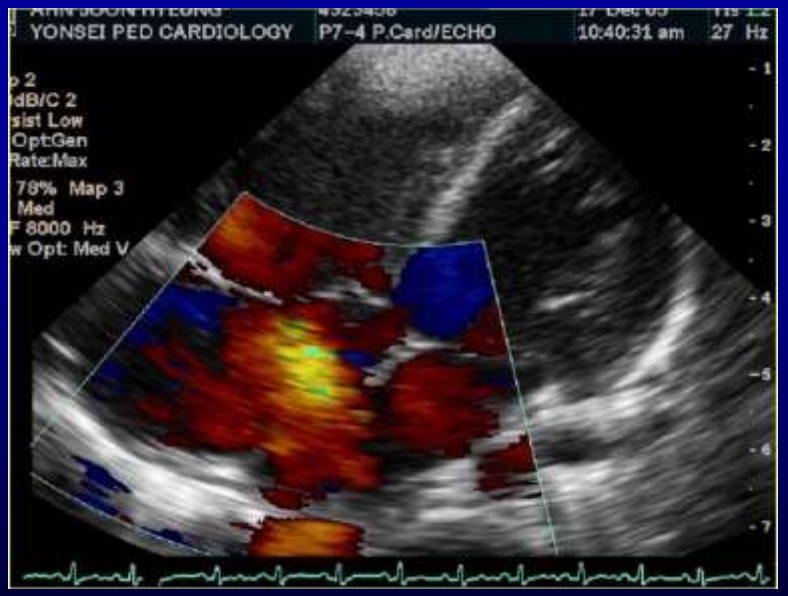
McMahon et al. Heart 2002 / Tortoriello et al. Pedatr Cardiol 2002 / Holzer R and Hijazi ZM. Curr Opin Cardiol 2004

- “outgrow” of the defect -

→ **waiting longer may render a suitable ASD unsuitable for device closure** *Holzer R and Hijazi ZM. Curr Opin Cardiol 2004*

Initial echo at 5mo (6.5kg)

F/U echo at 18mo (10kg)



Device Closure in Small Children

✓ **from late 90's – began with the availability of ASO**

- *Vogel M et al. Cardiol Young 2000;10:534*
  - **12 symptomatic small children < 2yrs of age / ASO**
  - **Age : 1.4± 0.4 yrs (0.9~1.8)**
  - **ASD size : 12 ± 4 mm / Qp/Qs ratio : 2.1 ± 0.5**

  → 2 (16%) required device removal & surgery

- *Lim DS et al. Pediatrics 2007;119:398*
  - **3mo old premature baby / 2.3kg** *(ventilator dependent)*

  → extubated 3 days after successful procedure

- *Beitzke A et al. Acta Pediatrica 2009;98:582*
  - **11 days old newborn / 3.4kg** *(after AS surgery)*

  → improved hemodynamics & clinical status

Literatures on ASD closure in small children

Author	Year	subject	N *(success)*	Wt	Age(mo)	ASD size	Device	device size
Butera G[1]	2003	≤5yrs	48	8-20(15)	8-60(42)	5-25(16)	38 ASO *(10 CS/SF)*	5-26/17-33
Patel A[2]	2006	<15kg	19*(16)*	8.0-14.4(13.2)	22-58(37)	2.5-25(16)	ASO	7-26(18)
Cardenas L[3]	2007	≤15kg	52*(49)*	4.7-15(13)	7-60(36)	5-20(12)	ASO *(2 SF/1 HSO)*	8-26(14)
Diab KA[4]	2007	<12mo	12*(11)* *+ 3 hybrid*	3.0-8.3(5.5)	0.5-11.9(8.2)	2.0-16(8.0)	ASO	4-20(10.1)
Dalvi B[5]	2008	<20kg	32	8-19(14.6)	NA	14-23(16.6)	ASO	20-32(24)
Fraisse A[6]	2008	≤15kg	35	3.6-15(13)	0-74(36)	NA	ASO	4-24(13)
Fischer G[7]	2009	<2yrs	71*(68)*	3.8-14.5(10)	3.9-23.8(17.2)	NA	ASO	6-22(15)
Thomas VC[8]	2012	<12mo	13	2.9-8.3(6.5)	NA	5-15(9)	ASO	6-16(9)
Petit CJ[9]	2013	<4yrs	61*(48)*	3.5-16.5(11.8)	4-45(35)	4-26(13)	ASO (9 HSO)	NA
Ammar RI[10]	2013	<2yrs	17	5.9-9.1(7.4)	9-18(10.3)	15.4±4.7	OFO	10-24(17.8)
Hill KD[11]	2013	≤20kg	34*(32)*	6.8-20(15.3)	5-84(47)	9.8±3.0	HSO	NA
Bishnoi RN[12]	2014	<8kg	68*(66)*	2.3-7.8(5.5)	1-24(8.6)	4-9(8.6)	ASO(3 HSO)	4-20(8)
Abu-Tair T[13]	2016	<10kg	14	6.4-9.7(8.9)	NA	5-17(11)	GSO	15-30(22.5)

1. J Am Coll Cardiol 2003;42:241, 2. Catheter Cardiovasc Interv 2006;68:287, 3. Catheter Cardiovasc Interv 2007;69:447, 4. J Thorac Cardiovasc Surg 2007;134:960, 5. Catheter Cardiovasc Interv 2008;71:679, 6. Cardiol Young 2008;18:343, 7. Catheter Cardiovasc Interv 2009;73:949, 8. Congenit Heart Dis 2012;7:204, 9. Pediatr Cardiol 2013;34:220, 10. J Invasive Cardiol 2013;25:76, 11. Catheter Cardiovasc Interv 2013;81:654, 12. Pediatr Cardiol 2014;35:1124, 13. Pediatr Cardiol 2016;37:778

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Problems encountered during the device closure in small children

- **Large delivery system / small vascular access**
  → *risk of vascular access injury*
- **Rigid coupling of device-delivery cable & relatively stiff delivery system**
  → *risk of damage to the cardiac structure*
  → *difficulty in checking the proper device position*
- **Small LA : insufficient space for opening of the LA disc**
- **Excessive rim width of atrial disks in smaller ASO**
  → *device contact to adjacent structures, esp. mitral valve (potential abandonment of the procedure)*
  → *small total septal length preclude implantation of a larger device (septal length & device size mismatch)*
- **Lack of long-term data in small children**

How to overcome the problems? (I)

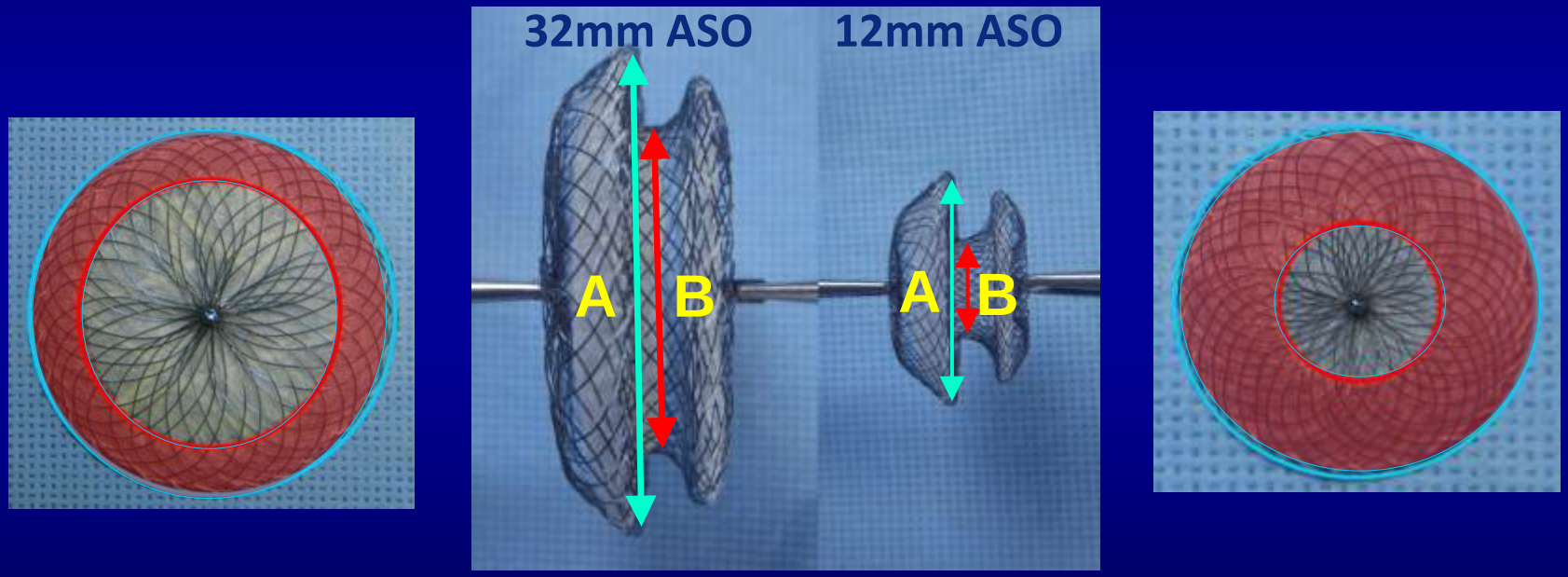
- **Large delivery system / small vascular access**
- **Rigid coupling of device-delivery cable & relatively stiff delivery system**

  → *sophisticated technique & meticulous approach*

- **Small LA : insufficient space to accommodate the LA disk**

  → *Technical modifications (LADEDT/BAT) are also useful in small children* *Dalvi BV et al. CCI 2008;71:679*

- **Excessive rim width of atrial discs in smaller ASO**
  → *'relative' MV rim deficiency*
  septal length & device size (LA disk size) mismatch

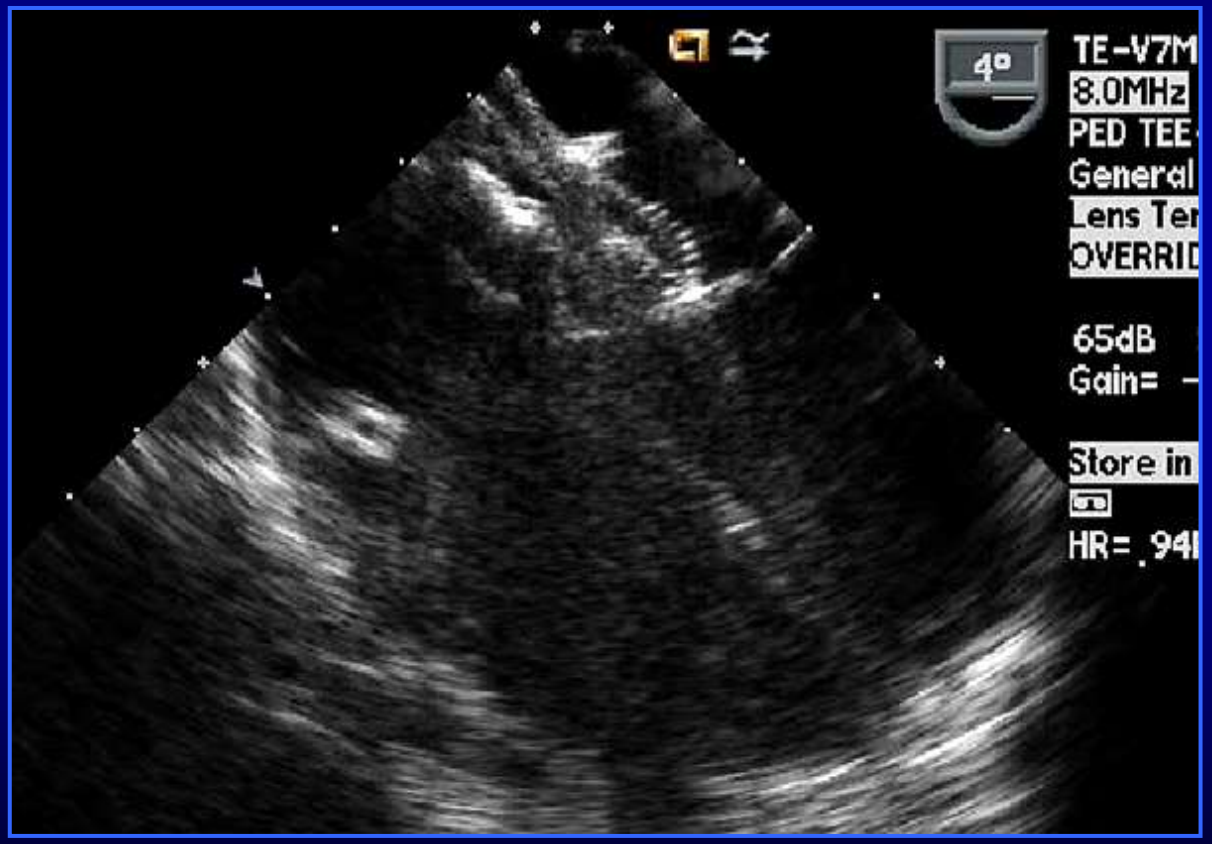


A/B = 1.5 **A/B = 2.4**

38mm ASO A/B = 1.4 *vs.* **5mm ASO A/B = 3.4**

LA disc encroaching to MV :

- *often >5mm rim is not sufficient*
- *more common problem in small children !*



How to overcome the problems? (II)

✓ **Excessive rim width of atrial disks in smaller devices**

→ *'relative' MV rim deficiency*
septal length & device size (LA disk size) mismatch

- needs further modification of device design

- choose a device acc. to the total septal length (=LA disk diameter)

Amin Z. CCI 2006;68:778
Fischer G et al. CCI 2009;73:949

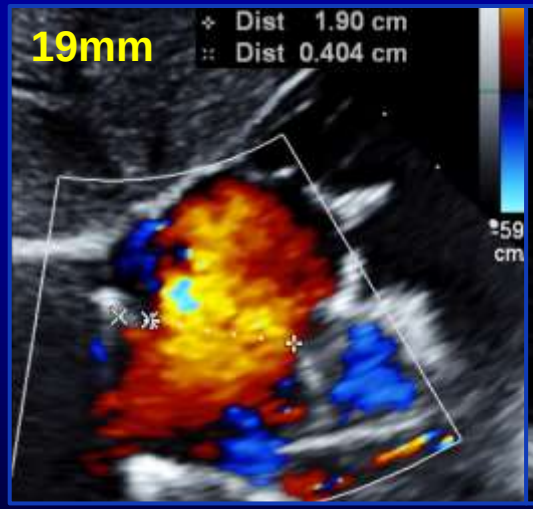
- use of non self-centering device

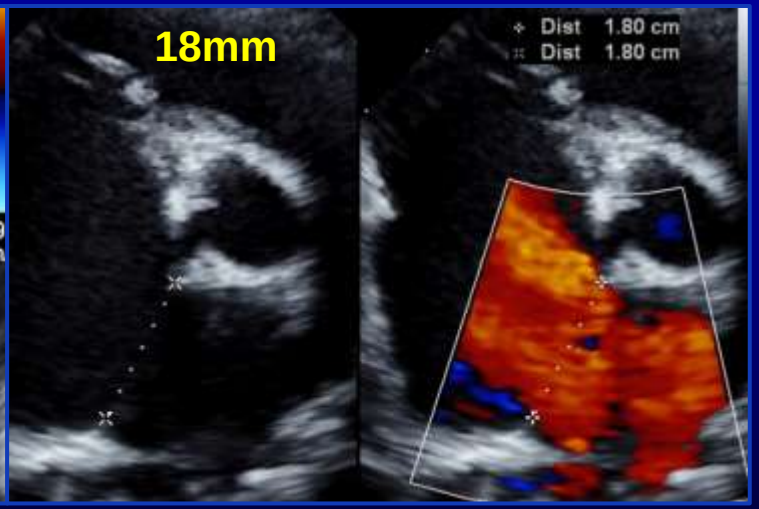
Hill KD. CCI 2013;81:654
Abu-Tair T. Pediatr Cardiol 2016;37:778

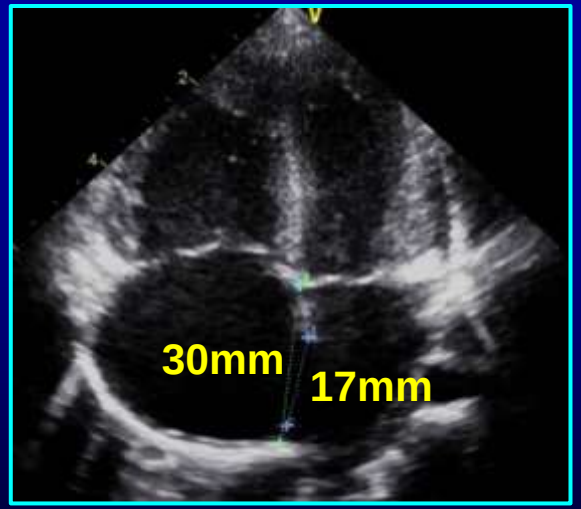
Case 1: small child with large ASD

- device size selection to fit the septal length -

F / 1yr 9mo
ROS : poor wt gain (+), freq URI (+)
Wt: 9.2kg (3p) BSA : 0.43m2
Echo : ASD 2^{O} 17~19mm, Ao & IVC rim deficiency
(total septal length on 4CV: 30mm)
Qp/Qs=2.2, PAP=25/10(15)mmHg





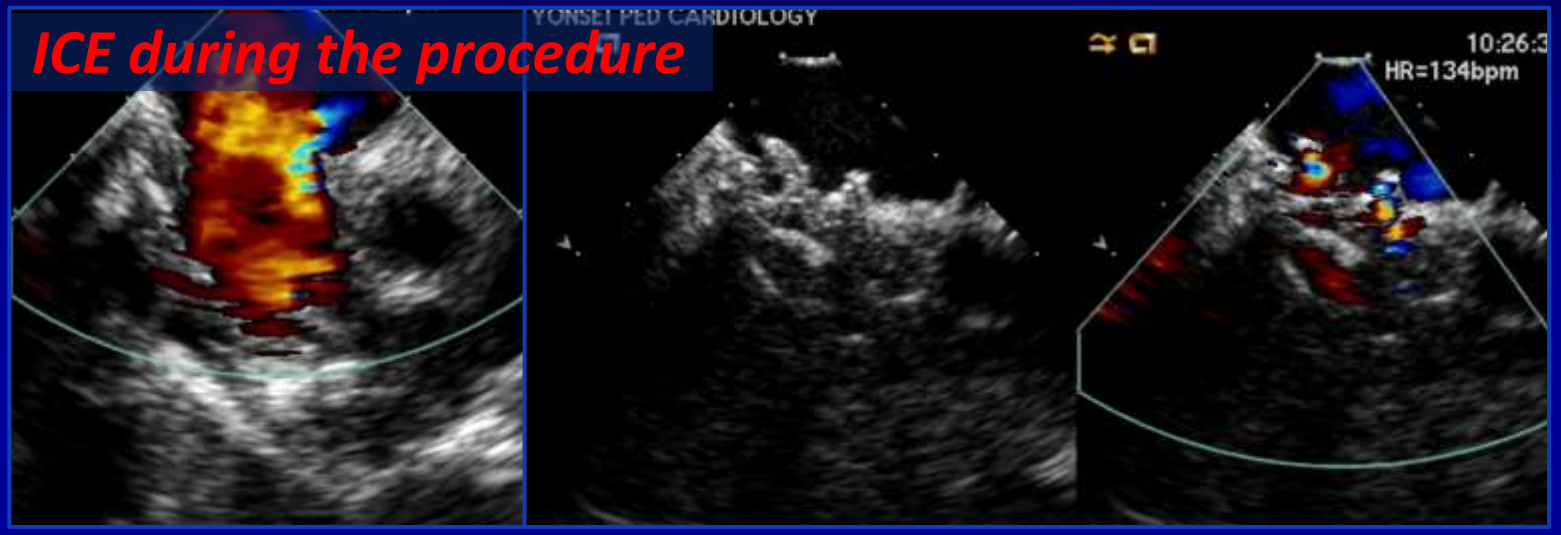


Case 1: small child with large ASD

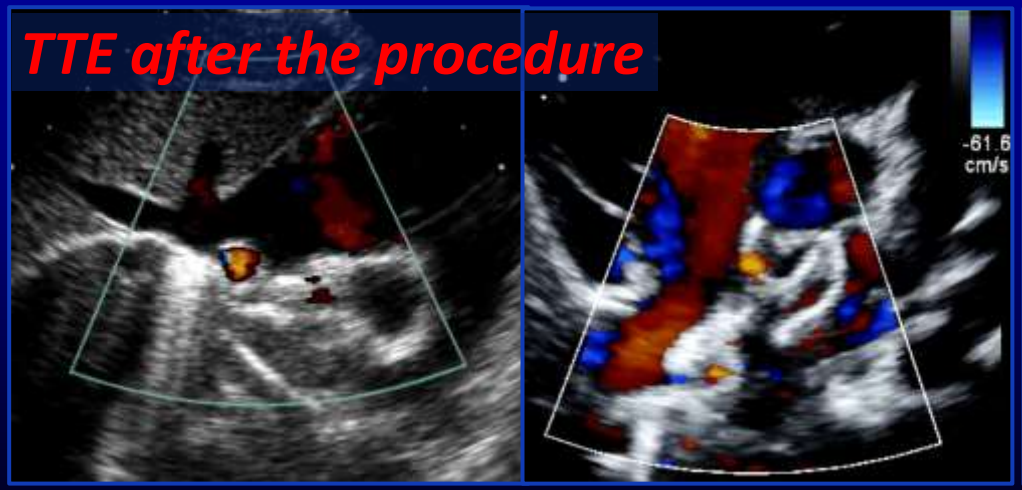
- device size selection to fit the septal length -

total septal length=LA disc diameter

ICE during the procedure



TTE after the procedure



F/U TTE

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Case 2: small child with large ASD

- device size selection to fit the septal length -

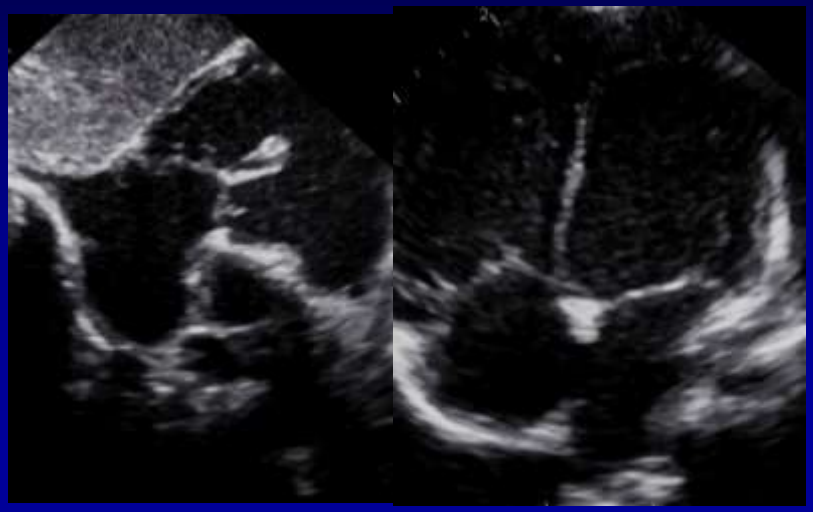
F / 1yr 6mo

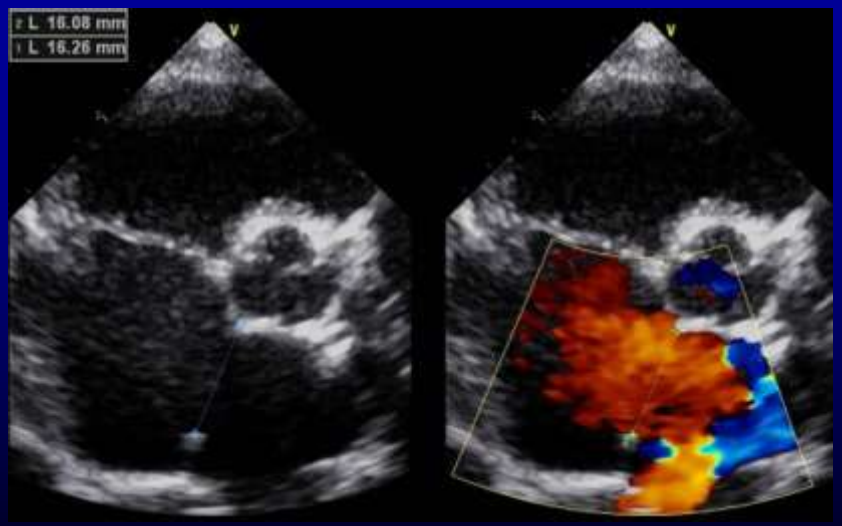
ROS : resent seize in wt gain (+), freq URI (+)

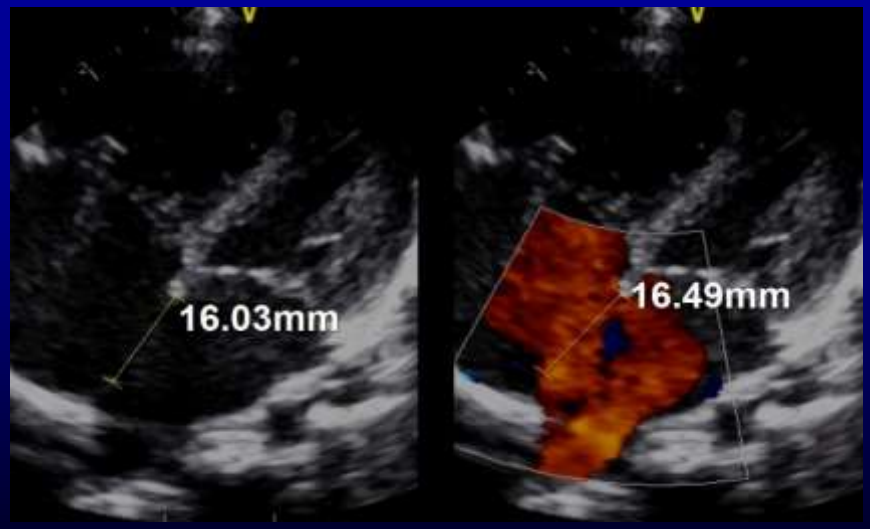
Wt: 9.4kg

Echo: ASD 2^{O} 16x19mm, Ao & IVC rim deficiency
flimsy posterior & IVC rims
(total septal length on 4CV: 32mm)

Qp/Qs=1.8, PAP=25/15(18)mmHg







Case 2: small child with large ASD

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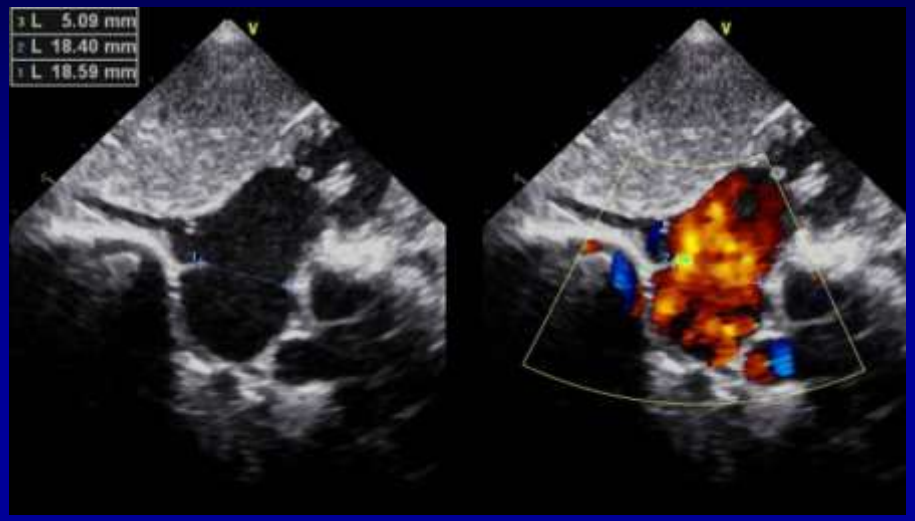

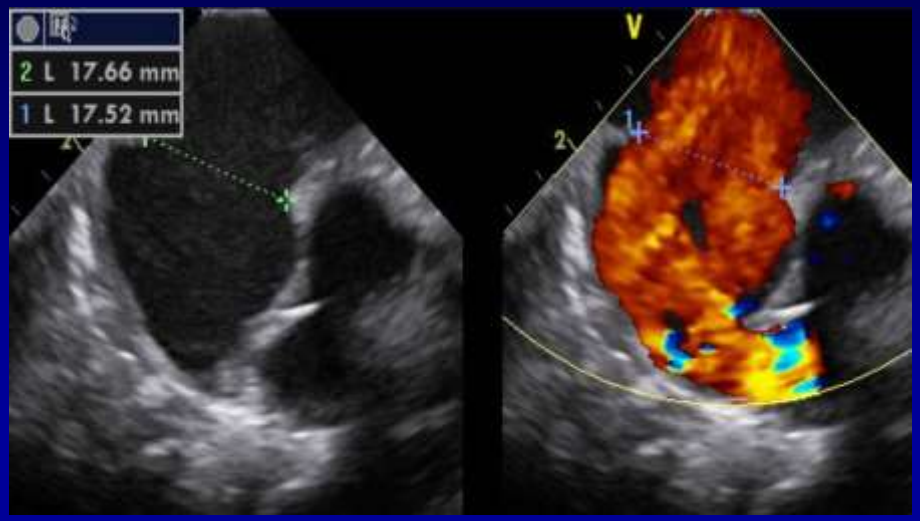

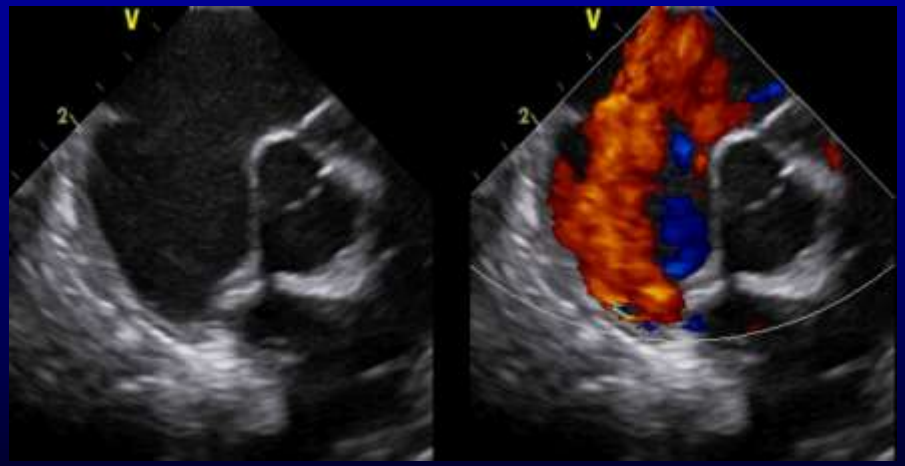

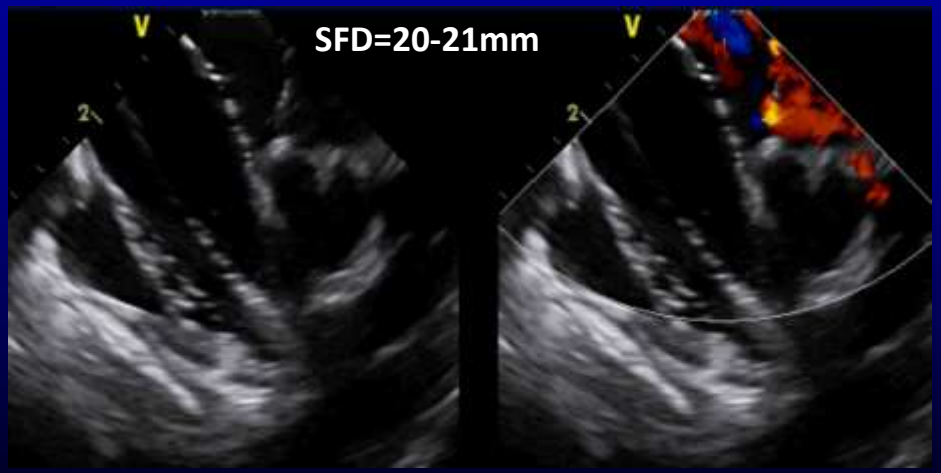

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Case 2: small child with large ASD

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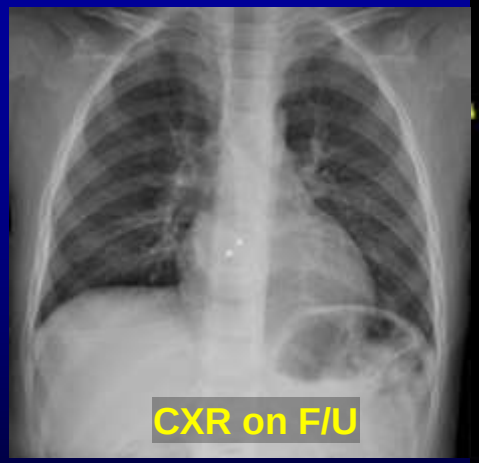

next day echo

F/U echo

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Concerns on Long-term Outcome

- ✓ **Concerns on erosion risk**

  : deficient & unstable rims, a small atrium & septum, soft surrounding tissue in small children – prone to erosion

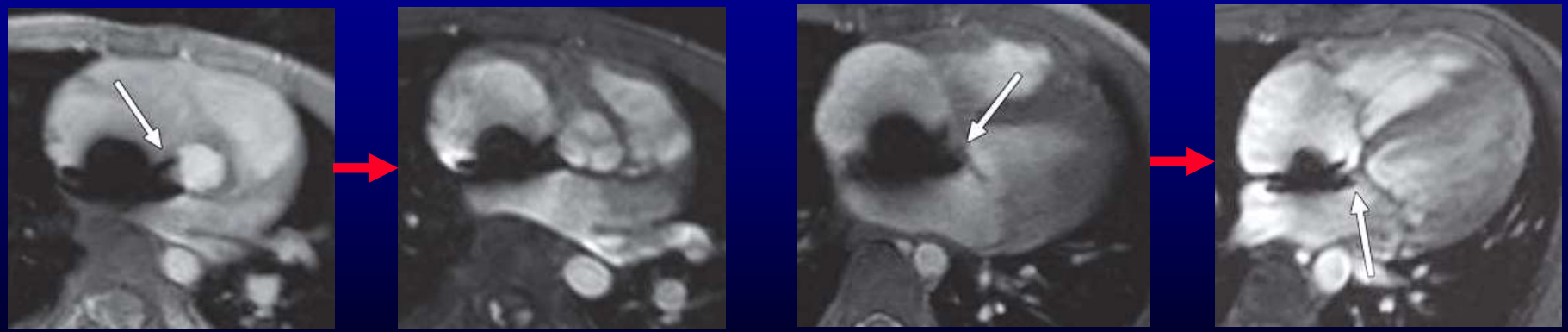
  → use of flexible & potentially less traumatic (?) device

  : GSO (or HSO) *Pediatr Cardiol 2016;37:778 / CCI 2013;81:654*

- ✓ **Concerns on long-term consequence of contact between device and cardiac structure / potential obstruction**

  : distance btw ASO & surrounding structures ↑ with time in growing children → likely ↓risk of long-term complication

  AJR 2012;199:1136



Lapierre C et al. AJR 2012

Case 3: small child with large ASD
- non self-centering device : GSO -

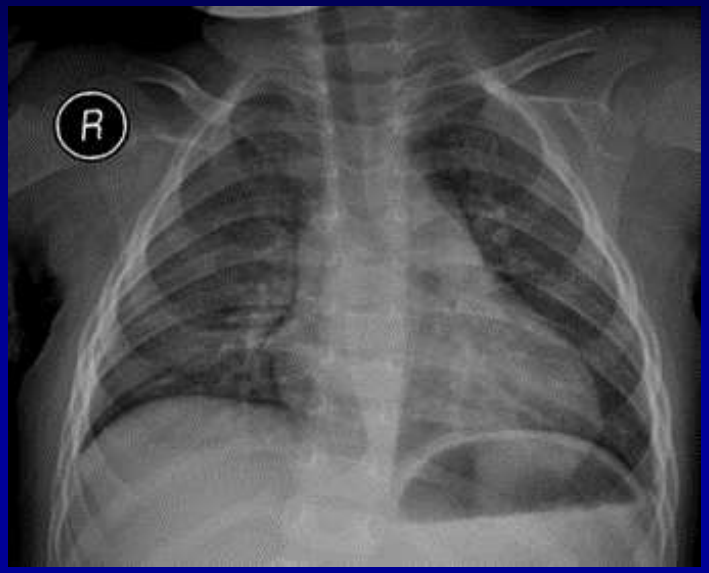
F / 1yr 3mo

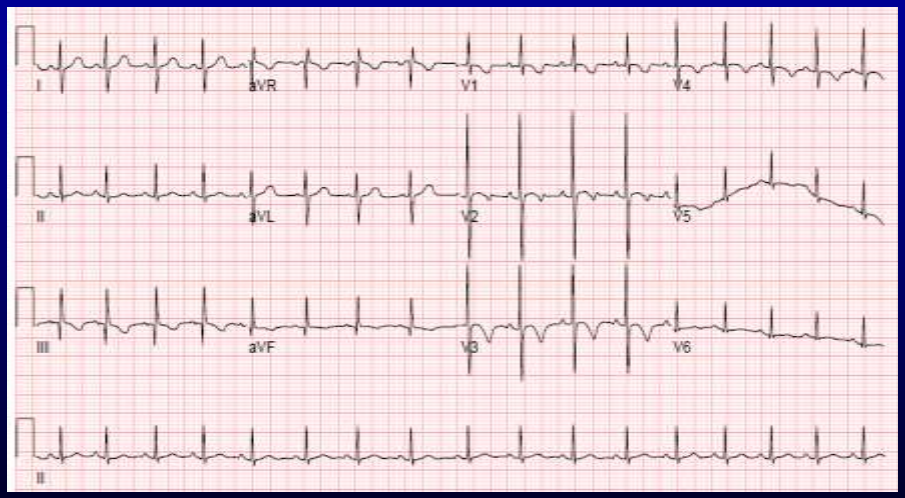
ROS : recent poor wt gain (+),
frequent resp. infection (+)

Wt: 9.7kg (15-25p) Ht: 77cm (50p)

Echo: secundum ASD 12x14mm
Ao rim deficiency (+)
outgrow of ASD size (+)
ASD size at 6mo : *7mm*
→ *12x14mm* at 12mo of age

Chest X-ray : cardiomegaly





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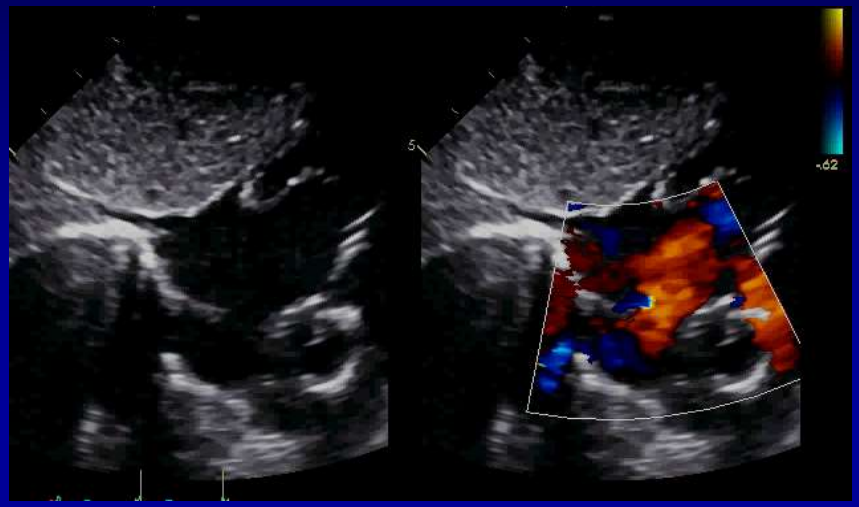
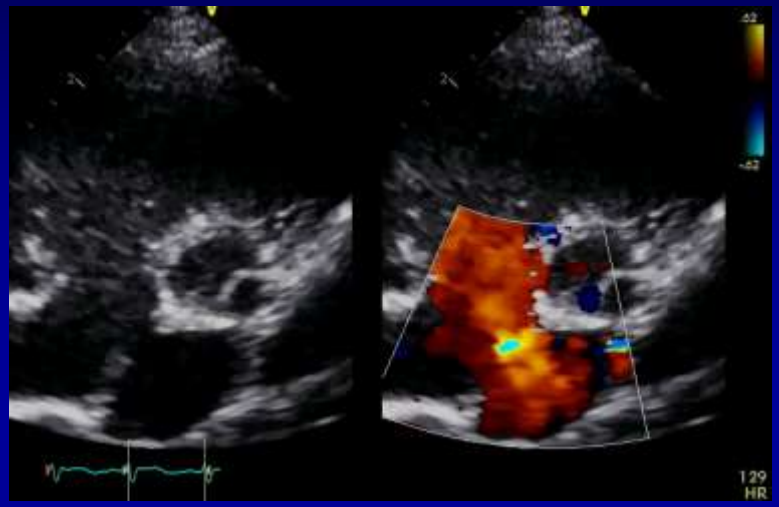
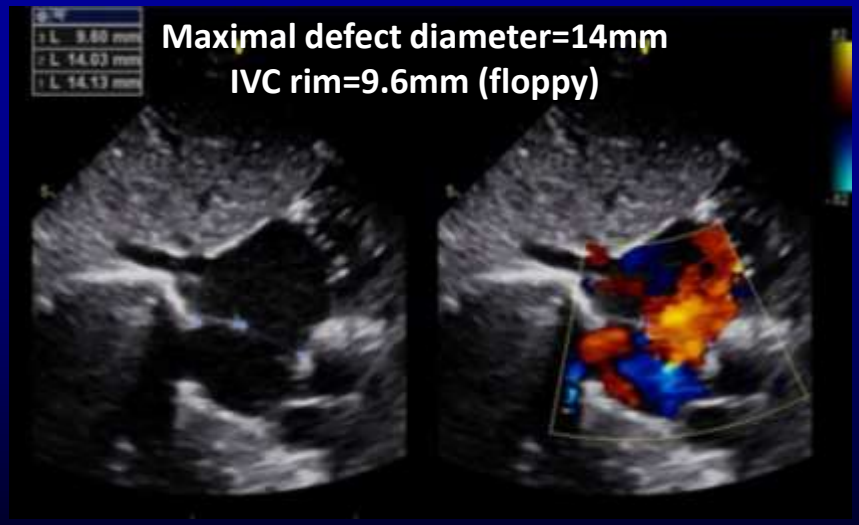
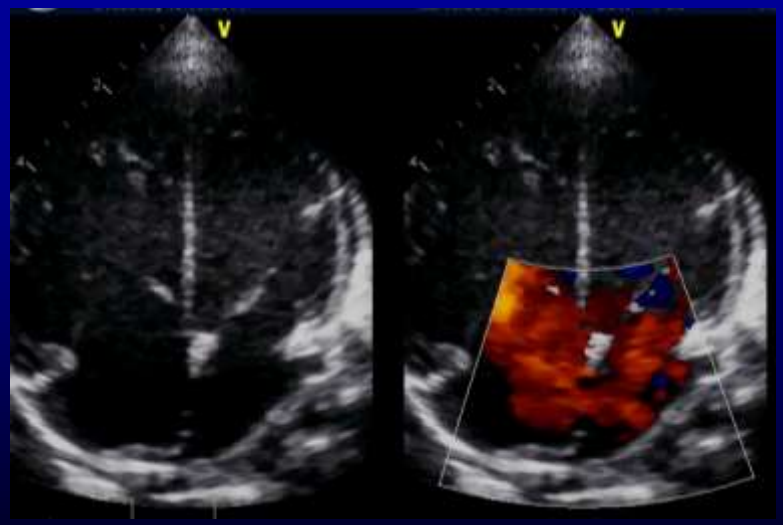






Maximal defect diameter=14mm
IVC rim=9.6mm (floppy)



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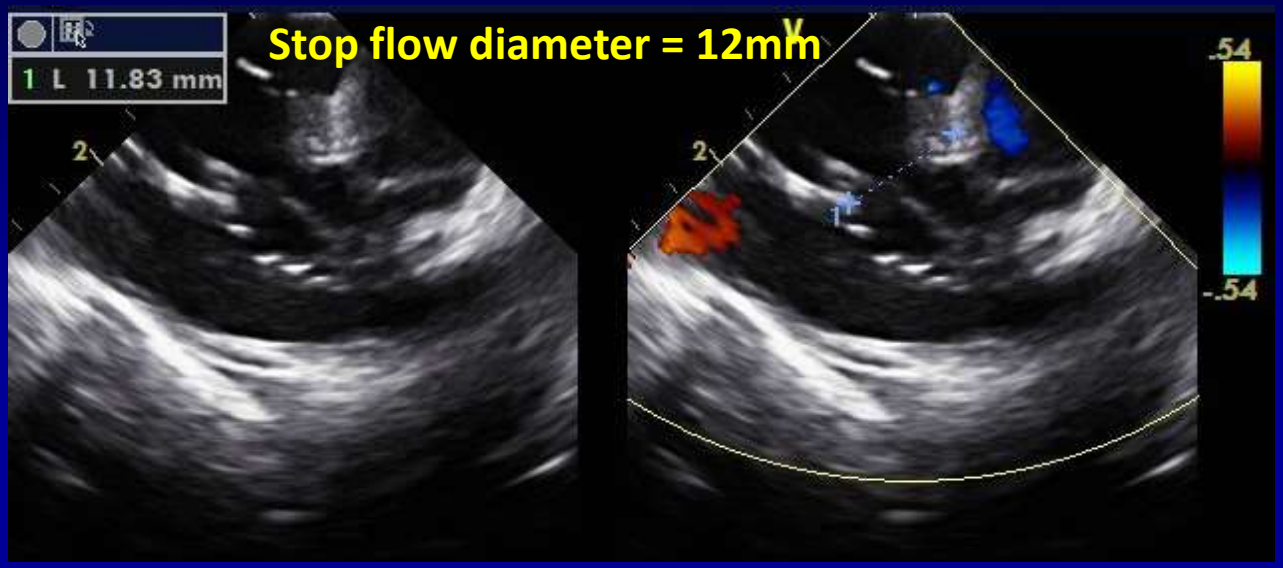
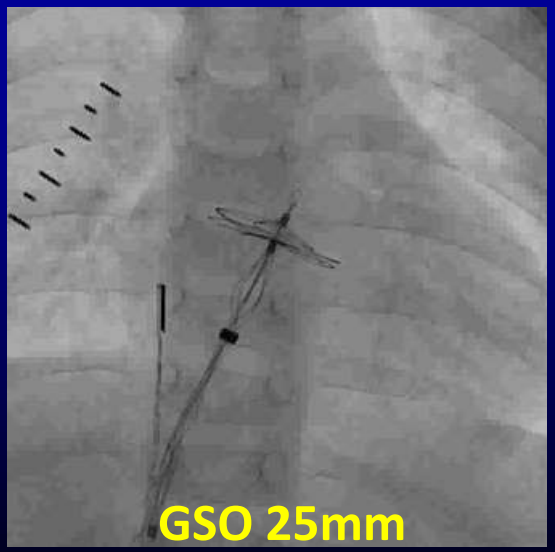
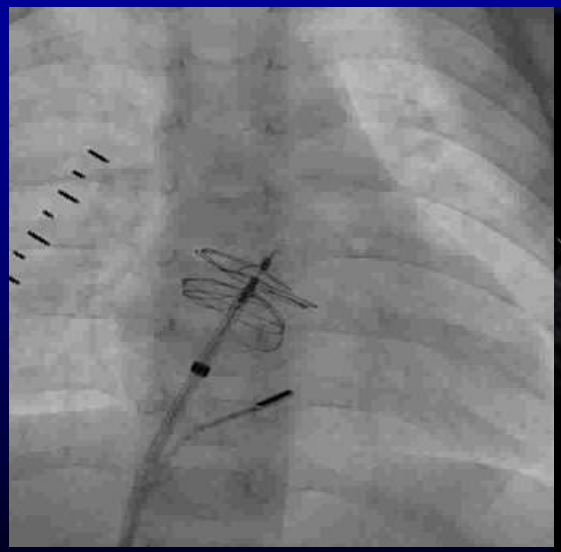
Case 3: small child with large ASD
- non self-centering device : GSO -







Case 3: small child with large ASD

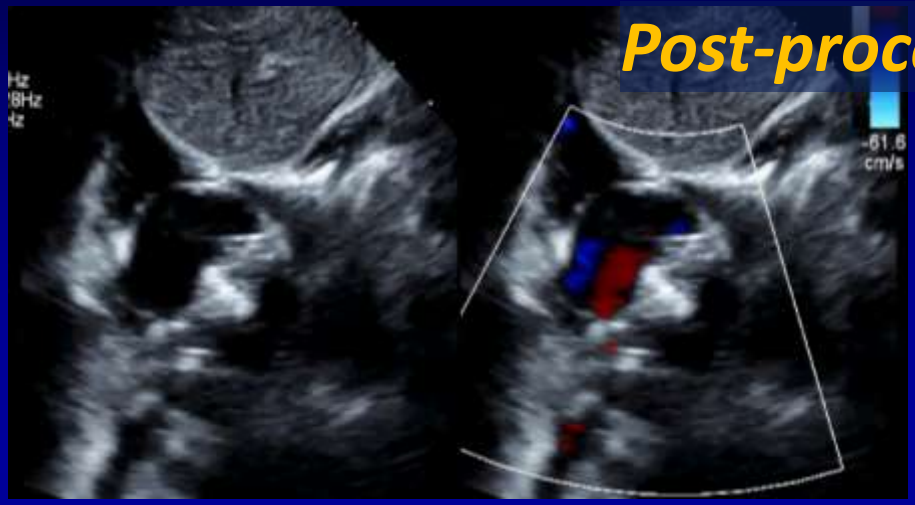
- non self-centering device : GSO -

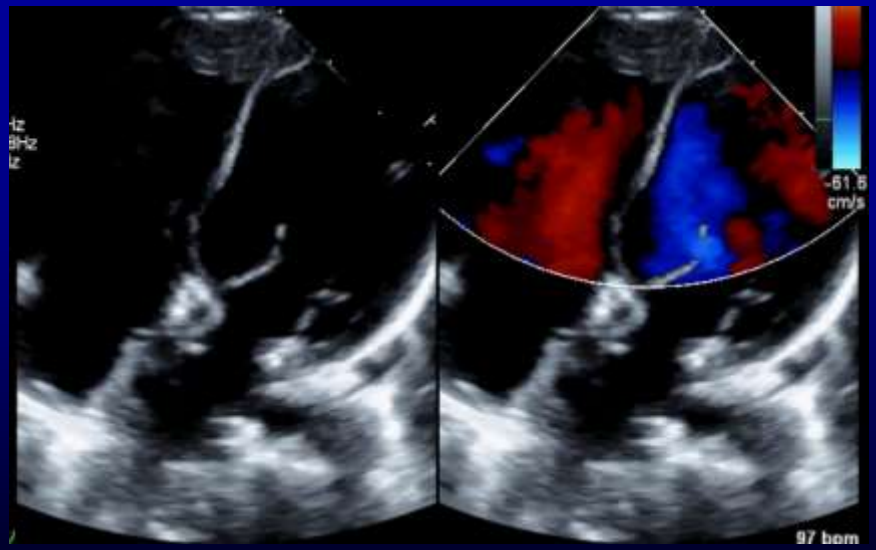
after device release

Case 3: small child with large ASD

- non self-centering device : GSO -

Post-procedural TTE

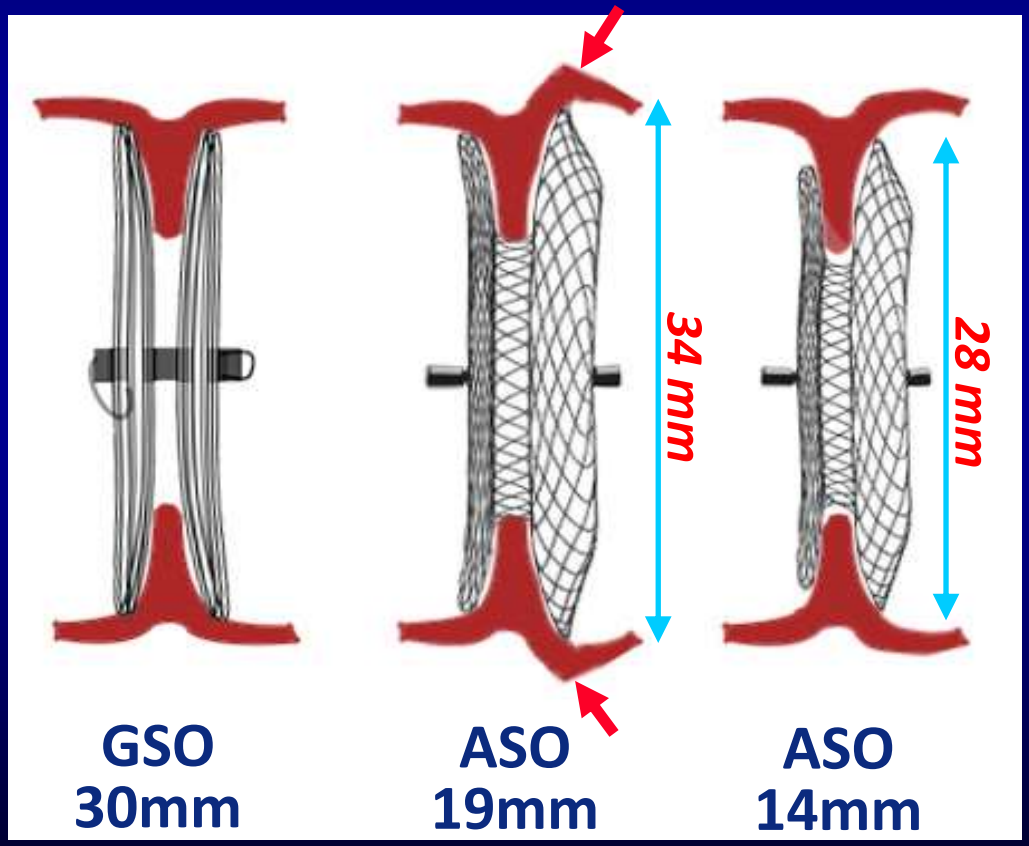




Pictorial comparison: different size/type of device

- ✓ **Example of a small child**

  BWt - 8kg / Defect size – 16mm / Total septal length 28mm



ASD closure in small Children
- Severance Cardiovascular Hospital Experience -

Subjects

- **Apr 2004 ~ Dec 2015**

  Div. of Pediatric Cardiology

  Severance Cardiovascular Hospital, YUHS

- **169/1557 small children with ASD secundum**

  - **Device Group**

    124 pts ≤ 10kg of BWt at the time of closure

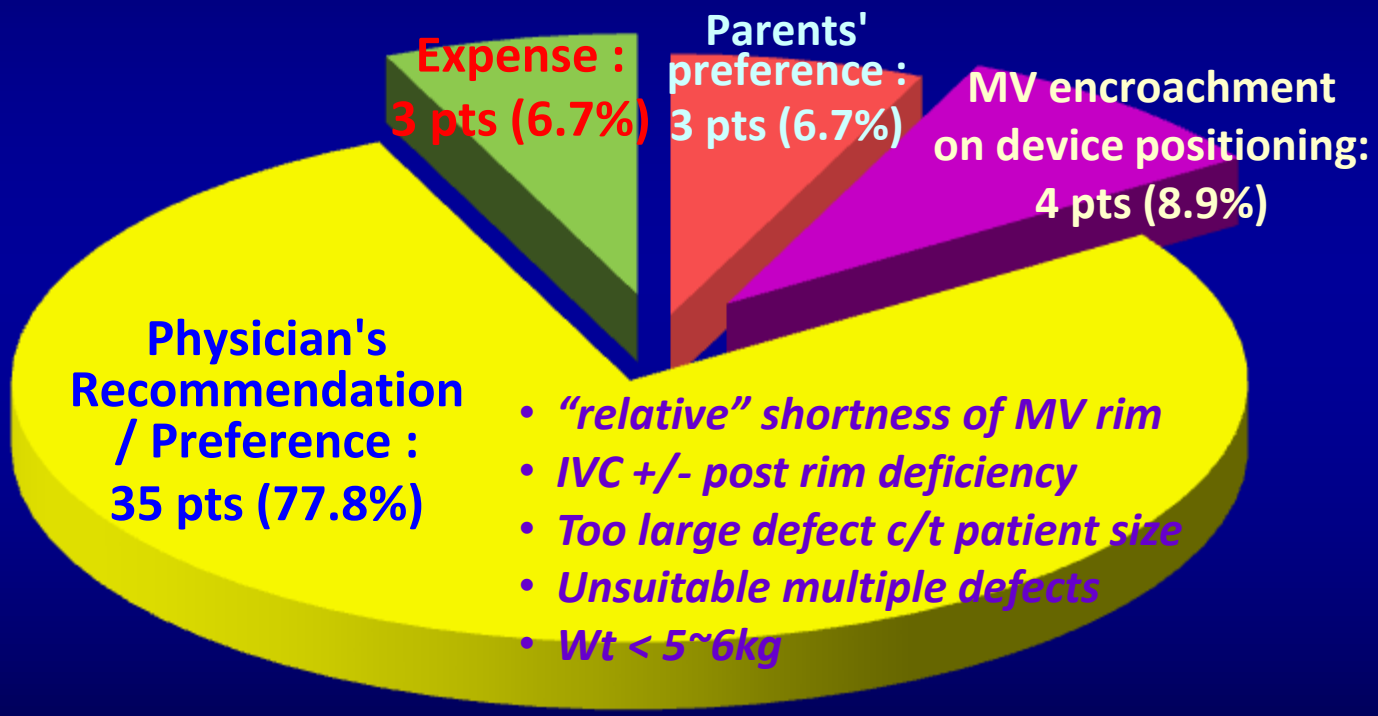
    out of 1,207 device closure

  - **Surgery Group**

    45 pts ≤ 10kg of BWt at the time of surgery

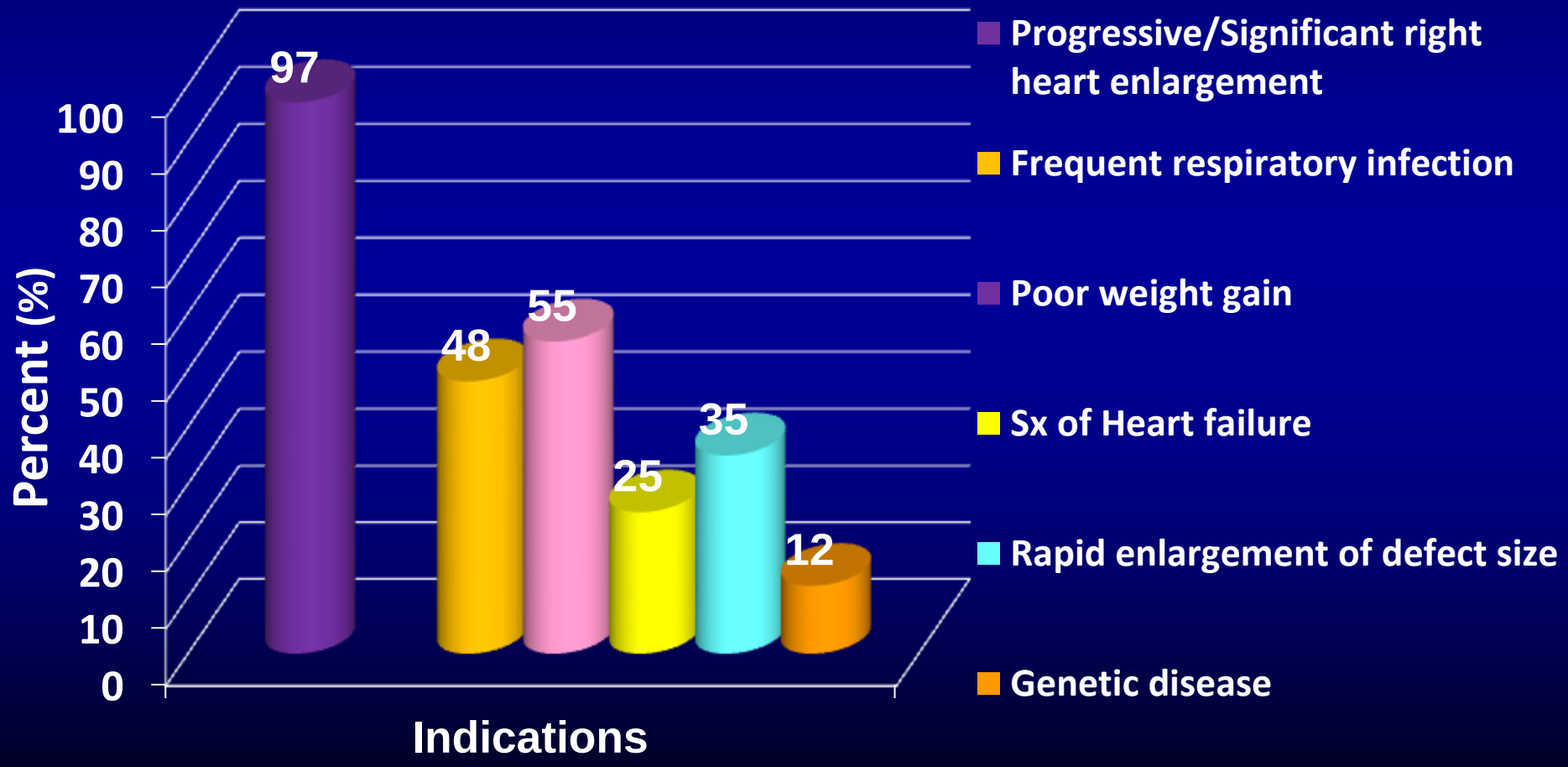
    out of 350 surgical closure

- Reason for Choosing Surgery -



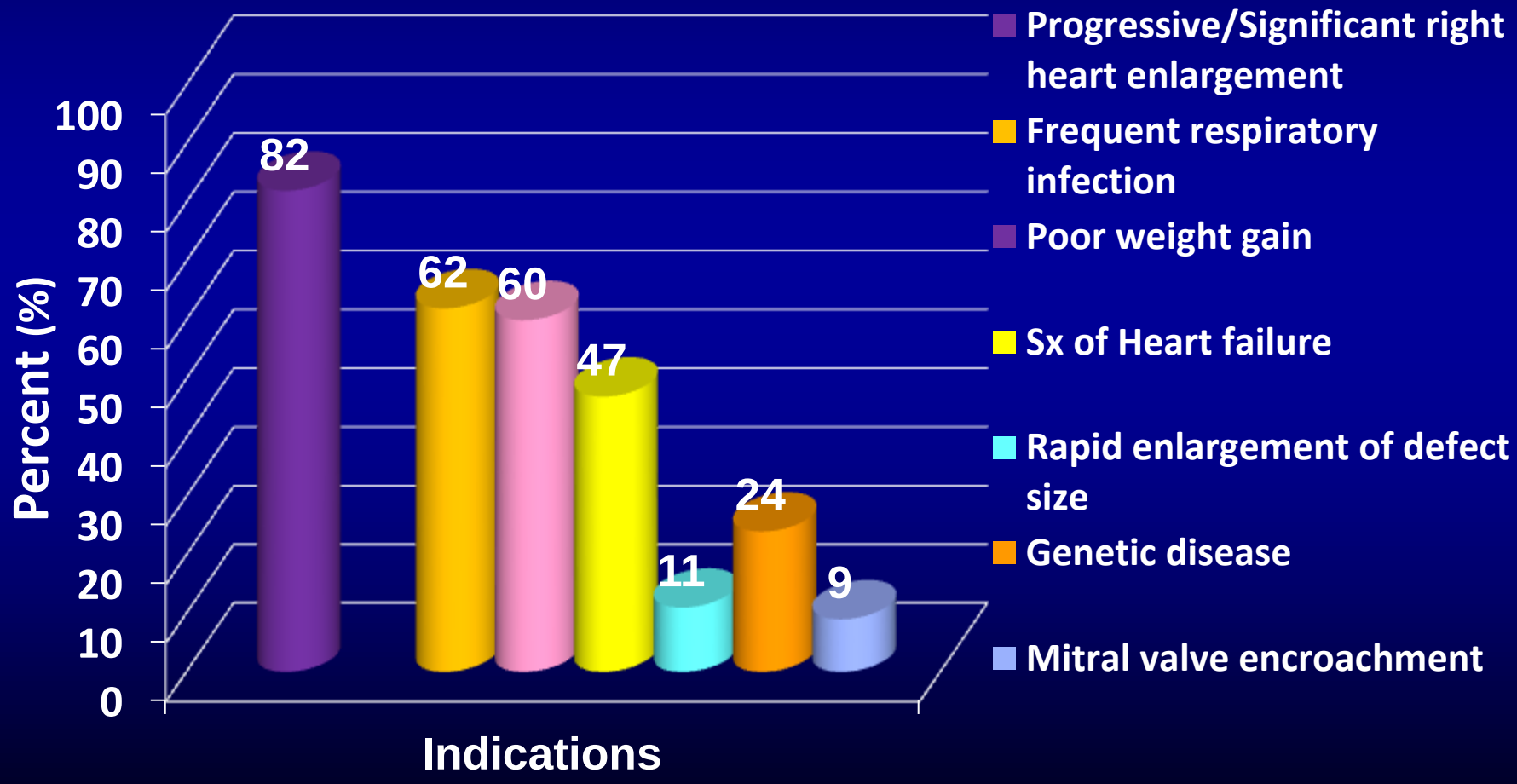
Indications for Early Intervention

- Device Group -



Indications for Early Intervention

- Surgery Group -



Patients' Characteristics

	Device group (N=124)	Surgery group (N=45)	P-value
Sex (F:M)	81 : 43 (1.9 : 1)	25 : 20 (1.3 : 1)	0.282
Age (mo)	16.8 ± 6.1 (5.6 – 30.7)	12.5± 5.4 (1.0 - 26.5)	0.001
Weight (kg)	9.1 ± 1.0 (5.6 – 10.0)	8.0 ± 1.8 (2.8 – 10.0)	< 0.001
Defect size (mm)*	12.5 ± 3.2 (6.0 – 22.0)	15.1 ± 4.4 (8.0 - 23.0)	0.001
Total septal length (mm)	29.3 ± 3.5 (18.0 – 43.0)	27.8 ± 4.9 (15.0 - 41.0)	0.06
Defect size/TLS	0.42 ± 0.10 (0.19-0.62)	0.54 ± 0.11 (0.32-0.77)	< 0.001
Device size (mm)	13.8 ±3.3 (8.0 – 25.0)	-	NA
Qp/Qs ratio	2.1± 0.59 (1.50 - 4.80)	-	NA
F/U duration (mo)	36.7 ± 10.4 (6.0 - 63.0)	38.9 ± 12.4 (5.0 - 84.0)	0.457

** determined by TTE with color Doppler mapping*

Co-morbidities

	Device group (N=124)	Surgery group (N=45)	P-value
Perinatal Hx	**20 (16.1%)**	**8 (17.7%)**	NS
Prematurity (<36weeks)	11 (8.9%)	4 (8.8%)	
Perinatal Asphyxia	1 (0.8%)[+]	1 (2.2%)[+]	
LBW in full term baby	9 (7.3%)	4 (8.8%)	
Chronic lung disease (BPD)	**6 (4.8%)**	**3 (6.6%)**	NS
Genetic disease	**15 (12.1%)**	**11 (24.4%)**	**0.045**
Down syndrome	4 (3.2%)	7 (15.6%)	
Digeorge syndrome	2 (1.6%)	2 (4.4%)	
VACTER syndrome	2 (1.6%)	1 (2.2%)	
Others	7 (5.6%)	1 (2.2%)	
Neuropsychiatric disease	**6 (4.8%)**	**2 (4.4%)**	NS
Epilepsy	5 (4.0%)	1 (2.2%)	
Hypoxic ischemic encephalopathy	2 (1.6%)[*]	1 (2.2%)	
Autism	1 (0.8%)	0 (0.0%)	

Complex Conditions

	Device group (N=124)	Surgery group (N=45)	P-value
Large*	**103 (83%)**	**45 (100%)**	**0.209**
Rim deficiency **	**91 (73.4%)**	**34 (75.6%)**	**0.563**
Except for Ao rim	36 (29.0%)	14 (31.1%)	
Multiple defects	**34 (27.4%)**	**8 (17.8%)**	**0.072**
Combined Procedures	**19 (15.4%)**	**7 (15.5%)**	**0.109**
PPV or pulm valvotomy	14 (11.4%)	2 (4.4%)	
PDA closure or ligation	5 (4.1%)	5 (4.1%)	

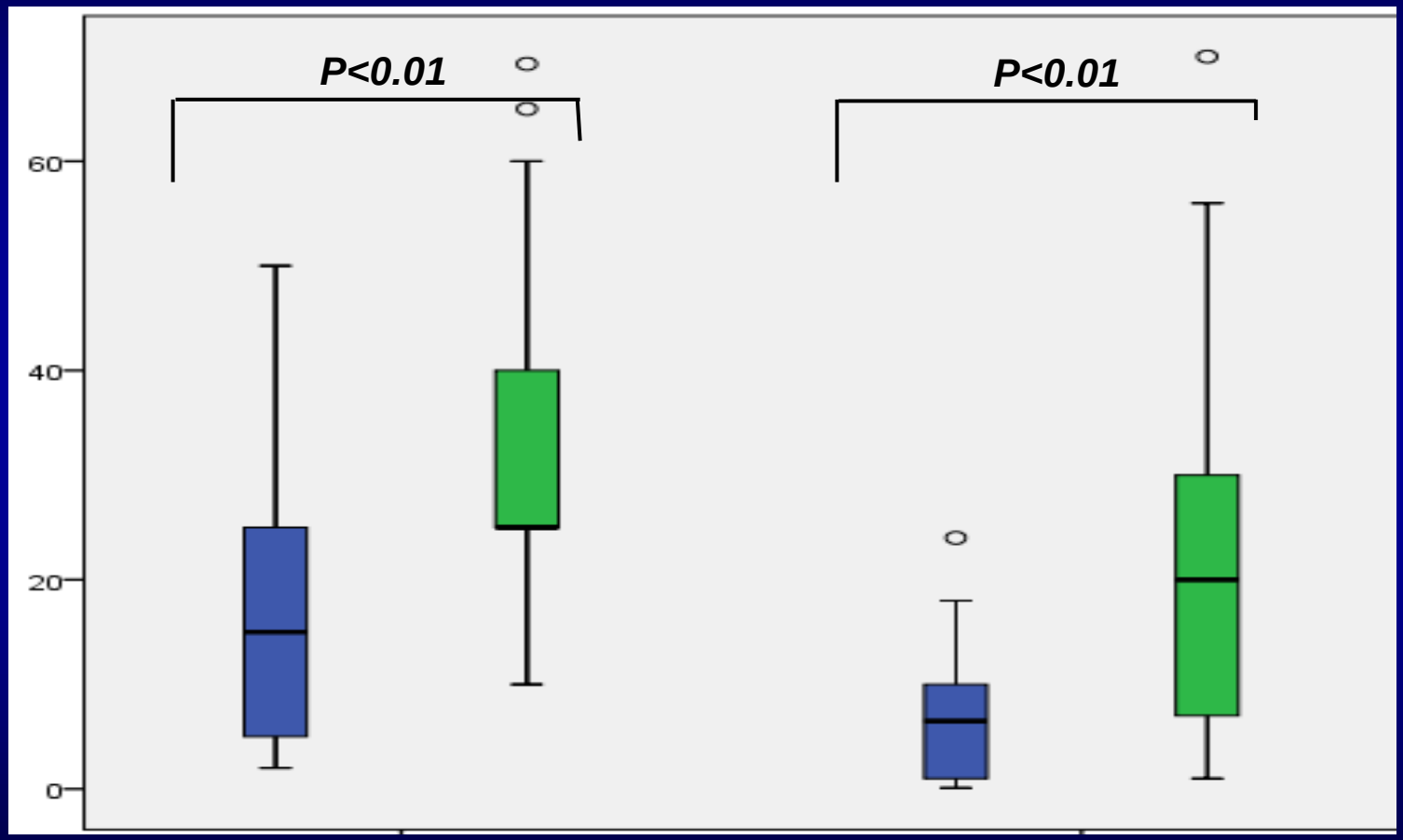
**: by conversion of relative size according to the BSA assuming a large defect in adult ≥ 25mm (except for multi-fenestrated defect), **: <5mm of at least 1 rim (from defect margin to SVC, IVC, PV, AV valve, posterior atrial wall or coronary sinus)*

Success Rate and Complications

	Device group (N=124)	Surgery group (N=45)	*P-value*
PSR (%)*	**124/128[+] (96.8%)**	**45/45 (100)**	**NS**
mitral encroachment	4 (3.2%)		NA
Complete closure (%)			
at discharge	110/124 (88.7%)	43/45 (95.%)	NS
latest f/u	**123/124 (98.6%)**	**45/45 (100%)**	NS
Complication rate	**2/124(1.6%)**	**5/45 (11.0%)**	**0.04**
Major	0 (0.0%)	0 (0.0%)	NS
Minor	**2 (1.6%)**	**5 (11.0%)**	0.04
Transient atrial arrhythmia	**2 (1.6%)**	0 (0.0%)	
Pericardial effusion	0 (0.0%)	**4 (8.8%)**	
Wound infection	0 (0.0%)	**1 (2.2%)**	
	+ 4 switch to surgery	**+ 20 transfusion**	
Hospital Stays	**4.0 ± 0.3 (3.0 – 5.0)**	**11.1 ± 5.4 (7.0- 45.0)**	**<0.001**

*+ included 4 cases of mitral encroachment with subsequent surgical closure, * Procedural success rate*

Catch-up growth during F/U



- Conclusion -

- ✓ Transcatheter closure of secundum ASD is safe and effective even in small children, and may be an attractive treatment option for small children who requires early intervention
- ✓ However, long-term data in larger population are required for rare complication such as erosion to extend general recommendation for early intervention in small children
- ✓ Meticulous approach and individualized strategy for each patient are mandatory to maximize the efficacy and safety of device closure of ASD in small children


Thank You
for Your Attention!

Erosion

Echocardiographic Predictors of Cardiac Erosion After Amplatzer Septal Occluder Placement

Zahid Amin,* MD, FSCAI

CCI 2014;83:84

Zero degree view on TEE

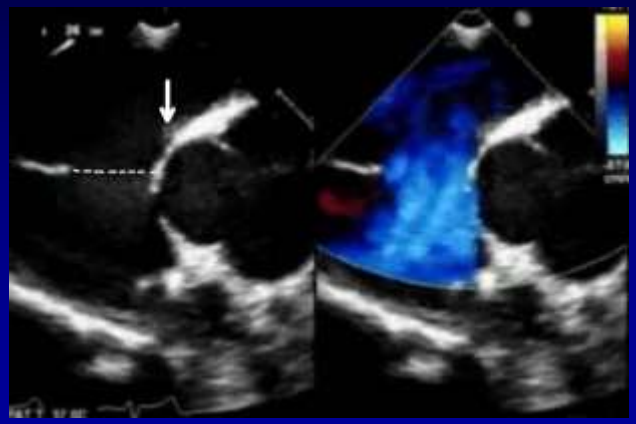
- **TS recess – may be in direct contact with the device**
- **Vulnerable to the edge of device : Ao-atrium fistula**

✓ **12 new cases since 2005**

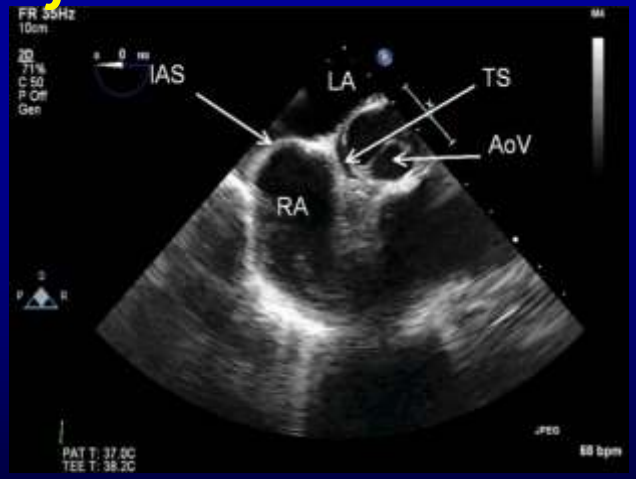
- **Contact :** ***most important,*** all pts had
  - absent Ao rim in multiple views
  - <2mm or absent Ao rim at 0 degree view (bald aorta)
  - poor posterior rim consistency
- **Dynamic ASD** (change in defect size a/t cardiac cycle) - 50% pts
- **Malalignment of atrial septum** – 42% of pts
- **Echo predictors after device placement**
  - tenting of the atrial free wall into the TS (overall 50% of pts)
  - wedging of the discs btw posterior wall / aorta (66.7% of pts)
  - pericardial effusion

wedging of disks btw Ao-posterior wall

malalignment of IAS



tenting of the atrial free wall into the TS



Amin Z. CCI 2014;83:84