Interventions of Aortic Valve Stenosis

Tips and Tricks

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Percutaneous aortic valve stenosis interventions

- Percutanous Aortic Valvuloplasty:
  - Neonates
  - Children
  - Adults
- Transcatheter Aortic valve implantation (TAVI)

Balloon Aortic Valvuloplasty: The History

- **1984 Aortic stenosis in Children – Lababidi**
- **1985 Acquired Aortic stenosis in 3 pts– Cribier**
- **1987 Aortic stenosis in Children - Choy**
- **1987 Cribier - 92pts and Block - 55pts**
- **1986 Mansfield Registry**
- **1987 NHLBI Registry**

What is the role of Balloon Aortic Valvuloplasty in 2013?

1) Neonatal, childhood and adolescent applications are well established.

2) Fetal application remains experimental.

3) The rare adult with AS

Progress

- First reported by Lababidi in 1984
  Lababidi et al.,Am J Cardiol 1984:53;194-197
- Significant adverse event rate in early reports
  - Femoral arterial injury
  - Aortic regurgitation
  - Death
- Major life threatening complications related to age
  - 11/204 (5%)
  - Death in 5/11 less than 1 year old
  Rocchini et al., Am J Cardiol 1990:65;784-789
- Low profile balloons
- Retrograde approach
- Rapid ventricular pacing
- Operator experience

Balloon Aortic Valvuloplasty in children

(Non calcific= fibrotic valve)

- The predominantly fibrotic nature of these congenitally stenotic valves makes them well suited for balloon valvuloplasty.
- Effective in up to 90% of the time, with a mortality rate of approximately 0.7%.
- Survival at 8 years has been reported to be 95%, with the need for repeat intervention 25% at 4 years and 50% at 8 years.

Moore et al., J Am Coll Cardiol,

Indications

1. Transvalvar gradient of >50 mmHg(AR < mild)

Class I

- Symptoms with peak gradient >50 mm Hg
- Gradient >60 mm Hg
- New ECG changes at rest or with exercise >50 mm Hg

Class IIa

- Gradient >50 mm Hg in patient who desires competitive sports or pregnancy

Class III

- Gradient <50 mm Hg with no symptoms or ECG changes

ACC/AHA guidelines .J Am Coll Cardiol 1998; 32:1486–1588.

2. Critical Neonatal AS with adequate LV size

Technique:

- Retrograde approach.
- Advance the soft end of a straight wire out of a pigtail, gently probe for the valve orifice (post. and to LT) .
- Transvalvar gradient is measured.
- Left ventriculogram and the aortic annulus is measured at the hinge points of the valve.
- The balloon diameter is chosen to be 75% to 90% of the annulus diameter,> than 100% is more likely to be associated with AR.
- Pressure pullback is performed, followed by an aortogram for aortic regurgitation.

Double balloon technique

- Double balloons are used when the annulus is larger than 22 mm.
- Double-balloon technique, not totally obstructing flow, may make it easier to maintain balloon position
- Double balloon sizing; using Yeager's formula

Yeager S J Am Coll Cardiol 1987,9:467

Aortic regurgitation

- Increased risk with larger balloon/annulus ratios
- Increased risk with young age

Fratz S et al.,Circulation 2007;117:1201-1206

- Increased risk with bicuspid, asymmetrically thick valves
- Increased risk with time

Tips

- You may need different wires for entry into LV
- Not exceed 0.9-0.95 of the annulus diameter
- Balloon length shouldn’t exceed 3cm in children(2in NB)
- Serial dilatations using several balloons can help gradient reduction and minimize the risk of AR
- Use a road map to put the balloon centre opposite the annulus
- Always leave the exchange wire in place (manipulate slowly---perforation!)
- Low profile balloon
- Don’t exceed the balloon rated burst pressure

Balloon displacement/stability

- In infants and children with AS, CoA,there are several pharmacological as; Adenosine (a powerful drug that creates arterial hypotension and leads to transient cardiac standstill after bolus injection)

  De Giovanni et al.,Heart 1998;80:330–3 , /Or mechanical techniques were described to overcome the balloon movement; none, however, have proved entirely satisfactory.
- An alternative method to achieve balloon stability is the use of rapid ventricular pacing.

RV pacing during BAV

Rationale:

- Rapid right ventricular pacing enforces VT and absent A/V synchrony and thus Ventricular filling is compromised
- Ventricular contractility is reduced because of the dyskinesia due to apical stimulation. Thus, reduced SV, CO ---decreased blood pressure.

Daehnert et al.,
Heart. 2004 September; 90(9): 1047–1

RV pacing during BAV cont.

Technique:

- Via IJV access, 4French bipolar pacing catheter is introduced to the right ventricular apex.
- A single chamber pacemaker capable of rapid stimulation is connected, the VVI mode chosen, and effective sensing and stimulation confirmed.

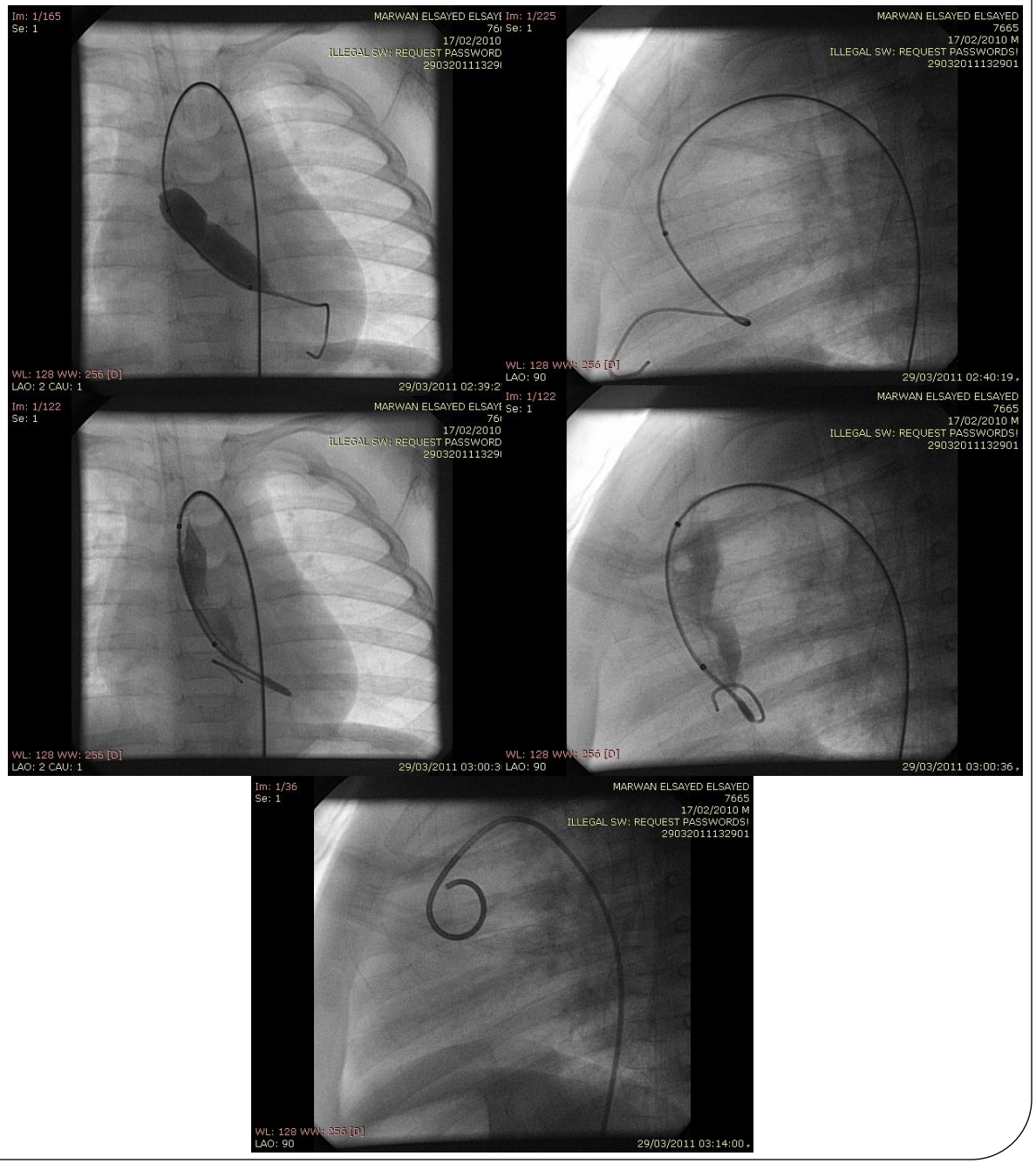
Daehnert et al.,
Heart. 2004 September; 90(9): 1047–1050

RV pacing during BAV cont.

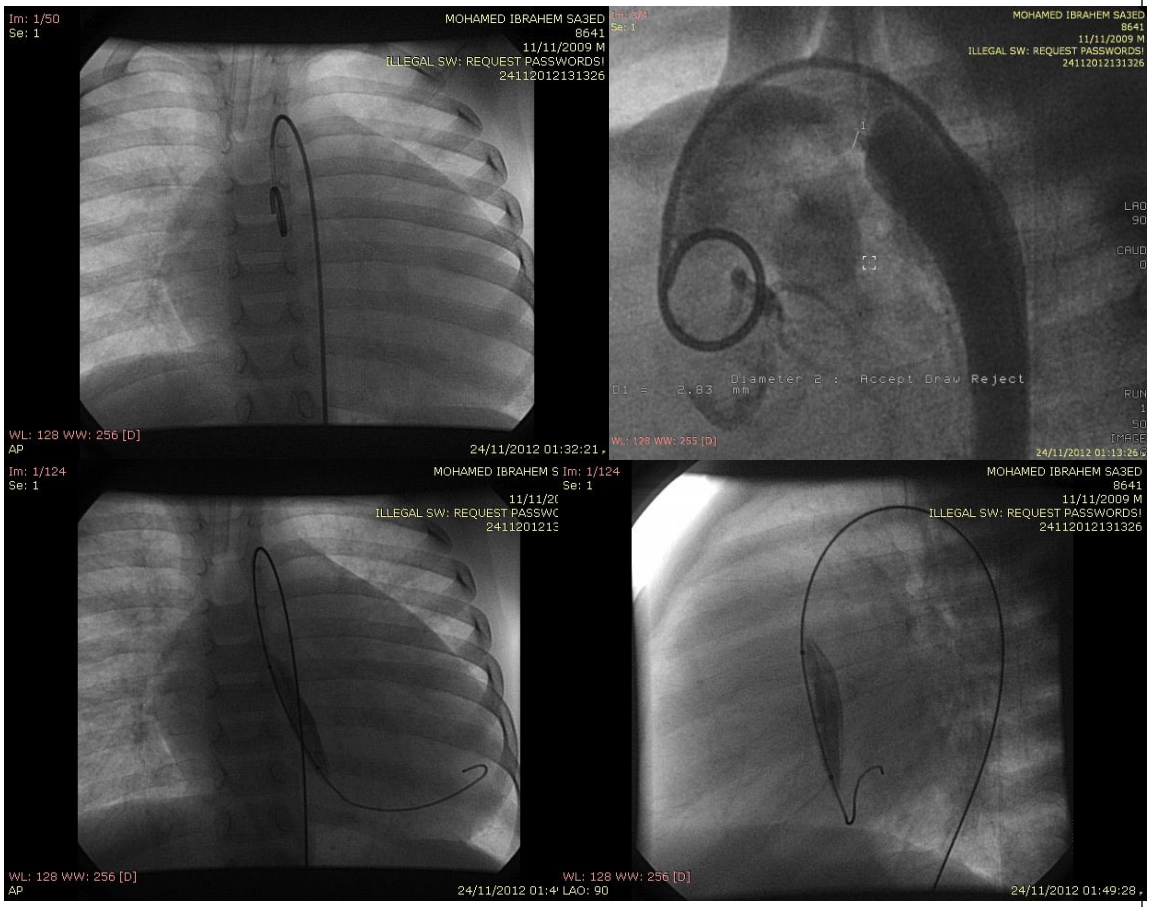
- Rapid ventricular pacing is initiated at a rate of 180 per minute and increased by increments of 20 per minute to a rate that achieves a drop in SBP by 50% and PP by 25%.
- The balloon is inflated only after the desired pacing rate is reached. Pacing discontinued after balloon deflation.

Daehnert et al.
Heart. 2004 September; 90(9): 1047–1050

- Pt. 1:
  - M,11mo., 12 Kg,76cm
  - Severe AS
  - bicuspid Ao valve
  - Annulus14mm
  - Gradient 80mmHg
  - Tyshak II, 12/4 then 13/4
  - Gradient dropped to 20mmhg, mild AR



- Pt. 2:
  - M,3 yrs,10Kg, 83cm
  - Severe AS, LV dysfn. FS 22%
  - PDA 3mm, PHTN; 75 mmHg
  - Ao Annulus: 12mm
  - Gradient 65mmHg
  - Tyshak II 12/4mm
  - Gradient



Balloon Aortic Valvuloplasty in neonates

Special techniques are useful in neonates:

- The umbilical artery (first week of life).
- Some centers use the carotid artery
- Trans-septal approach can be used, from either the femoral or the umbilical vein.

Special considerations in neonates

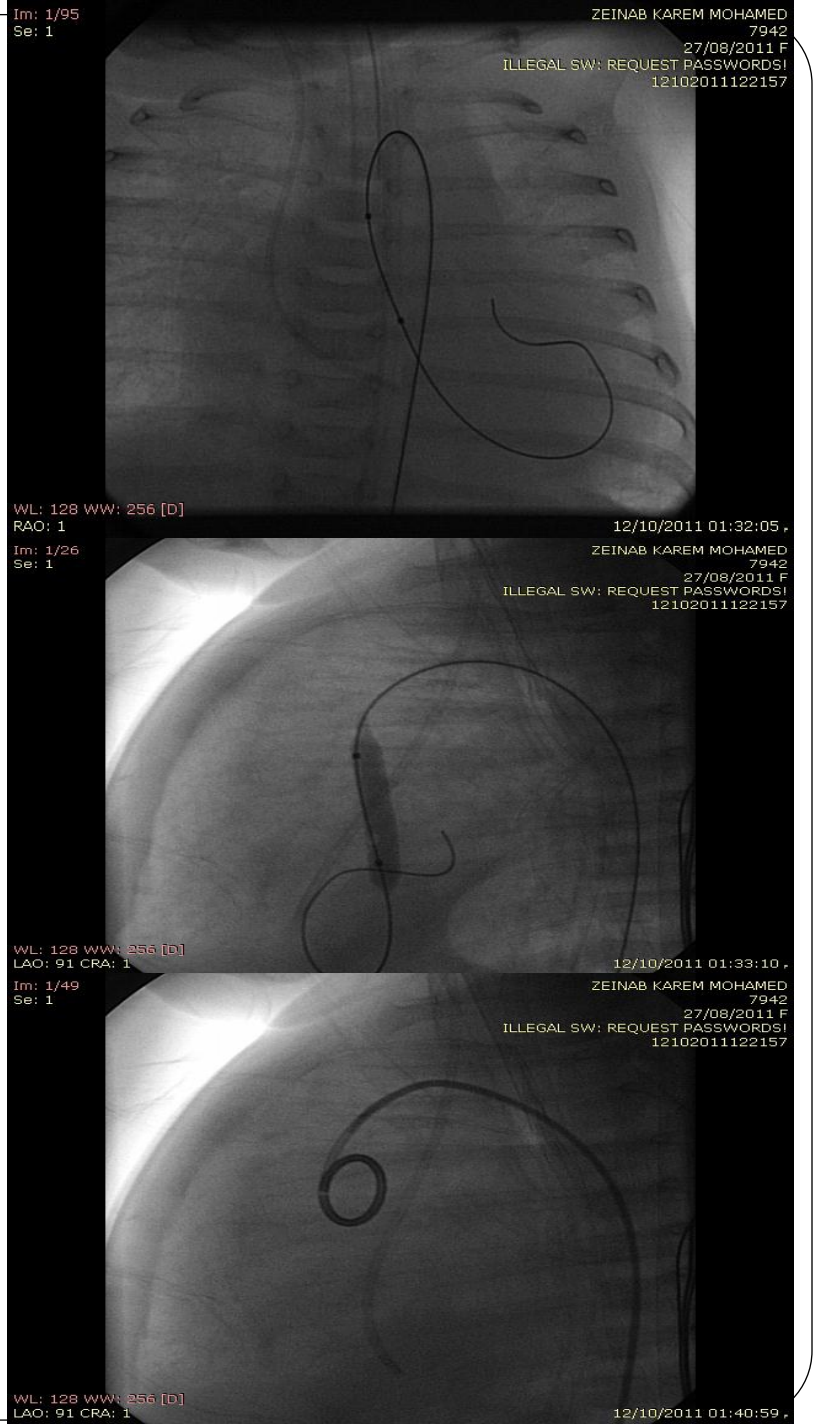
- Because of poor ventricular function and the common presence of a PDA, gradients can be underestimated.
- Special attention to LT heart structure Z-scores; smaller Z- scores might lead to less optimal gradient reduction and/or mortlity
- Identify associated EFE, PDA and coarctation.
- Presence of pre-BAV AR in cases of bicuspid aortic valve.

Special considerations cont.

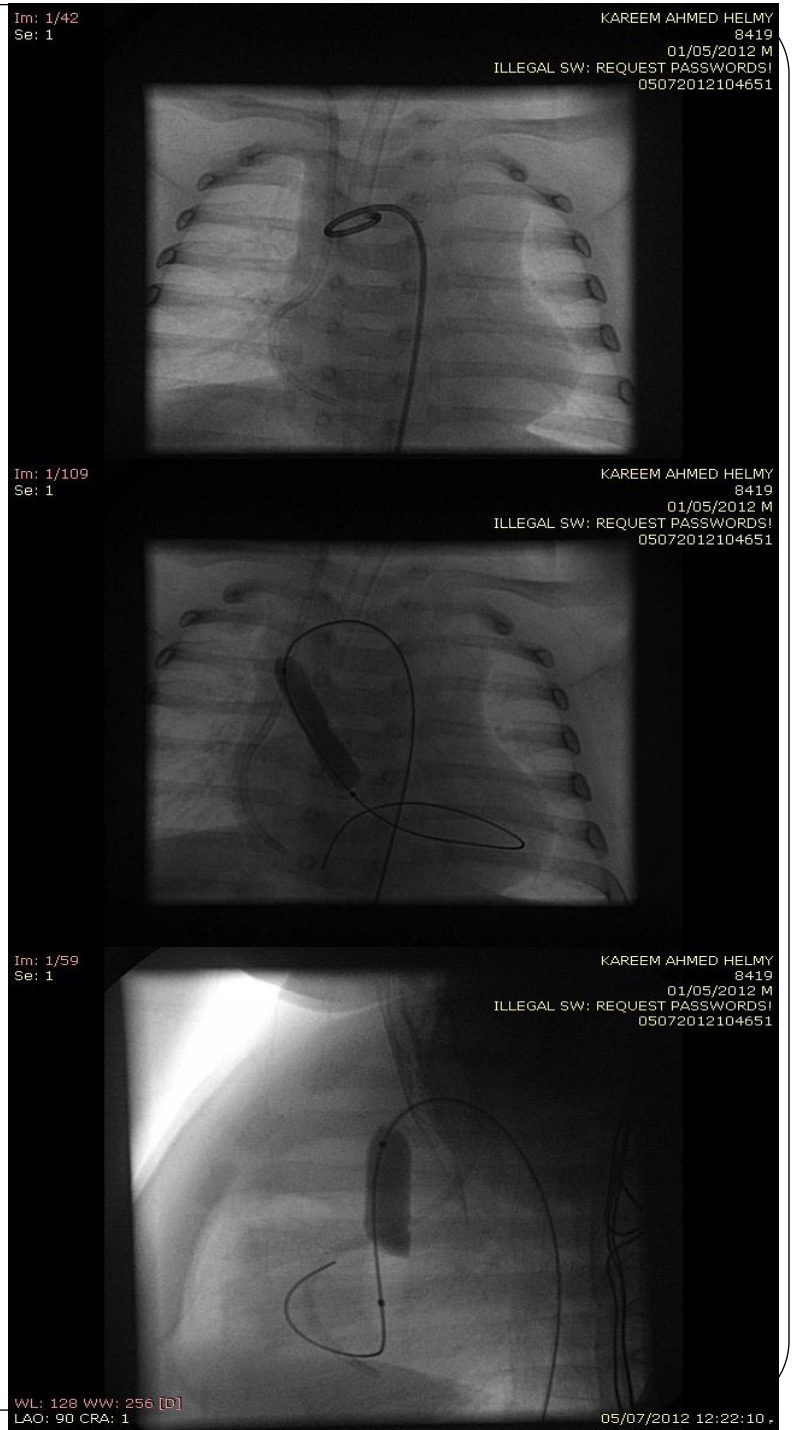
- Balloon/annulus diameter should never exceed 0.9.
- Antegrade vs retrograde approach(equivocal results for post BAV AR) Magee AG et al.,1997;30:1061-6
- Serial dilatations should be attempted in smaller annulus diameters.
- Repeat BAV may be required if the gradient doesn't drop by> 50% especially to avoid bigger balloon/annulus ratio and post intervention AR.
- Post BAV AR can develop insidiously so long term follow up is required

- **Pt. 1:**

- F, 1mo, 4.5 Kg
- Bicuspid Ao valve
- Severe AS, annulus 8mm
- LV dysfn. FS 20%
- IJV—rapid pacing
- Tyshak II 7/2
- Gradient dropped from 77mmhg to 8 mmHg



- Pt. 2
  - M,29 days,4 Kg, 53 cm
  - Severe AS, Bicuspid Ao valve
  - Ao annulus 8mm
  - Gradient: 120 mmHg
  - Tyshak II 6/3mm, then 7/3mm
  - Gradient dropped to 40 mmHg



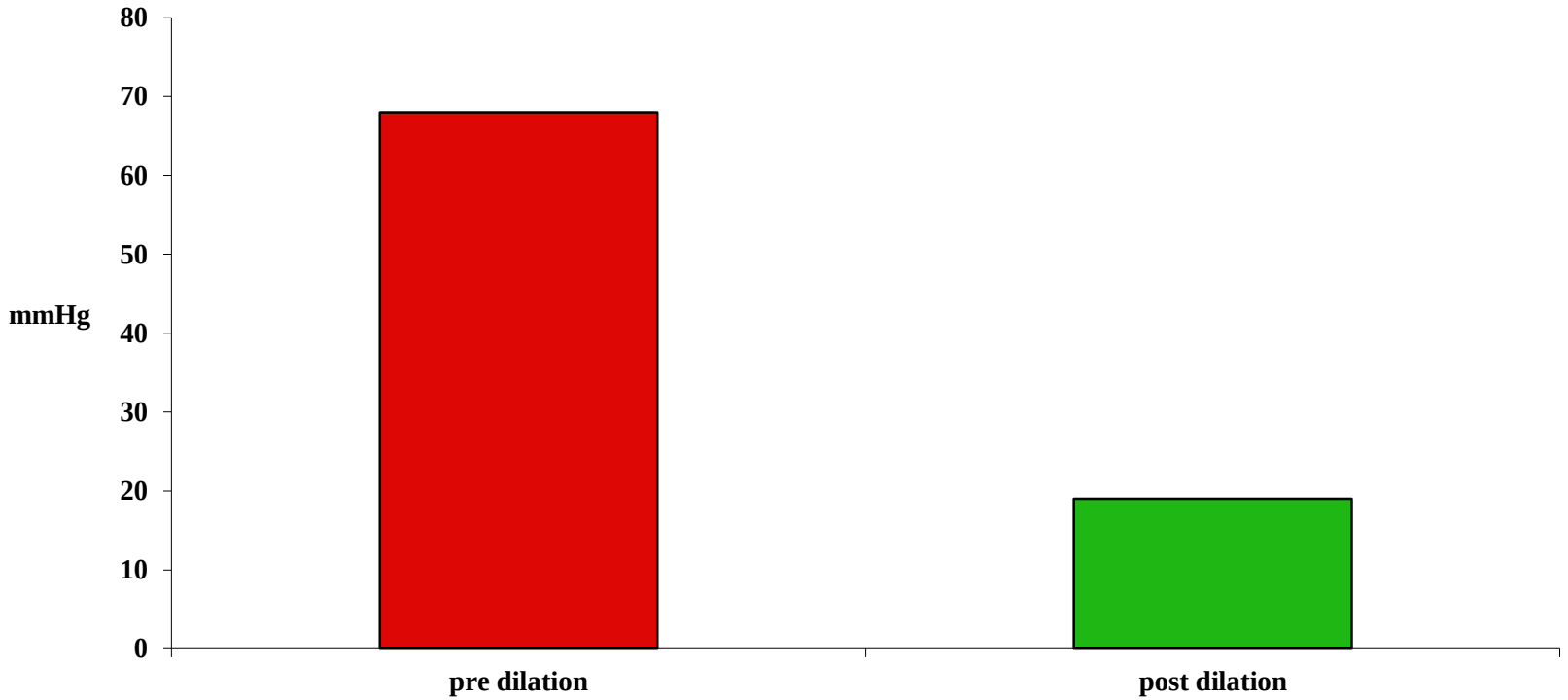
Cairo University Specialized Pediatric Hospital experience (Cairo, Egypt)

- 187 cases between Jan. 2005-Jan. 2013
  - Neonates 72/187(38%)
  - Infants and children115(62%)
- All performed via retrograde approach
- Bicuspid Ao valve 94/187 (50%)
- Associated PDA 25/187(13%)
- Associated Coarctation 19/187 (10%)
- Single balloon 164/187(88%)
- Double balloon 23/187(12%)

Demographic/ cath. data

	Neonates 72/187(%)	**Infants and children 115/187 (%)**
Mean Age:	14 days (3-29 d)	28 months (1mo-9 yrs)
Mean wt:	3.2 Kg (2-4.9 Kg)	6.5 kg(5-24Kg)
Sex:	47 M (65%) 25 F (35%)	82 M(71%) 33 F(29%)
LV failure:	89%	62/115 (54%)
Duct dependant:	36/72(50%)	-
Mean annulus diameter :	6 (5-8)mm	8(6-10)mm
Mean initial balloon diameter:	5(4-7)mm	7(5-9)mm
Mean largest balloon diameter:	7(6-9)mm	9(6-10)mm
Mean balloon/annulus ratio:	0.84	0.94
Mean procedure time:	72 min	65 min
Median no. of balloons/pt	2 (2-5)	2(1-4)

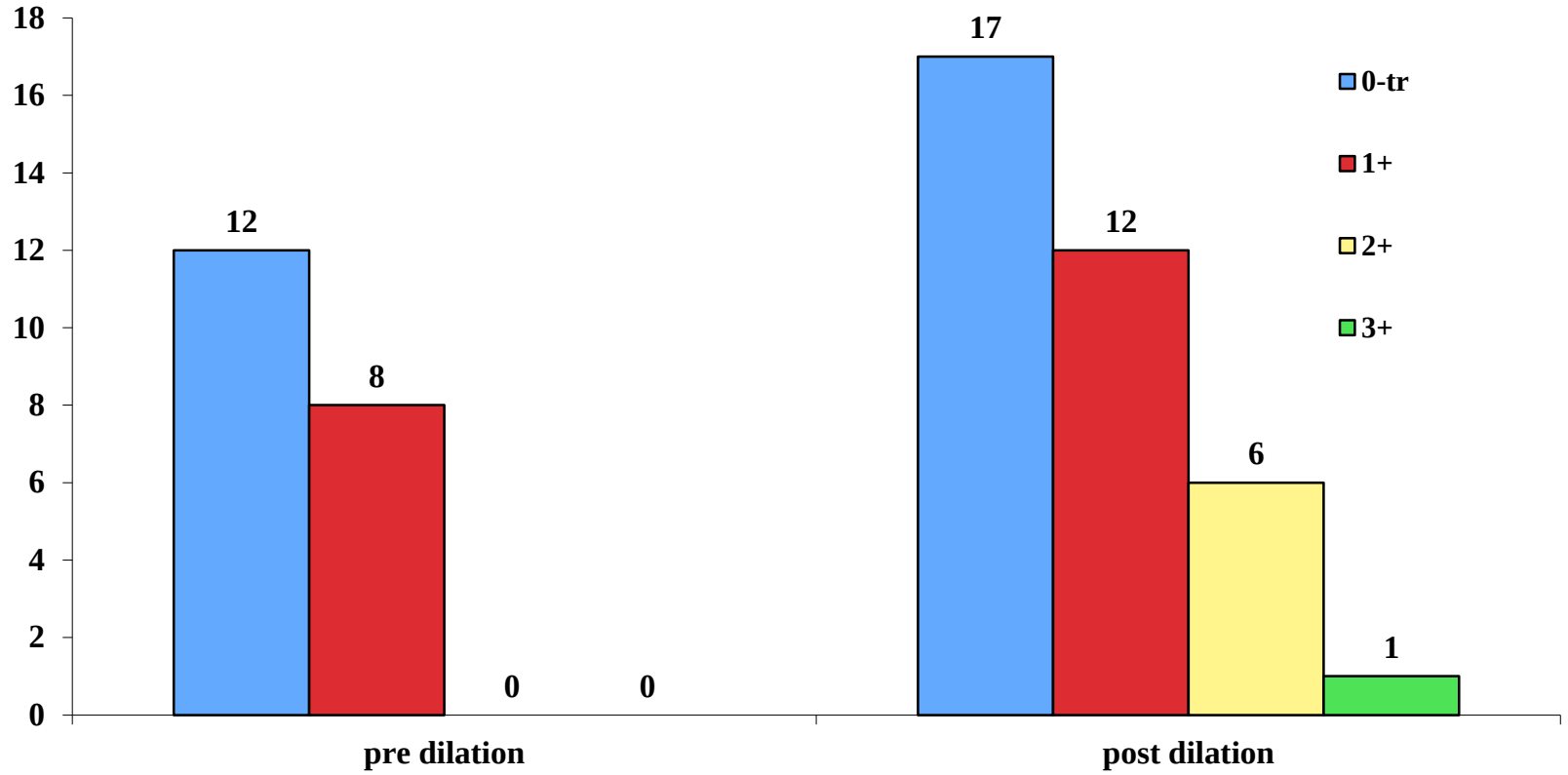
Gradient Reduction



$p < .001$

Aortic Regurgitation

36/187 cases(19%)



Complications and Outcome

- 9/187(5%) minor events
  - 1 VF, spontaneous recovery
  - 8 persistent reduced pedal pulses requiring heparin or thrombolytic Rx
- Three cases required blood transfusions
- Combined intervention
  - For PDA(ADOI) in 17/25(68%) cases
  - For Coarctation (BA) in 12/19(63%) cases
- Repeat BAV in 27/187(14%) with a mean of 14 months
- AR at 3 years follow up
  - Trivial-mild :29/187 (16%)
  - Moderate : 6/187 (3%)
  - Severe :1/187 (0.5%)

Balloon Aortic valvuloplasty in Adults
(Calcific valve)

- Limited role (unpredictable initial benefit and the very high rate of recurrence or restenosis).
- Ideally all symptomatic adult patients with calcific aortic stenosis should undergo aortic valve replacement as the treatment of choice.
- ? Important palliative role in patients who are not candidates for immediate valve replacement.

Indications;

1. Cardiogenic shock
2. Bridge to surgical replacement
3. Poor surgical risk; > 90 yrs
4. Critical symptomatic stenosis requiring emergency non cardiac surgical intervention

Technique

- Goal is to increase the AVA > 100% and to achieve a valve area of at least 1 cm 2.
- Normal-sized adults begin with a 20-mm diameter. If a desirable result has not been achieved, change to a 23-mm diameter balloon and repeat the procedure.
- If still unsatisfactory employ a dual-balloon technique, using a pair of 15- or 18-mm balloons if aortic annulus size permits

Balloon Aortic Valvuloplasty Major Series

- **Mansfield Scientific Registry, n = 492**
- **NHLBI Registry, n = 674**
- **Cribier (French Registry), n = 406**
- **Block , n = 375**
- **Safian , n = 170**
- **Lieberman , n = 165**
- **Lewin , n = 125**
- **Ferguson , n = 73**

Balloon Aortic Valvuloplasty
Acute Outcome
“Success” ?

- Mansfield Registry
  - 87% Success - i.e. alive, no AVR, a significant AVA
- NHLBI
  - 95%
- Kuntz et al
  - 93%

Balloon Aortic Valvuloplasty
Acute Hemodynamic Results

674 pts in NHLBI Registry

44% M; 56%F; 78 ±9 yrs	Before	After BAV	p
Valve Gradient, mmHg			
Mean	55 ±21	29 ±13	**<0.0001**
Peak to peak	65 ±28	31 ±18	
Valve Area, cm^2	0.5 ±0.2	0.8 ±0.3	**<0.0001**
Cardiac output, L/min	4.0 ±1.2	4.1 ±1.3	**<0.0001**
Aortic Pressure, mmHg	87 ±16	90 ±17	**<0.0001**
LV systolic Pressure, mmHg	196 ±39	172 ±32	**<0.0001**
LVEDP, mmHg	22 ±9	19 ±9	**<0.0001**
PA Pressure, mmHg	31 ±13	30 ±12	**<0.0001**

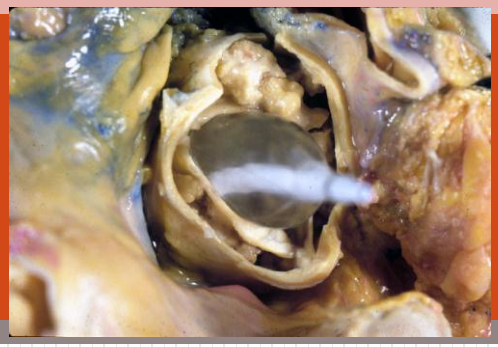
Circ 1991;84:2383-2397

Balloon Aortic Valvuloplasty

Complications - %

		Death	CVA	Perf^{n}	MI	AR	Vasc
Mansfield Registry	(492)	7.5	2.2	1.8	0.2	1.0	11
NHLBI	(674)	3.0	4.6	1	1	1	27
Cribier	(334)	4.5	1.4	0.6	0.3	0	13.1
Safian	(225)	3.0	0.4	1.2	0.5	0.8	7.5
Block	(308)	5.0	2.0	0.3	0.5	0	9.0
Lewin	(125)	10.4	3.2	0	1.6	1.6	9.6

Balloon Aortic Valvuloplasty poor outcome ?



The patient

- Current illnesses
- CAD
- Res. AVA (< 1 cm^2)

The procedure

- Fracture of calcific nodules
- Commissural splitting
- Annular stretching

Thank you