Cardiac Interventions in Pregnancy

Introduction

0.2%–4% of all pregnancies are complicated by cardiovascular diseases:

At present congenital heart disease in developed countries and rheumatic valvular disease in developing countries is the most common cardiovascular conditions during pregnancy.

- With our current understanding of pathophysiology of various conditions majority of clinical scenarios can be managed medically

- Percutaneous or surgical interventions are needed rarely to improve maternal and possible fetal outcomes

- Percutaneous intervention is preferred as the first line of therapy whenever possible as surgery is associated with very high fetal loss and late morbidity.

Percutaneous interventions

Issue is to avoid radiation risk to the fetus:

- Timing of intervention
- Limiting Radiation exposure

Percutaneous interventions-Timing

- The best time is considered to be after the fourth month in the second trimester.

- Organogenesis is complete
- The fetal thyroid is still inactive
- Uterus is still small and not in the field of radiation

Percutaneous interventions- Reduce Radiation Exposure

- Use ultrasonic guidance (TTE or TEE) as much as possible
- Use low Fluoroscopy frame rate
- Fluoroscopy and cineangiography times should be as brief as possible –ALARA principle
- The gravid uterus should be shielded from direct radiation.

Surgical Interventions

- Only if medical or percutaneous options not possible and mother's life is in danger
- Timing- emergent vs nonemergent
- Management during Cardiopulmonary bypass

Surgical Interventions-Timing

- The best time is between the 13th and 28th week
- Surgery during the first trimester-higher risk of fetal malformations and during the third trimester- higher incidence of pre-term delivery, maternal complications
- Fetal survival increases as gestational age increases, the opposite however is true for maternal mortality due to higher rate of hemodynamic deterioration
- If gestational age is >28 weeks - delivery before surgery should be considered.

Surgical Interventions- CPB Management

- To lower the fetal mortality and long term morbidity from surgery:
- Minimize the pump time
- Maintain adequate uteroplacental flow :
  - Pump flow >2.5 L/min/m2
  - Maintain perfusion pressure >70 mmHg
  - Maternal haematocrit >28%
  - Normothermic perfusion, when feasible
  - Avoid hypocapnia

Valvular heart disease

- Goal of management is to maintain adequate cardiac output for uteroplacental flow and growth of the fetus

- To avoid pulmonary and systemic congestion

Valvular heart Disease

- Stenotic (MS,AS,PS,TS) vs regurgitant (MR,AR,PR,TR) conditions: Regurgitant conditions are well tolerated during pregnancy and be managed medically in the majority

- Right sided vs left sided : right sided even severe stenotic conditions (PS,TS) can be managed without the need for interventions during pregnancy

Mitral Stenosis

- Patients with previously undiagnosed severe mitral stenosis (MVA < 1.5 cm2) typically present with congestive heart failure with or without atrial fibrillation during the late second or early third trimester of pregnancy.

- Majority of these patients can be effectively managed medically with judicious use of beta blockers, diuretics, digoxin and anticoagulation in patients with atrial fibrillation to prevent thromboembolic complications.

Mitral Stenosis-Indications for interventions during pregnancy

- Percutaneous Balloon Mitral Commisurotomy:

- suitable valve morphology with no other contraindications (LA thrombus or moderate to severe mitral regurgitation)

- severe mitral stenosis (mitral valve area ≤1.5 cm2) who remain in New York Heart Association functional **class III or IV** and/or have pulmonary hypertension (Pulmonary artery systolic pressure (PASP) > 50 mm of Hg) despite appropriate medical management

Mitral Stenosis

- If PBMC is not feasible, mitral valve surgery (closed mitral commissurotomy, open mitral commissurotomy or mitral valve replacement) only in NYHA functional class IV despite medical therapy.

- **Closed mitral commissurotomy :**
- sometimes the only approach available in some of the developing countries but the lack of training in the developed countries makes it not an option.
- It does not require cardiopulmonary bypass, and is therefore associated with better fetal outcomes compared to open commissurotomy or MVR.

Mitral Stenosis-Indications for surgical interventions during pregnancy

- Only if patient remains in NYHA functional **class IV** (pulmonary edema) and patient is not a candidate for PBMC.

- Maternal morbidity and fetal morbidity as well as mortality with surgical valve interventions remain high

Mitral stenosis-PBMC

Table 1. Outcomes of Catheter Balloon Commissurotomy During Pregnancy

Study	No. of Patients	Age (y)	GA (wk)	MV Area (cm^2) pre/post	MV Gradient (mmHg) pre/post	PASP (mm Hg) pre/post	Fluoroscopy Time (min)	Postprocedure Severe Mitral Regurgitation Requiring Surgery	Procedural Success	Maternal Mortality	Fetal Mortality (Abortion+ Stillbirth)
Mishra et al[16]	85	23±4	25±5	0.8±0.5/2.0±0.5	29±9/7±4	NA	3.6±3.2	1 (1.2)	80 (94)	0	0
Esteves et al[17]	71	27±6	24±7	0.9±0.2/2.0±0.3	18±7/3.9±3.1	NA	NA	3 (4.6)	71 (100)	0	2 (4.2)
Nercolini et al[18]	44	28±6	23±6	1.2±0.3/2.1±0.4	16±6/8±4	54±23/35±11	NA	0	42 (95)	0	4 (8.1)
Farhat et al[19]	44	29±6	26±6	1.0±0.2/2.4±0.4	22±8/5±3	56±24/36±16	16±7	1 (2.3)	43 (97.7)	0	0
Routray et al[20]	40	23±5	24±5	0.8±0.3/1.9±0.4	28±10/7±4	NA	5.5±3.8	0	38 (95)	0	1 (2.5)
Gupta et al[21]	40	24±5	21±11	0.8±0.2/1.7±0.2	26±7/9±5	66±24/47±16	7.8±1.9	1 (2.5)	39 (97.5)	1 (2.5)	1 (3.4)*
Sivadasanpillai et al[22]	36	26±4	27±5	0.7±0.2/1.6±0.3	NA	70±17/48±13	5.4±5.8	0	35 (97.2)	0	0
Kalra et al[23]	27	25±3	22±4	0.8±0.2/2.2±0.2	31±8/6±3	NA	5.6±2.2	1 (3.7)	26 (96.3)	0	1 (3.7)
Mangione et al[24]	23	28±7	25±6	1.1±0.2/2.0±0.2	18±5/6±2	NA	19±9	0	23 (100)	0	1 (4.3)
De Souza et al[25]	21	25±5	25±7	1.0±0.3/2.2±0.4	16±9/5±3	NA	NA	0	20 (95)		0
Patel et al[26]	20	30±6	30±3	0.8±0.2/1.7±0.2	18±6/6±2	52±13/37±7	9.2±3.4	0	20 (100)	0	0
Abouzied et al[27]	16	23±3	25±6	0.9±0.3/1.8±0.3	23±7/6±3	59±18/33±12	Less than 11 (max)	0	16 (100)	0	0
Iung et al[28]	13	30±8	26±4	1.0±0.2/2.0±0.2	23±5/8±4	NA	15±9	0	13 (100)	0	0
Esteves et al[29]	13	26±7	25±6	0.9±0.3/2.1±0.3	20±6/4±2	62±24/32±14	NA	0	13 (100)	0	0
Martínez-Reding et al[30]	9	31±7	24±6	0.9±0.1/1.8±0.4	21±7/7±1	78±30/47±39	10–15 (range)	1 (11)	8 (89)	0	0
Ribeiro et al[31]	7	32±8	26±9	0.8±0.1/2.0±0.3	NA	NA	16±7	0	7 (100)	0	0
Salomé et al[32]	3	32±4	24±2	1.1±0.2/2.1±0.5	18±9/6±1	NA	15.6±12.0	0	3 (100)	0	0
Glantz et al[33]	1	27	29	0.6±2.8/NA	19±2/NA	88±64/NA	NA	0	1 (100)	0	0
Smith et al[34]	1	29	23	0.95±1.78/NA	14±6/NA	NA	NA	0	1 (100)	0	0
Safian et al[35]	1	39	13	1.4±2.4/NA	16±8/NA	23±18/NA	20.6	0	1 (100)	0	0
Overall	515	26±6	25±6	0.9±0.3/2.0±0.4	23±9/6±4	61±23/40±16	8.5±7.3	8 (1.6)	507 (98)	1 (0.2)	10 (2)

GA, gestational age; MV, mitral valve; PASP, pulmonary artery systolic pressure; NA, not available.
Data are mean±standard deviation or n (%).
* Eleven elective terminations, 29 pregnancies continued.

Aortic Stenosis

- In contrast to mitral stenosis majority of aortic stenosis related to congenital etiology with bicuspid valve in 95% of patients
- Low and fixed cardiac output can lead to reduced placental blood flow and to IUGR, low birth weight, miscarriage, preterm labor and even fetal death but risk for maternal mortality is low

Aortic stenosis

- Maternal morbidity is development of congestive heart failure.
- The Incidence is low (11% in ROPAC registry -8% with moderate AS vs. 18% with severe AS).
- The need for percutaneous or surgical intervention is very low (2%) and majority of patients can be managed with bed rest and diuretics.
- ACC/AHA guidelines suggest aortic Valve intervention (PBAV or AVR) as a reasonable option for pregnant patients with severe AS only if there is hemodynamic deterioration despite medical therapy or persistence of NYHA class III to IV HF symptoms

Aortic stenosis-PBAV

- There are no large series of PBAV in pregnancy but multiple isolated reports show excellent immediate results with low risk to mother and fetus and full term pregnancy.

- Most common Complications is mild to moderate aortic regurgitation.

- However majority of patients require surgical AVR on follow up after delivery

Aortic stenosis-TAVR/SAVR

Symptomatic severe aortic stenosis who are not candidates for PBAV :

- Moderate to heavily calcified aortic valve
- Moderate to severe aortic regurgitation
- Degenerated bio prosthetic valve

TAVR offers a theoretical advantage over surgical AVR in pregnancy.

TAVR

- Preprocedure assessment of valve size by TEE vs CT especially in bicuspid valve
- Radiation risk to fetus with CT of abdomen for vessel size, procedural requirements and length of procedure
- Higher risk of moderate to severe paravalvular regurgitation in bicuspid valve
- Risk of pacemaker implantation in young patient with long term consequences (2-30%)
- Higher reported vascular complication rates
- Unknown long term durability of the currently available valves

Pulmonic Stenosis

- Large Case control study shows no maternal or fetal complications in patients with isolated pulmonic stenosis and normal right ventricular function irrespective of the severity of the stenosis
- Need for pulmonic valve intervention in pregnancy is rare

Pulmoniv Stenosis

- PBV of native valves can be done in rare cases of suprasystemic gradients with right ventricular dysfunction
- Percutaneous valve implantation for degenerate conduits has been reported.
- Need for surgical pulmonary valve replacement should be extremely rare and has not been reported

Pregnancy Related ACS

- The incidence of pregnancy-related Acute Coronary Syndrome is expected to increase with increasing maternal age

- A high index of suspicion is necessary to diagnose acute coronary syndrome in pregnant patients

Pregnancy-Associated Myocardial Infarction (PAMI)

- 75% of patients present with ST- elevation MI (STEMI) with most cases occurring either during the third trimester of pregnancy or the postpartum period
- Pregnancy Related Spontaneous Coronary Dissection (P-SCAD) is the most common cause. In addition high incidence of normal coronaries with thrombus (17%) and without thrombus (11%).

PAMI-Interventions

- In non-STEMI conservative approach including avoidance of coronary angiography if patient hemodynamically stable

- Coronary angiography and intervention in pregnancy has been linked to high incidence of iatrogenic coronary dissection leading to emergency CABG and even death.

PAMI-STEMI

- Reperfusion Therapy: Fibrinolysis vs PCI
- Fibrinolysis :
- there is a potential of extension of dissection. Therefore blinded use should probably be avoided.

- If PCI is not available and mother's life is in danger

PAMI-STEMI

- In stable low risk patient with PAMI a noninvasive approach may be considered in spite of STEMI:
- Catheter manipulation with high risk of iatrogenic dissection of Left main and/or proximal LAD/LCX
- PCI for P-SCAD has low technical success rates (≈50%) due difficulty in finding the true lumen with wire
- High rate of extension of dissection and intramural hematoma proximally as well as distally (25% - 60%), often leading to need for mechanical hemodynamic support and/or urgent bypass surgery.

PAMI-STEMI

Unstable high risk patients: emergent revascularization (PCI or CABG)

Coronary angiography: a careful and meticulous details in angiographic technique

- Initial nonselective injections to visualize the LM
- Avoid deep intubation of catheters
- Watch for pressure dampening
- Use minimum numbers of gentle contrast injections

PAMI-STEMI

- PCI: STEMI presentation with TIMI 0/1 flow in proximal large arteries, If PCI is feasible it is considered a first line approach
- CABG:
  - LM with LAD and/or LCX dissection
  - PCI is not feasible or is unsuccessful
  - Multivessel dissections.
- Conservative approach: dissection is limited to distal vessels or TIMI2/3 flow

ECMO-Indications During Pregnancy

- ARDS: H1N1 pneumonia ,trauma, aspiration, transfusion-related lung injury
- Cardiac failure (postpartum cardiomyopathy, or acute coronary syndromes)
- Cardiorespiratory failure (shock due to acute pulmonary embolism, amniotic fluid embolism)
- Eisenmenger Syndrome

ECMO

- Review of 45 patients treated with ECMO during pregnancy from 1991-2015 (Moore Et al):
- Most common indication: severe ARDS.
- Average gestational age at the time of initiation: 26 weeks,
- Days on support :12 days (range1-57 days).
- Overall survival : 78% for mothers and 65 % for the fetuses.

Fetal survival has been reported to be much higher when ECLS/ECMO is initiated after fetal viability

In Eisenmenger syndrome outcomes are poor.

ECMO

- Given the high potential for complete recovery young, healthy females with critical illness its use should not be delayed inspite of high complication rates (40-50%- bleeding due to anticoagulation, vessel injury during cannulation, induction of preterm delivery, compression of inferior vena cava from gravid uterus limiting venous inflow/outflow in prone position)

Thank You

History

- Echo: TTE 7/20 EF 27%, aneurysm in basal inferior wall and apex to distal anterior wall, hypokinesis of inferolateral wall and lateral wall, PA systolic pressure (36 mm of Hg)
- Left AMA due to worries about cost
- Now presented with afib with RVR , class 3 CHF symptoms , vague chest discomfort and no new ischemic changes at HR 150 compared to past EKG rate controlled with IV diltiazem
- Troponin 0.27> 0.31

Pertinent Physical Exam/Lab

HR 91 ,RR 22 ,BP 136 /109 Sat on 2L O2 96%

Otherwise No evidence of volume overload

Bun 45/Creatinine 1.9 (1.4 one month ago)

CT head (one month ago): Multiple old infarcts in multiple vascular territories mostly posterior circulation. New possibly subacute focal hypodensity in the right occipital lobe

Meds

- Aspirin 81 mg once a day
- Carvedilol 12.5 mg Q12 H
- Lipitor 80 mg once a day
- Lisinopril 5 mg once a day as outpt (on hold)
- No heparin or 2nd antiplatelet agent

Hemodynamics

- LV 120, 13, 35
- RA: -, 15, 14
- RV: 60/5, 14
- PCWP: -,45, 34
- PA: 60/34 (43)
- Thermal CO: 2.5/CI: 1.4
- PVR 221.8 dynes.sec/cm5 (2.8 wood)
- SVR: 2693 dynes.sec/cm5 (32.7wood)

- PA saturation: 47%
- Ao saturation: 93%

Hemodynamics

- PCWP (on IABP): -, 25, 22
- PA (on IABP): 48/23 (31)

HR-PCI

- At present, no single, unifying definition for HR-PCI exists but variables that contribute can be categorized into three major groups:
- 1) patient specific,
- 2) lesion specific, and
- 3) clinical presentation specific.

2015 SCAI/ACC/HFSA/STS Clinical Expert Consensus Statement on the Use of Percutaneous Mechanical Circulatory Support Devices in Cardiovascular Care

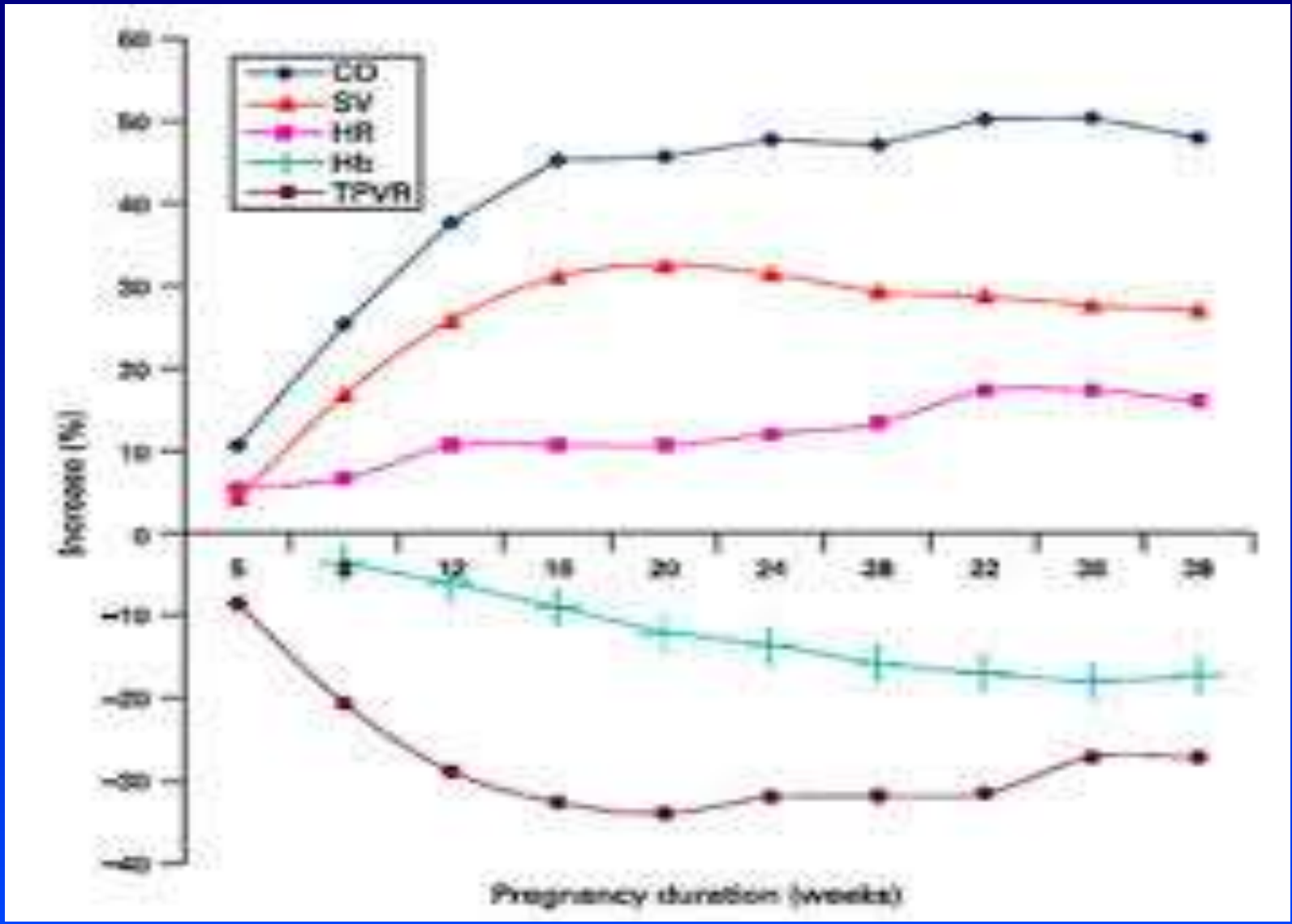
Inclusion Criteria

- a) Ejection Fraction ≤ 35% AND at least one of the following criteria:
- •Intervention on the last patent coronary conduit, or
- •Intervention on an unprotected left main coronary artery
- Or
- b) Ejection Fraction ≤ 30% and intervention in patient presenting with triple vessel disease.
- Three-vessel or triple vessel disease was defined as at least one significant stenosis (i.e. ≥ 50% stenosis by diameter) in all three major epicardial territories: left anterior descending artery (LAD) and/or side branch, left
- circumflex artery (LCX) and/or side branch, and right coronary artery (RCA) and/or side branch. In the case of left coronary artery dominance, a lesion in the LAD and the proximal LCX qualified as three-vessel disease.

MAE

- 1.Death
- 2.Stroke/TIA
- 3.Myocardial infarction
- 4.Repeat revascularization
- 5.Need for cardiac operation or thoracic or abdominal vascular operation or
- vascular operation for limb ischemia
- 6.Acute renal dysfunction
- 7.Cardiopulmonary resuscitation or Ventricular arrhythmia requiring cardioversion
- 8.Increase in aortic insufficiency by more than one grade
- 9.Severe hypotension, defined as: systolic blood pressure or augmented diastolic pressure (whichever is greater) <90 mmHg for ≥5 min requiring
- inotropic/pressor medications or IV fluid
- 10.Failure to achieve angiographic success defined as residual stenosis <30% after stent implantation.

Valvular Heart Disease- Physiological adaptation of pregnancy



History

- 52 y/o M with Hx of HTN, exertional angina >20 years
- Right sided Hemorrhagic stroke in 1998 (18 years ago), with residual left sided weakness
- Reported coronary angiogram in China 10 years ago with “75% stenosis of an artery” declined intervention due to cost)
- Admitted here one month ago with new ischemic stroke Rt occipital lobe and atrial fibrillation.