2014 전공의 연수교육

부산대학교 어린이병원

PDA, ASD, VSD

양산부산대학교병원 흉부외과
김형태

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• Fetal circulation

Sepration from placenta, Start of pulmonary ventilatrion & circulation (PVR ↓)
-> functional closure at 12~15hrs after birth
-> anatomical closure at 2~3wks after birth

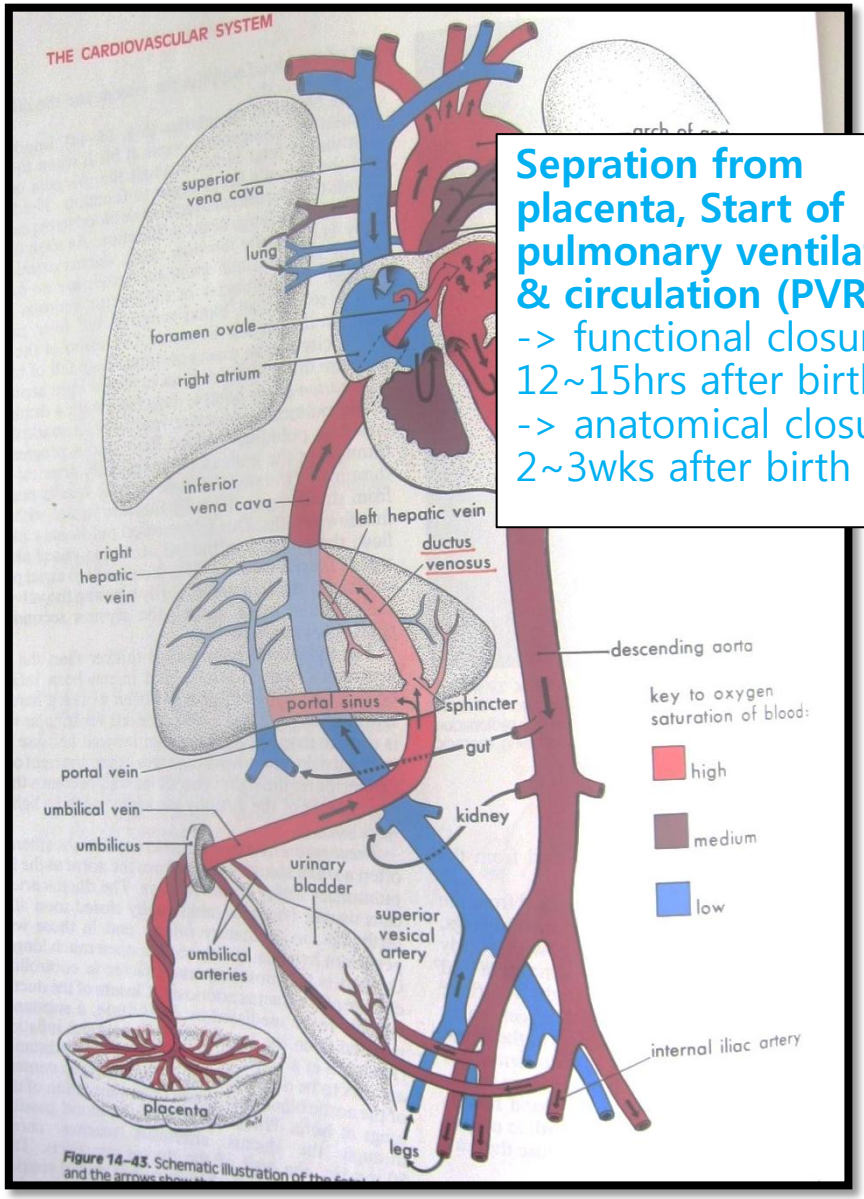


Figure 14-43. Schematic illustration of the fetal and the arrows show

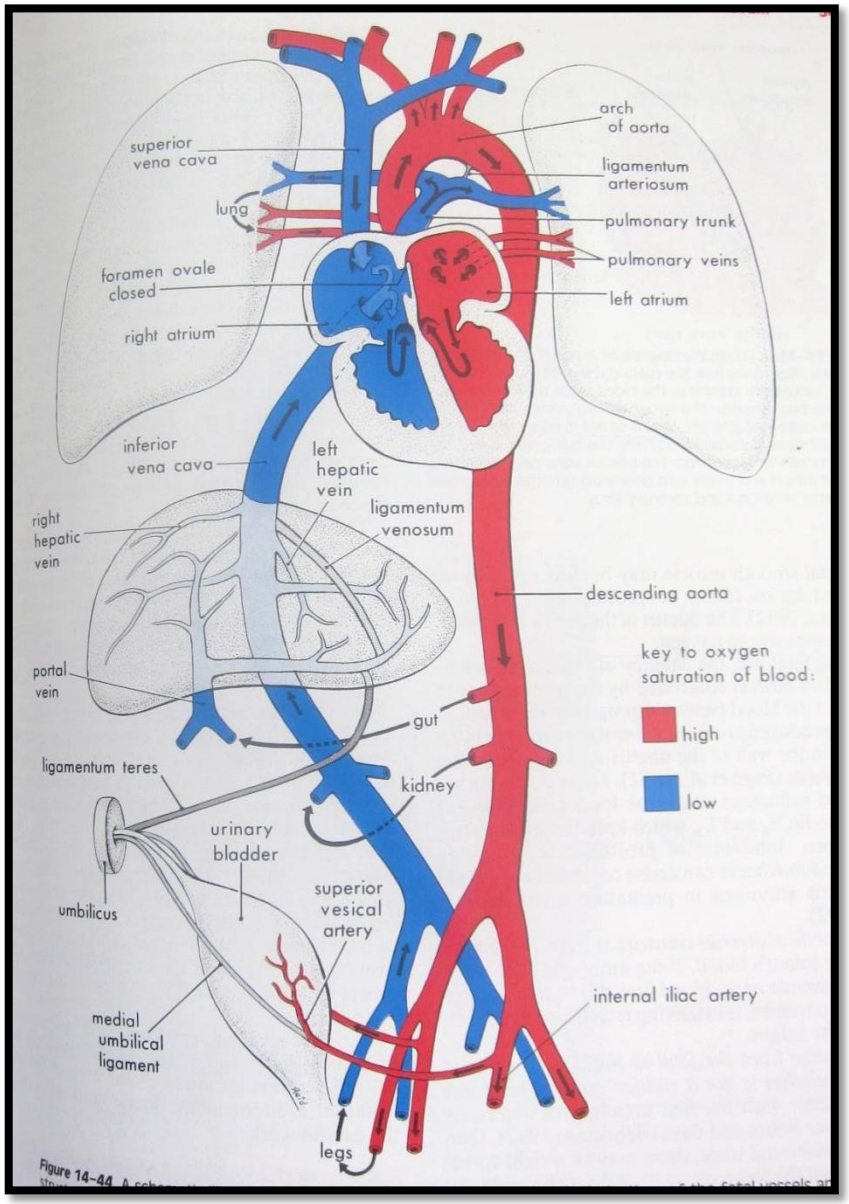


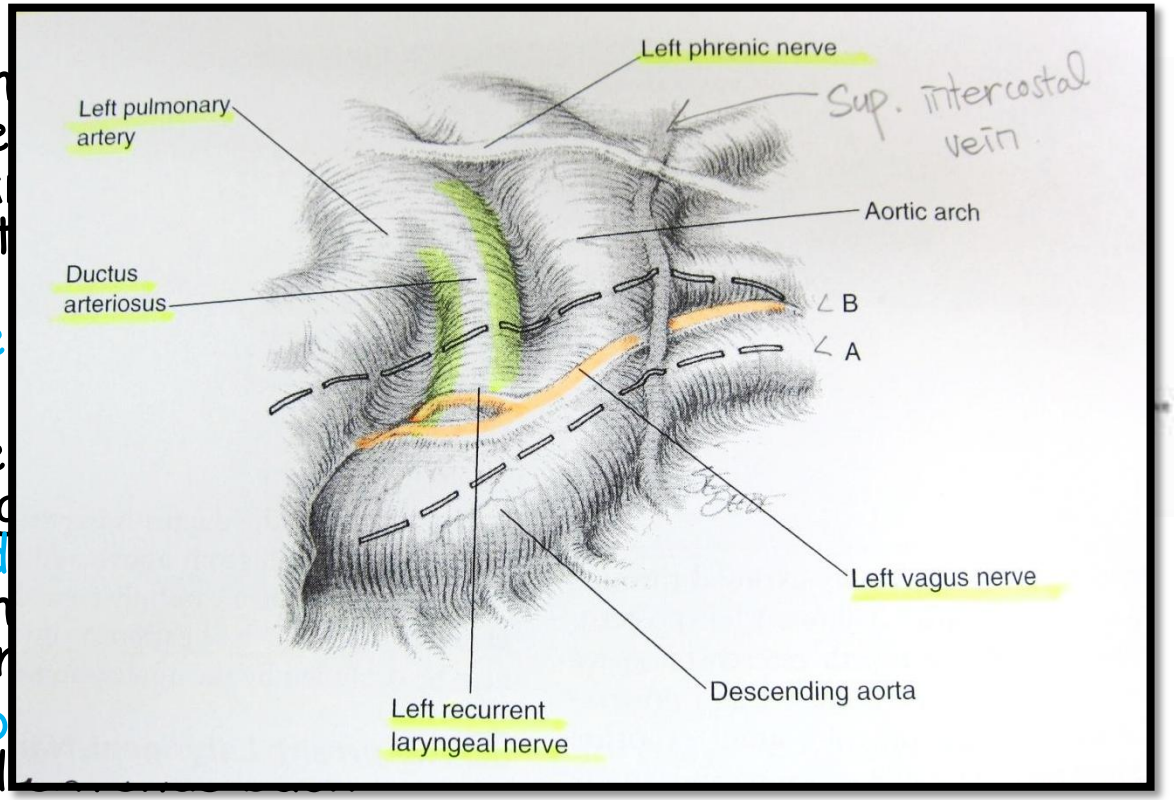
Figure 14-44

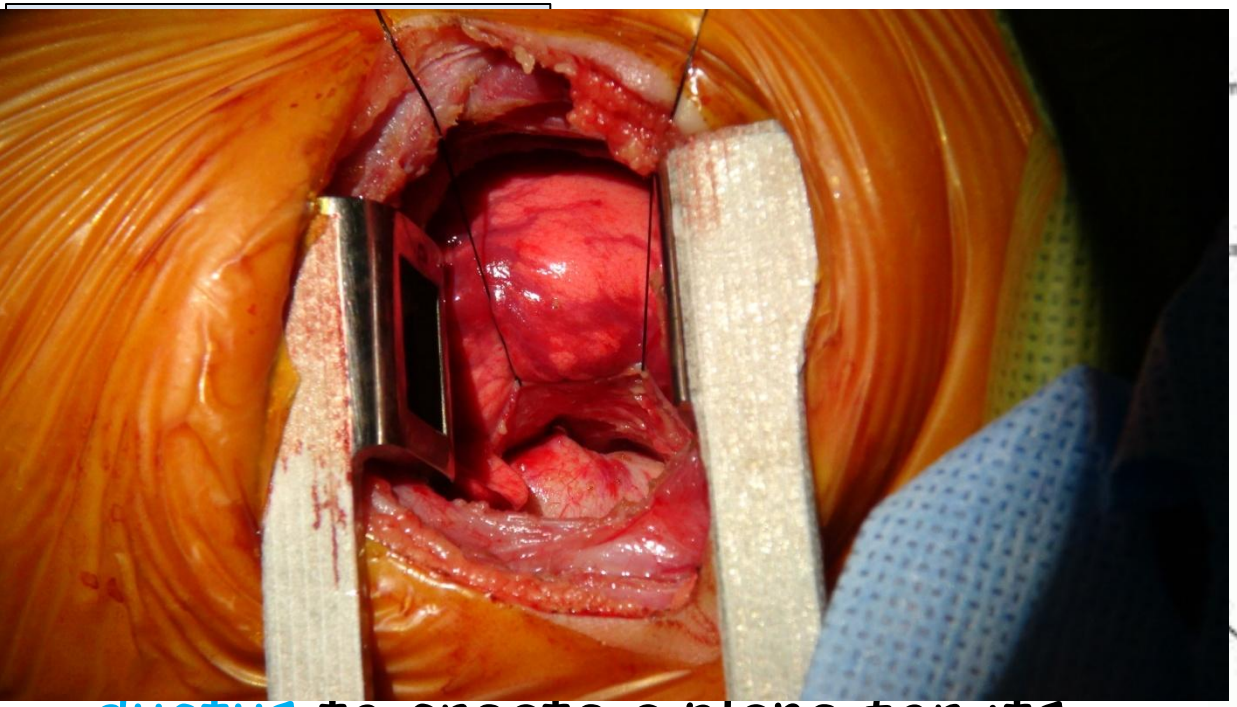
Patent ductus arteriosus (PDA)

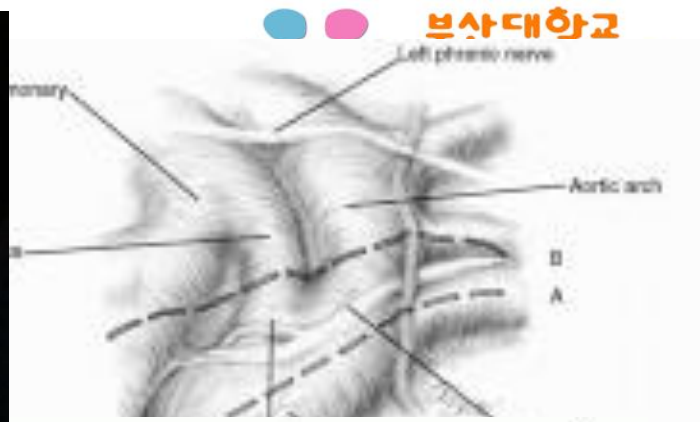
- **Incision**
- Left posterolateral thoracotomy through the fourth intercostal space

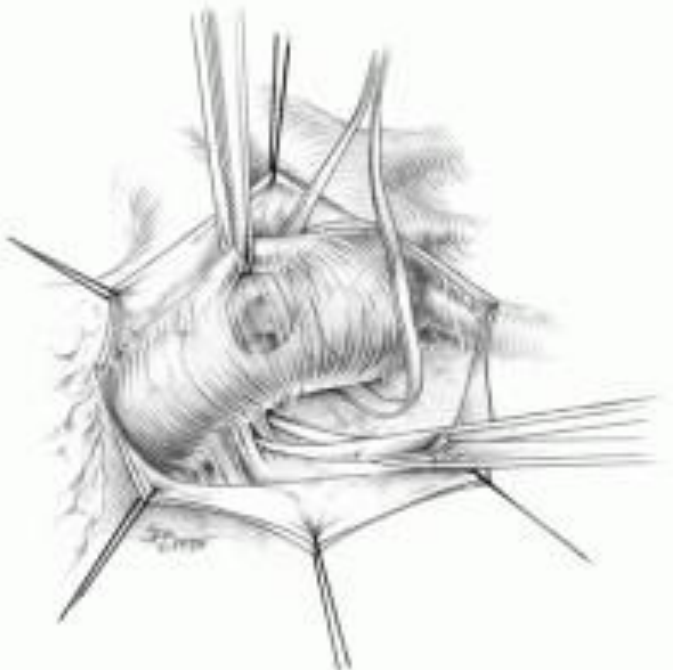
PDA

- **Surgical anatomy**
- The ductus arteriosus run
  aortic arch from the supe
  origin of the left pulmona
  through the pericardium t
  margin of the aorta at an
  opposite the origin of the
  artery
- The left vagus trunk ente
  the root of the neck in a
  left subclavian artery and
  carotid artery, crosses th
  ductus arteriosus, and cor
- The recurrent laryngeal b
  the ductus arteriosus and
  upward into the neck
- There are usually some lymph nodes buried in the hilum of the left lung that sometimes extend upward near the inferior margin of the ductus arteriosus





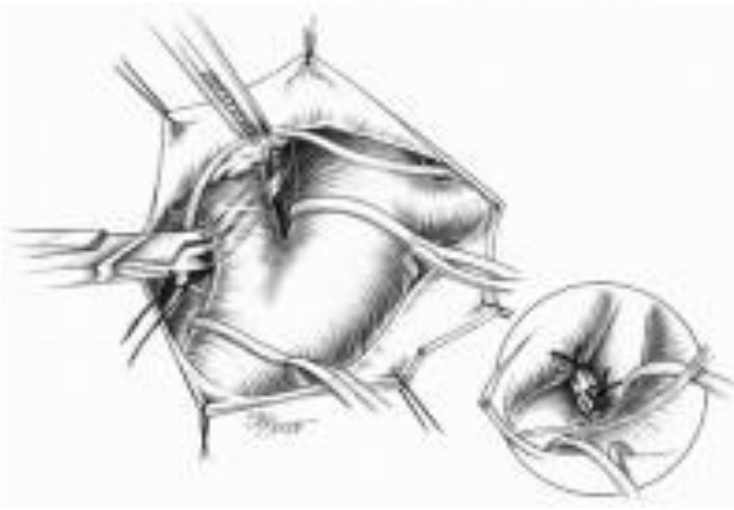




ductus to create a plane for its ligation or divisioin

- The ductus can also be occluded by the application of a metal clip
- The posterior aspect of the ductus arteriosus is always adherent to the surrounding tissues and can be torn during the process of mobilization -> dissection of the aorta is helpful

PDA



- **Technique for dividing and ligating the ductus arteriosus**
- Two heavy Ethibond sutures are individually passed behind the dutus, which is then securely ligated (double ligation)
- The ductus is divided between clamps and oversewn
- Another option is to occlude the ductus with one or two metal clips

PDA

- **Technique for dividing and ligating the ductus arteri**
- Occasionally t ductus arteri dissect, parti
- Injury to the during ligatio

- **A ductus arte**
- Digital pressu
- The aorta be and below the
- Access to the longitudinally, nerve
- By temporaril pulmonary art pericardium

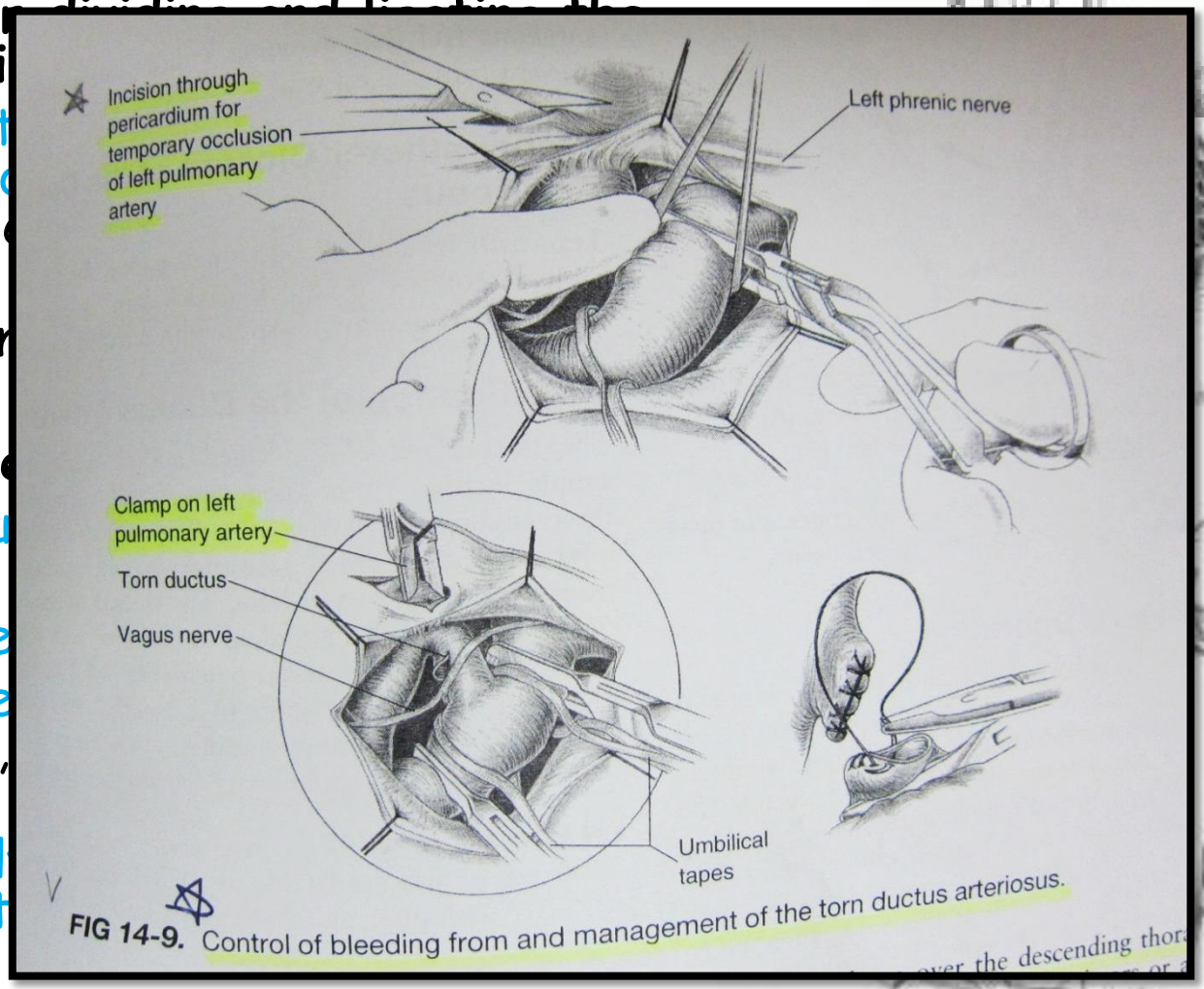
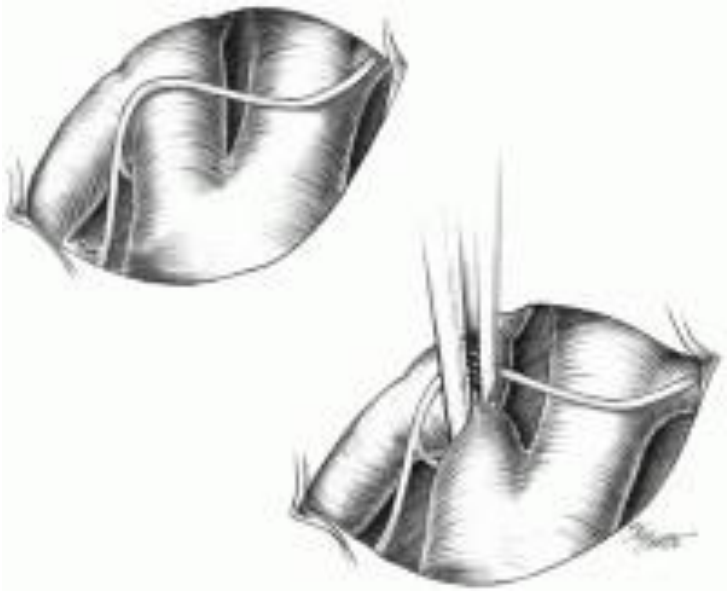


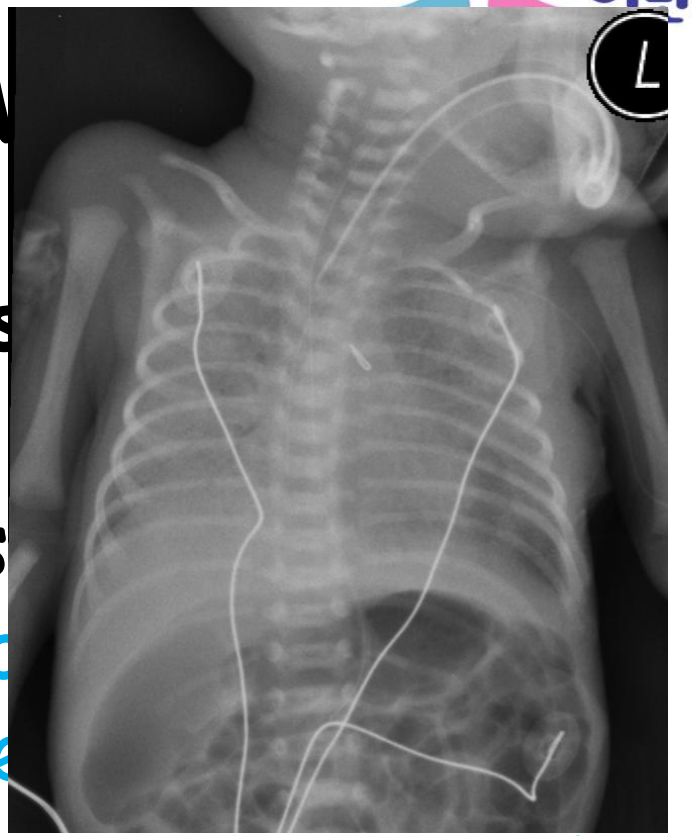
FIG 14-9. Control of bleeding from and management of the torn ductus arteriosus.

PDA

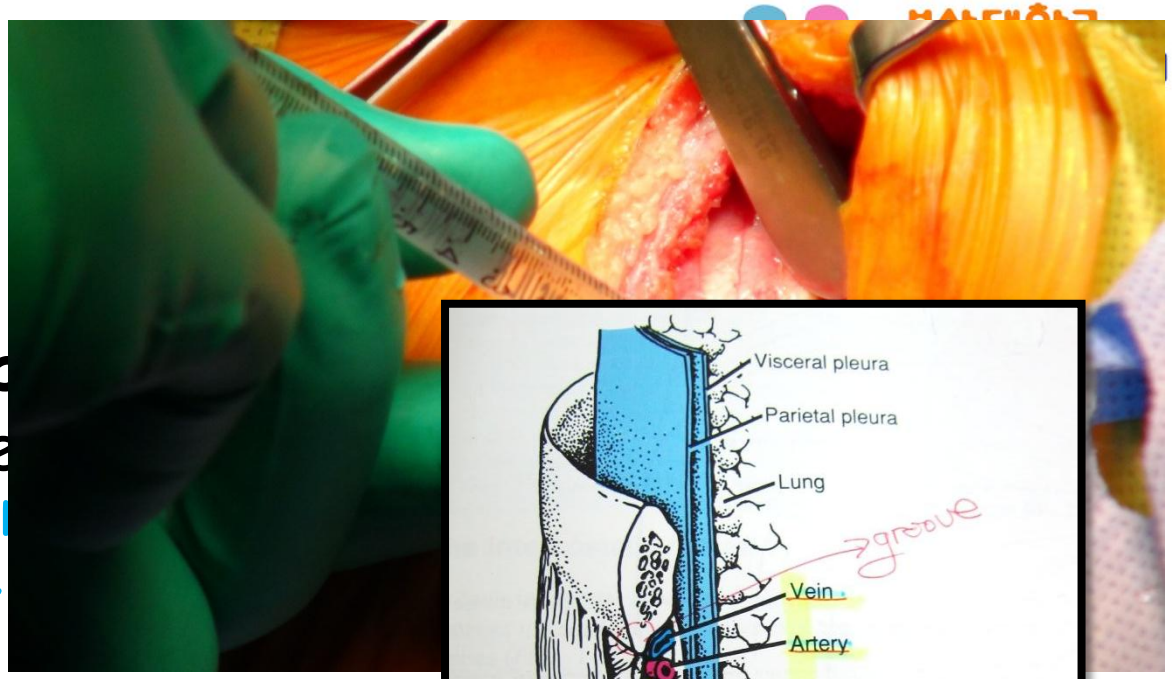
- **Technique for dividing and ligating the ductus arteriosus**
- Inadvertent ligation of the aortic arch
- Occluding the ductus arteriosus temporarily

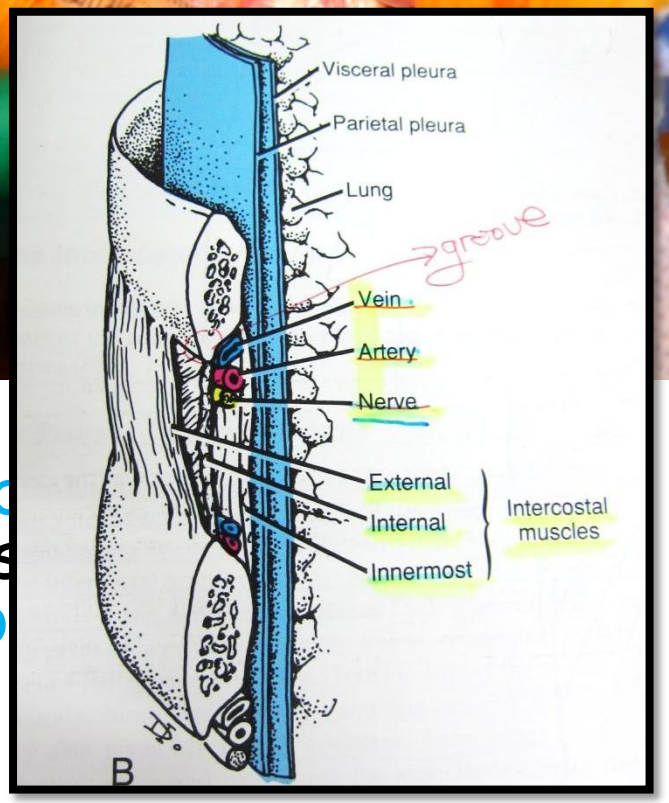


PDA



- **Closure of the ductus**
  premature infants
- The ductus arteriosus
  through a left thoraco
  fourth intercostal inte
- Occlusion of the ductus with a metal clip is the prefered method in premature infants





- **Completing the op**
- Rib blocks have be
  postoperative thor
  interspaces above
  incision
- In patients with coagulopathies
  anticoagulated, rib blocks should
  prevent extrapleural hematomas
  bleeding (premature infants sho
  injections)
- Sutures – the top of the rib
- If injury to the lung is noted, the chest tube should be left in place on suction for 12 to 24 hours

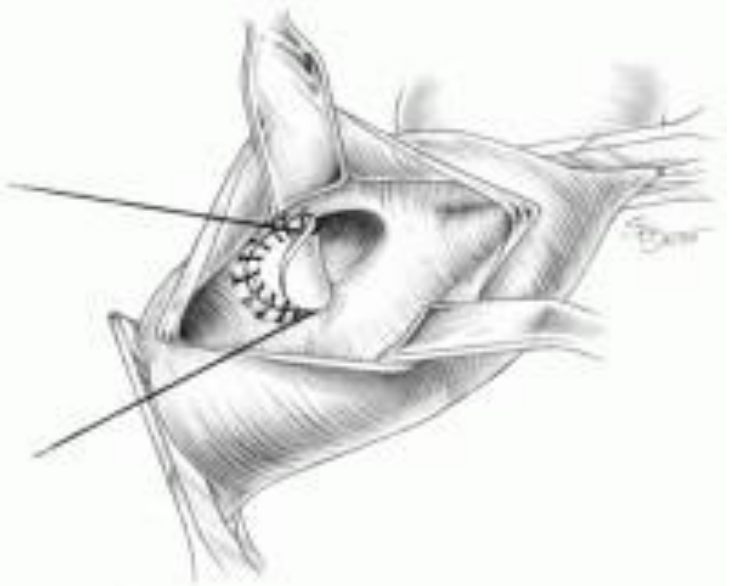
PDA

- Thoracoscopic closure of the ductus arteriosus

- Transcatheter closure of the ductus arteriosus

PDA

- **Calcification of the ductus arteriosus**
- The ductus may be calcified and/or aneurysmal, and simple ligation or division may not be feasible
- However, easier and safer to close the ductal opening through the pulmonary artery under direct vision with the patient on CPB



PDA

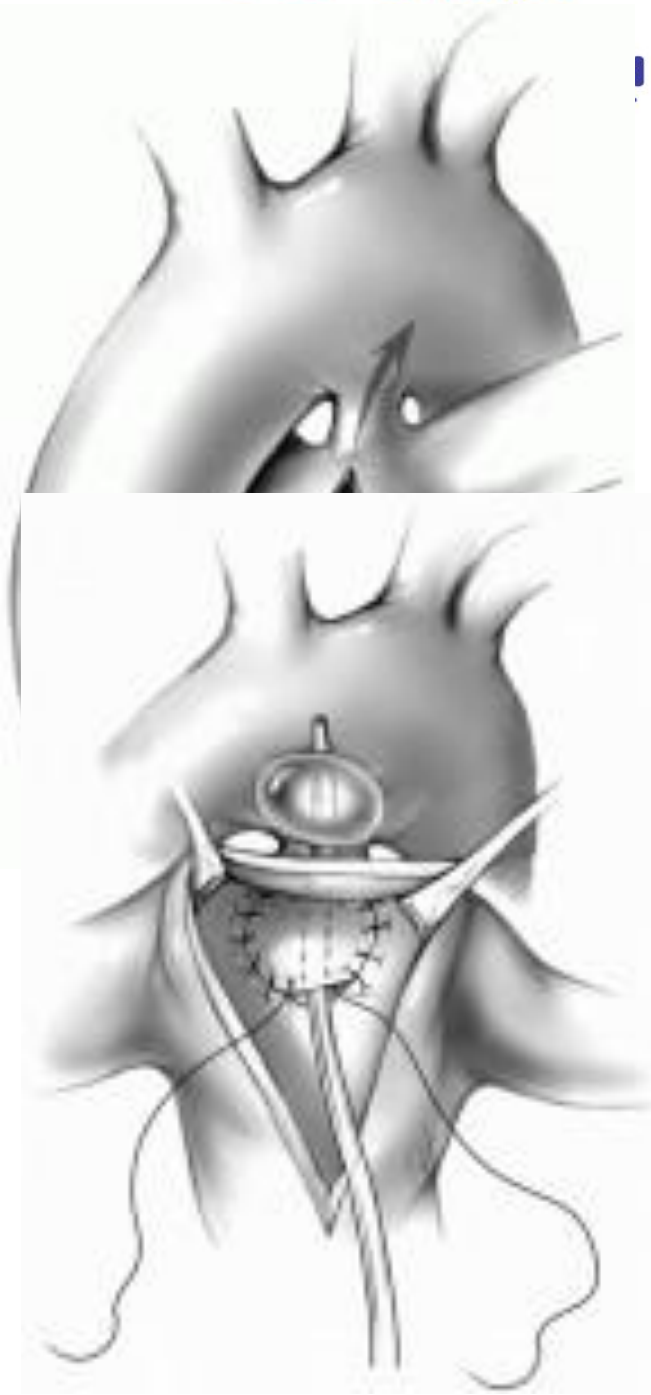
- Anterior approach to closure of the patent ductus arteriosus

- Technique in infants and children
- Used for infants and children with a patent ductus arteriosus undergoing repair of other congenital heart defects

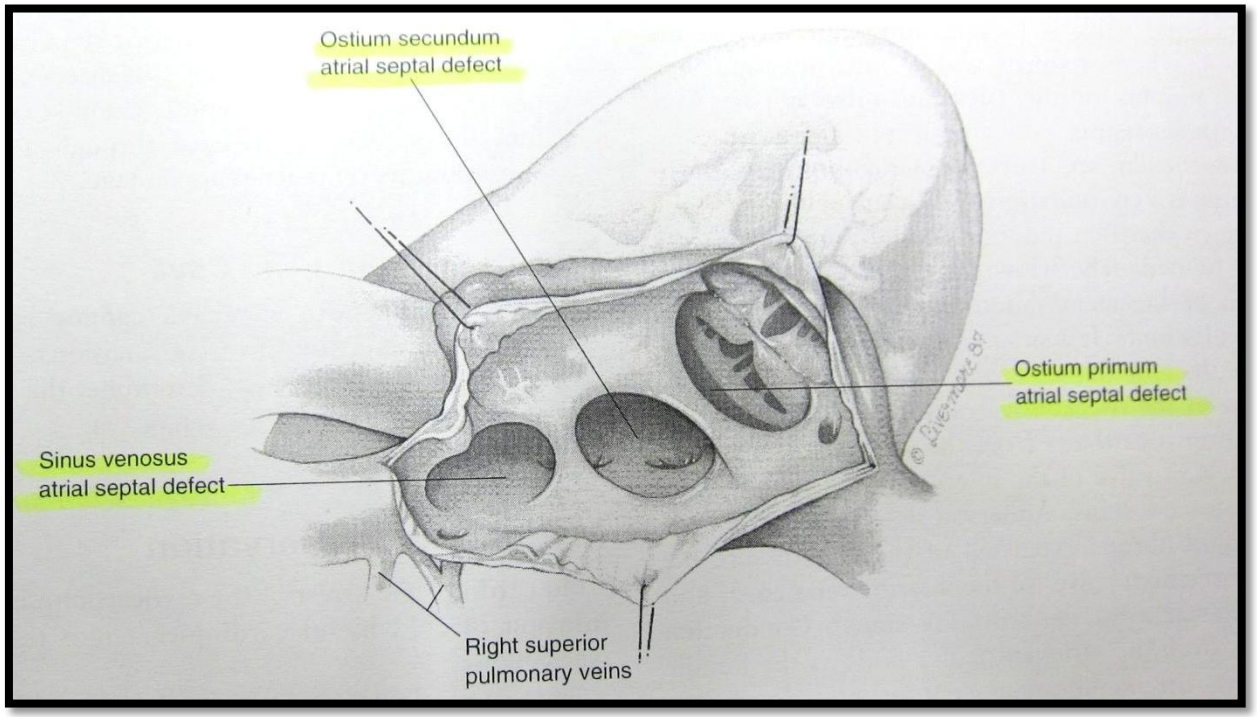
- Flooding of the pulmonary circulation
- Tearing of ductal tissue – especially on the aortic side
- Stenosis of the left pulmonary artery

PDA

- **Technique** in adults
- Closure of a patent ductus arteriosus in an adult can be safely accomplished through a median sternotomy on CPB
- During low flow, the MPA is opened longitudinally -> the opening of the ductus is identified, and an appropriately size Foley catheter is passed into the aorta
- Air embolism through the ductus arteriosus – the patient may be placed in Trendelenburg position to prevent this complication

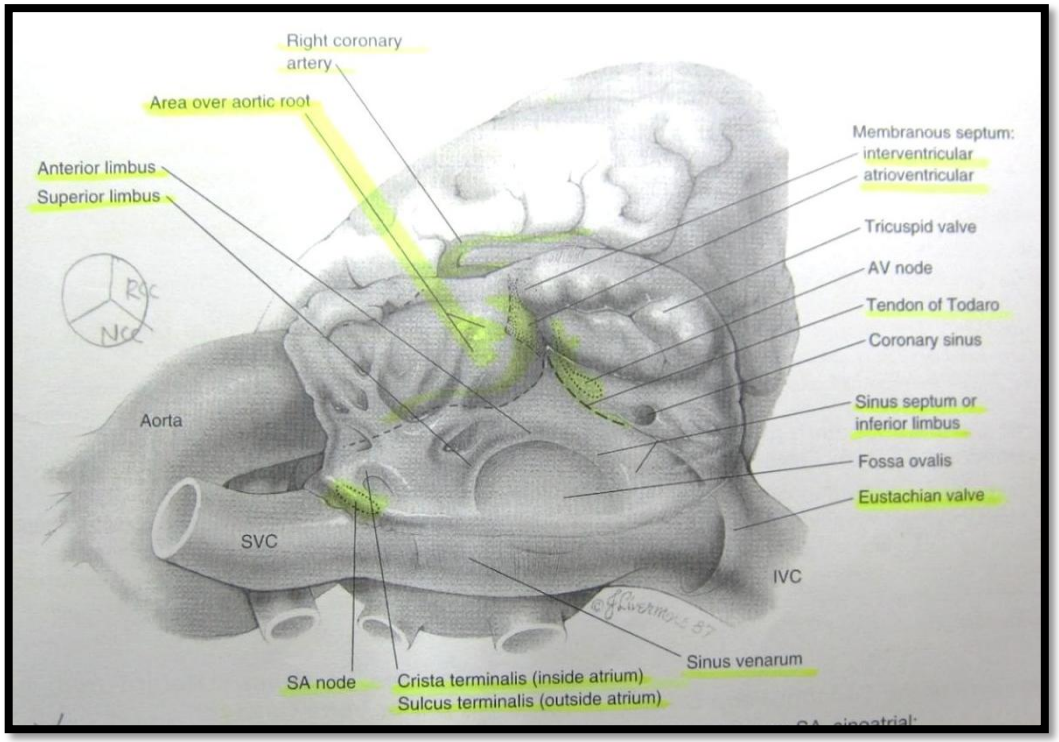


Atrial septal defect (ASD)



- **Ostium secundum defect** – m/c
- **Sinus venosus ASD** – usually anomalous drainage from the RUPV associated with these defects
- **Sinus venosus defect of the IVC type** – may be associated with anomalous Pulmonary venous drainage
- **Single common atrium**
- **Ostium primum defect** – extends down to the level of the atrioventricular valve orifices (part of the atrioventricular septal defect complex, partial AVSD)
- **Coronary sinus septal defect**, unroofed coronary sinus

ASD



- **Surgical anatomy of the right atrium**
- RA is formed by two components: the sinus venarum and the right atrial appendage (sometimes referred to as the body of the atrium)
- ***AV node*** – is situated at the apex of the triangle of Koch, the boundaries of which are the annulus of the septal leaflet of the tricuspid valve, the tendon of Todaro (running intramyocardially from the central fibrous body to the eustachian valve of the inferior vena cava), and its base, the coronary sinus

ASD

- **Incision**
- Median sternotomy
- Lower ministernotomy
- Submammary right thoracotomy

- **Cannulation**
- Preoperative echocardiography must determine the presence or absence of a left superior vena cava

- **Myocardial preservation**
- Alternatively, by inducing ventricular fibrillation

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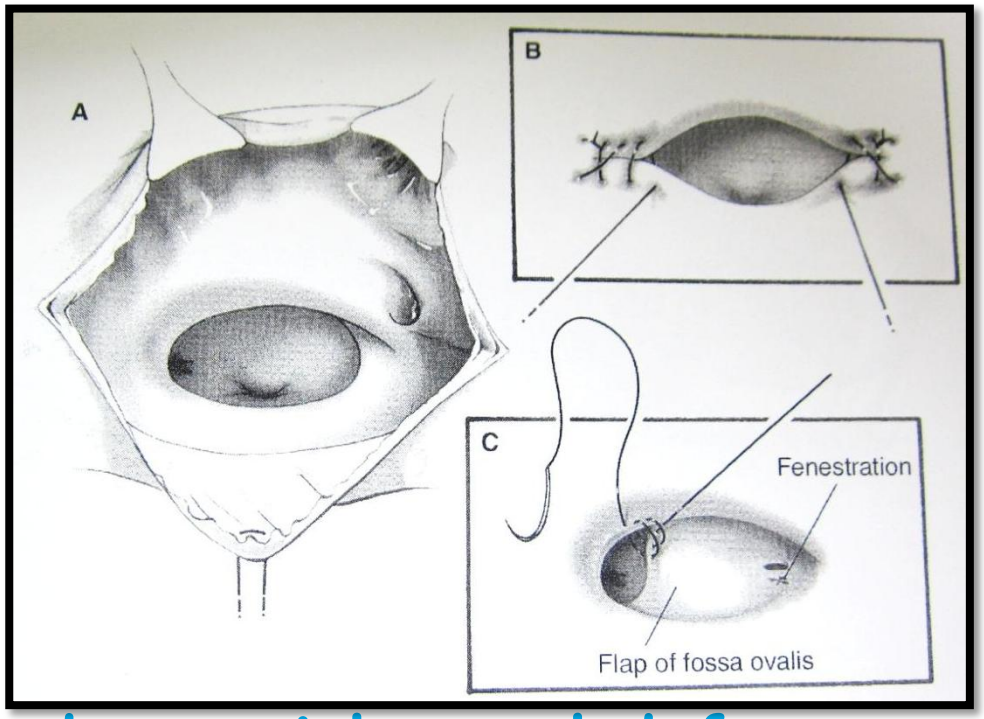
ASD



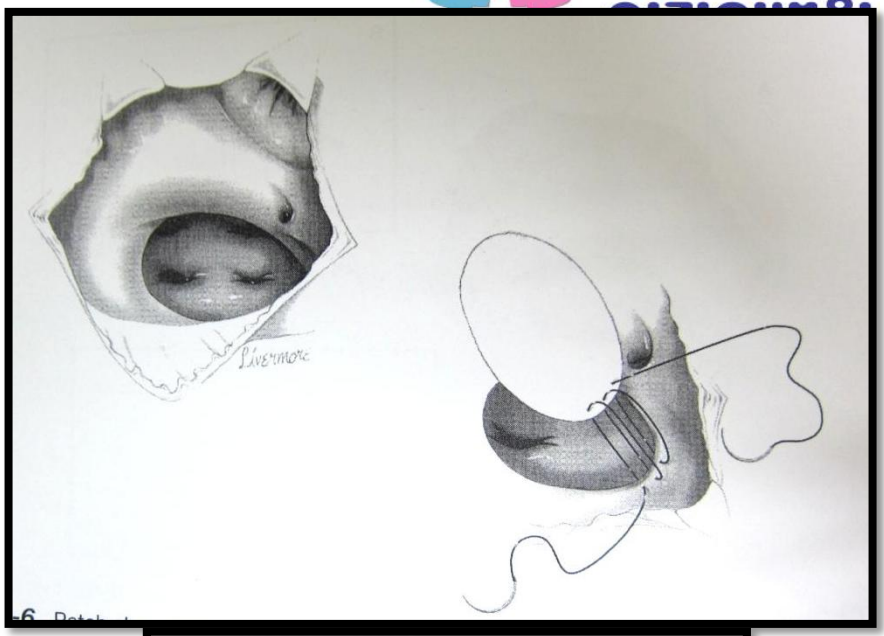
- **Ostium secundum atrial septal defect**
- m/c type
- **Technique**
- The tissue of the fossa ovalis is usually too weak and friable to provide secure closure
- Deep sutures should be avoided along the superior aspect of the defect because this area overlies the aortic root

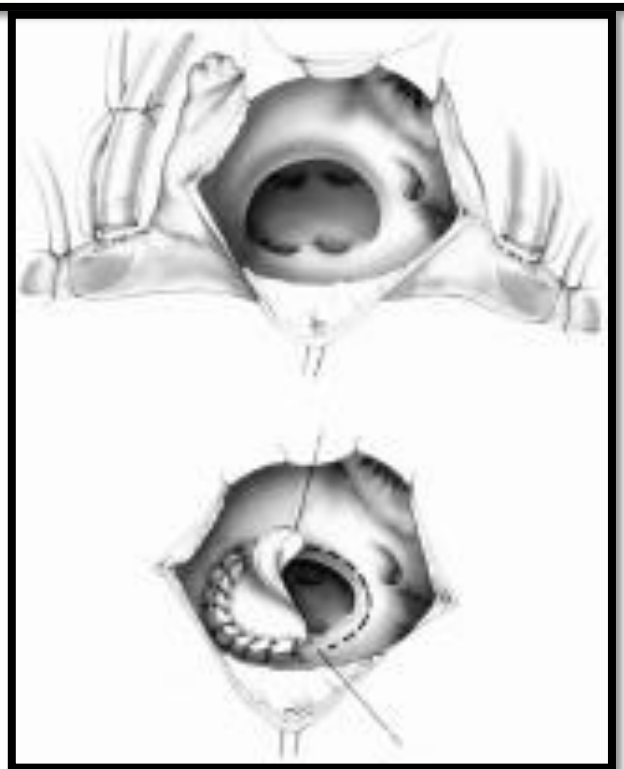
ASD

- **Creating a right-to-left shunt**
- Inadvertent approximation of the edge of the eustachian valve to the patch will creat a tunnel, diverting the drainage frome the inferior vena cava into the left atrium

- **Depth of sutures**
- As with direct closure, the suture must incorporate the thickened endocardium on both sides of the septum and not the fossa ovalis tissue, which is often very thin and friable

- **Right PV drainage into the right atrium**
- The patch must then be sewn to the atrial wall, anterior to the pulmonary vein orifices, to allow diversion of their drainage behind the patch into the left atrium

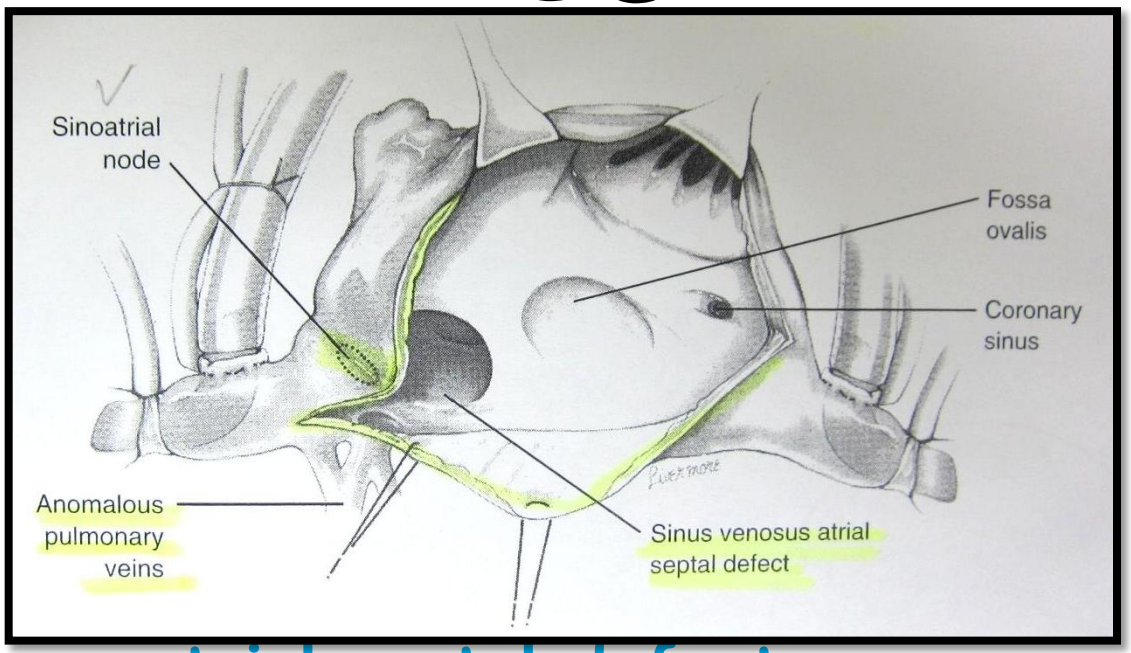




ASD

- **Transcatheter closure of atrial septal defects**
  - Effective in patients with secundum type defects that are not too large and have good rims on all sides
  - Rarely, the surgeon may be called upon to operate for a complication of these procedures such as malposition or embolization of the device or incomplete closure of the shunt

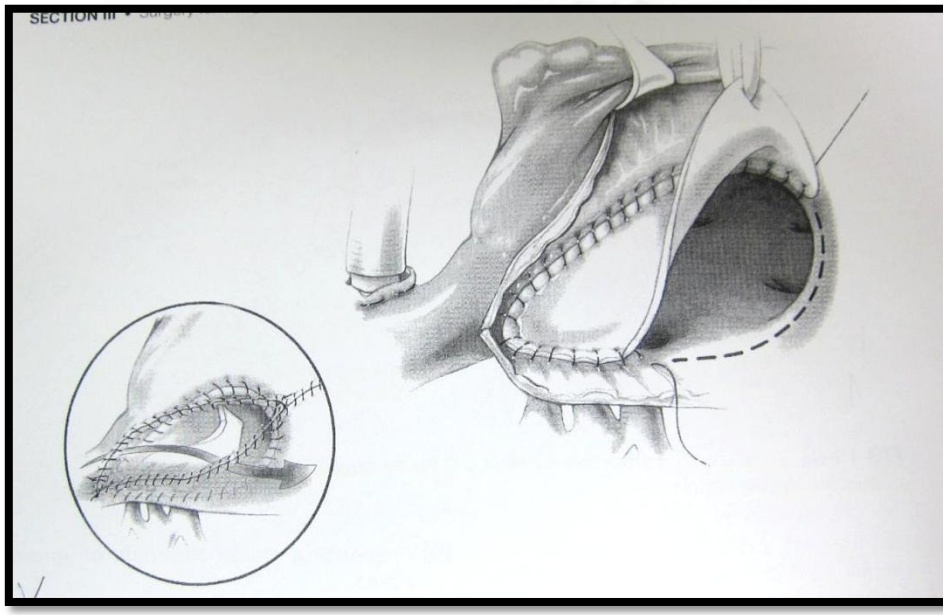
ASD



- **Sinus venosus atrial septal defect**
- Usually occur high on the septum close to the orifice of the superior vena cava
- Associated with anomalous drainage of right upper lobe pulmonary veins into the superior vena cava and right atrium
- Approximately 10% of patients also have a persistent Lt. SVC

ASD

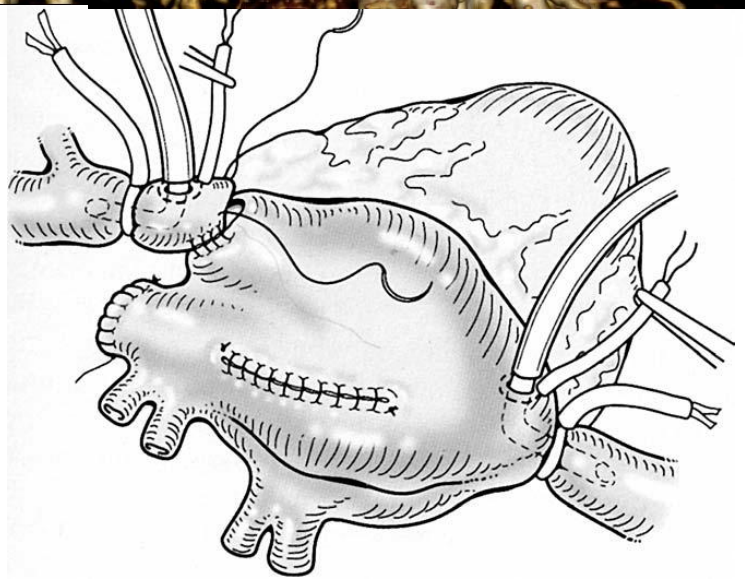
- **Technique**
- Drainage of venous return from a Lt. SVC
- Injury to the SA node
- Persistent Lt.-to-Rt. Shunt
- Preventing ostial stenosis of anomalous veins
- Obstruction of the pulmonary venous return
- Injury to the aortic root/valve
  - The extension from the sinus venosus defect to the fossa ovalis should be kept posterior



A second patch of pericardium is required to prevent narrowing of the SVC-RA junction

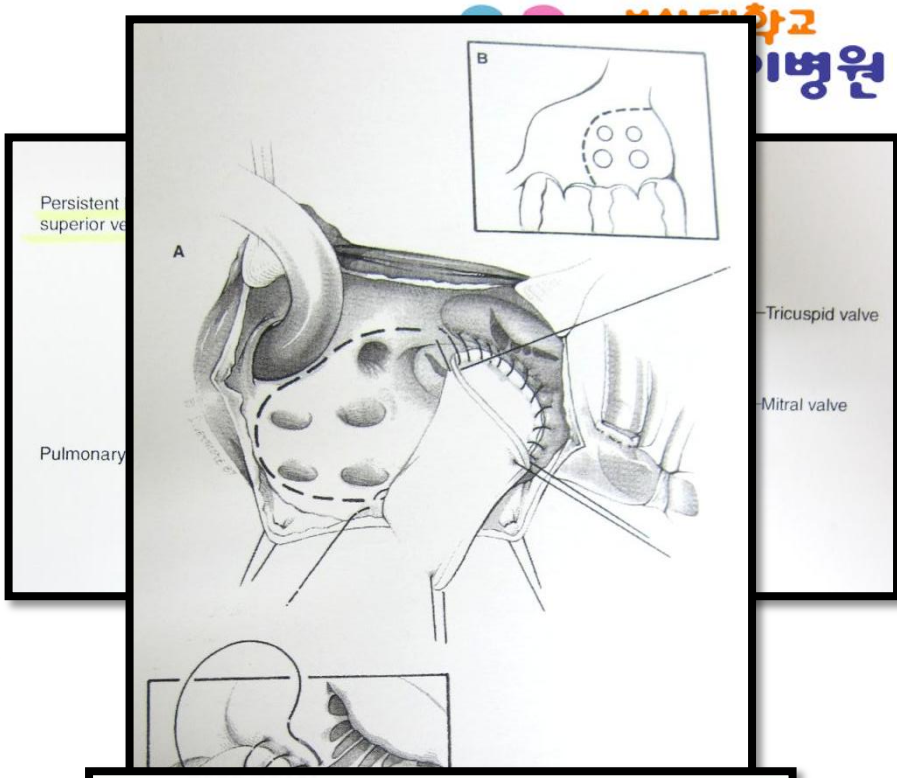
vein will rectify this situation

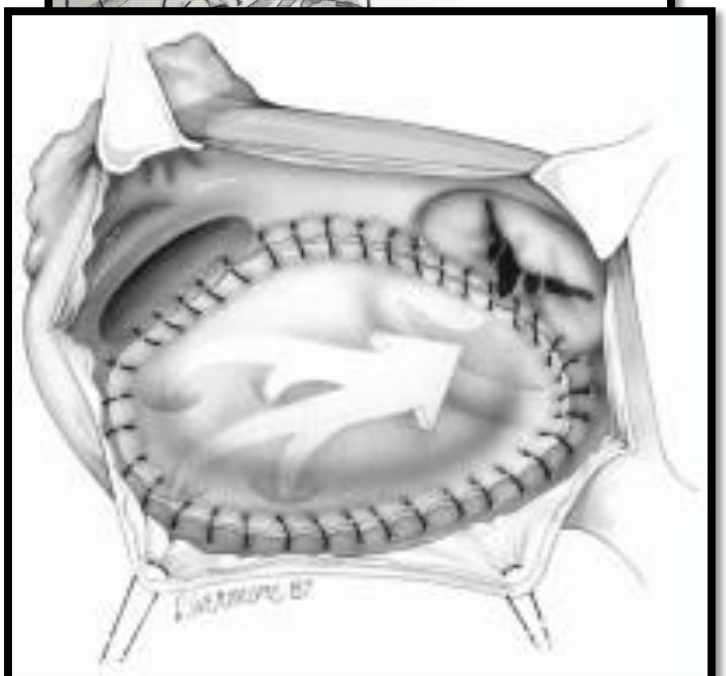
- **Caval division technique (Warden op.)**

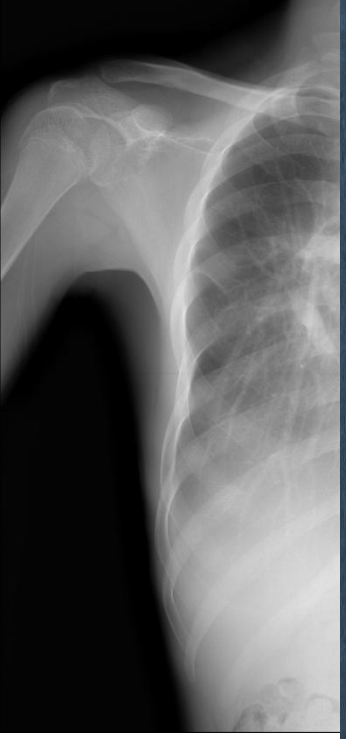


ASD

- **Common atrium**
- A patient with complete absence of the atrial septum, absence of the right superior vena cava, persistent left superior vena cava, and a cleft mitral valve
- The septation should start in the region of the annulus between the atrioventricular valves
- Suturing should include the annulus and a small amount of tricuspid valve tissue







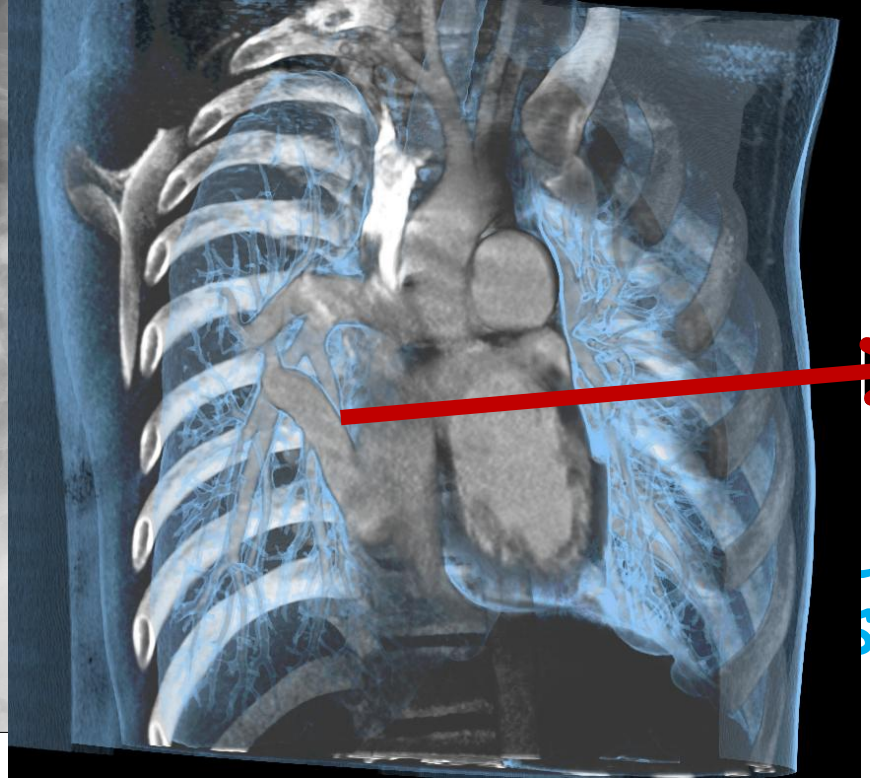
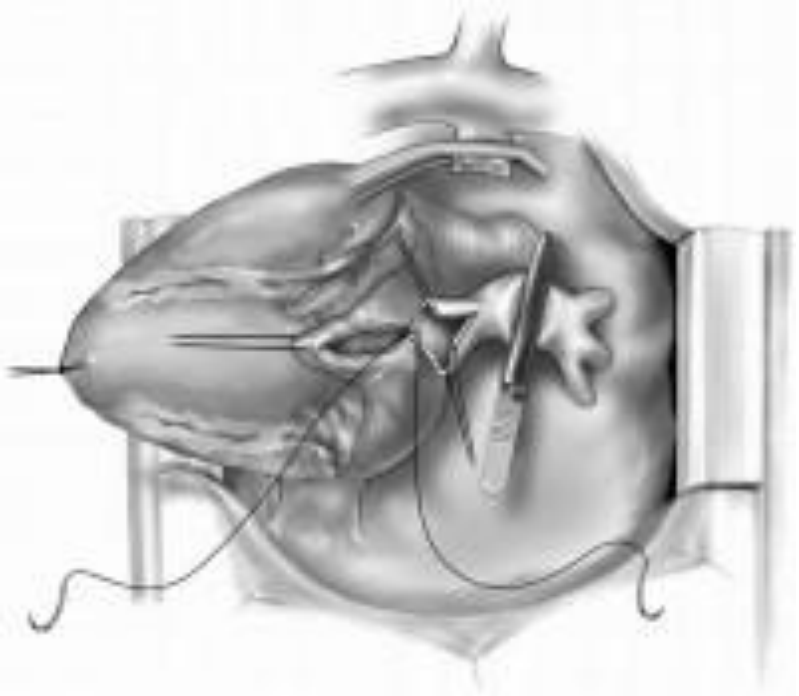


Figure 1 The curved Middle Eastern or Turkish sword, "scimitar."

- **Scimitar syndrome** consists of a large anomalous pulmonary vein draining the entire right lung or the right middle and lower lobes, passing inferiorly to enter the inferior vena cava just above of below the diaphragm

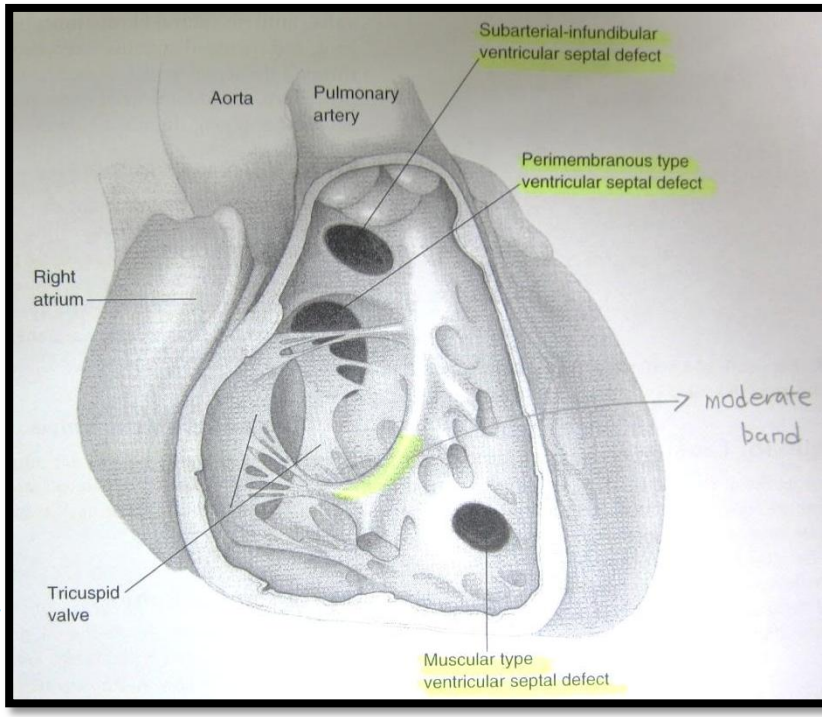
ASD

- **Left-sided partial anomalous pulmonary venous return**
- Surgical repair can be done through a left thoracotomy without CPB if the diagnosis is certain
- Most often, this abnormality is approached through a median sternotomy
- **technique**



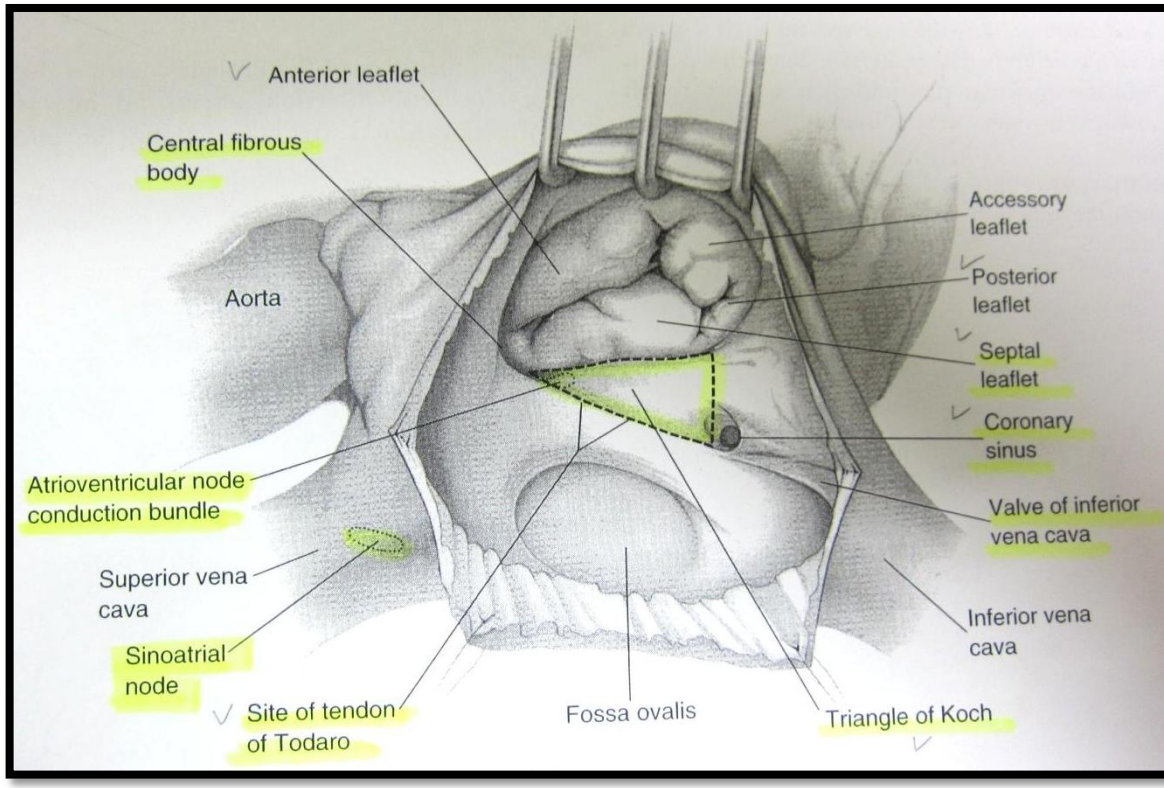
Ventricular septal defect (VSD)

- **Surgical anatomy**
- Perimembranous, subarterial-infundibular, and muscular types
- Because the path of the conduction tissue is intimately related to the inferior rim of the PM type VSD, an accurate knowledge of the surgical anatomy of this region is most helpful
- The AV node is situated in its usual position at the apex of the triangle of Koch, whose boundaries consist of the septal attrachment of the tricuspid valve, tendon of Todaro, and the coronary sinus as its base



VSD

- The **conduction tissue** passes from the AV node as the bundle of His through the central fibrous body and the tricuspid annulus into the ventricular septum, following a course along the inferior rim of the defect toward the left ventricular side of the septum



VSD

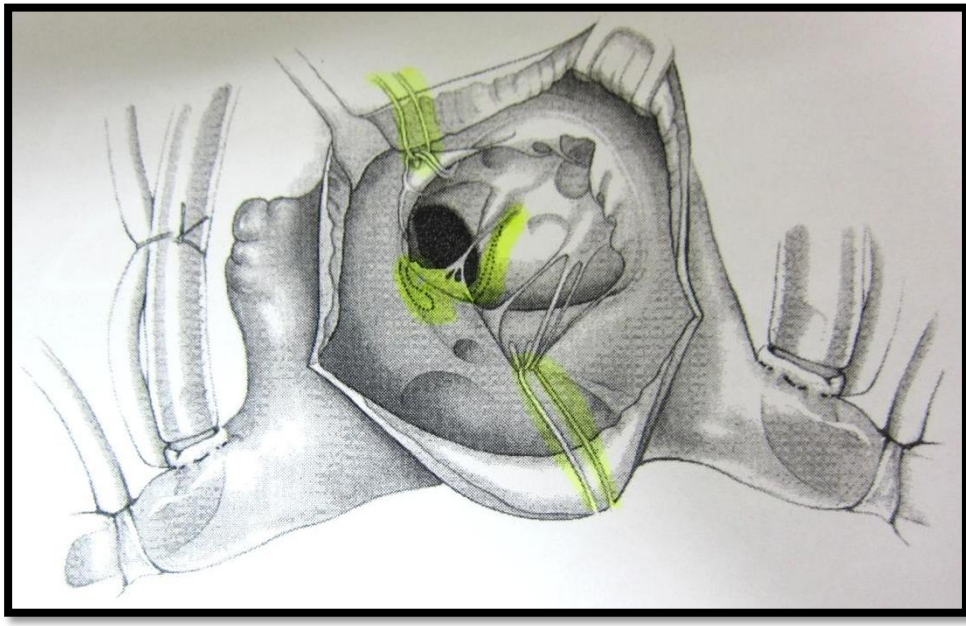
- **Surgical approach**
- Through median sternotomy

- **Cannulation**

- **Myocardial preservation**

VSD

- **Transatrial approach to a ventricular septal defect**
- Almost all the perimembranous and atrioventricular canal types of VSDs and many of the muscular variety can be exposed and closed through the right atrium
- A longitudinal or oblique atriotomy is made, starting at a point 0.5 to 1cm anterior and paralled to the sulcus terminalis, and is extended toward the orifice of the inferior vena cava

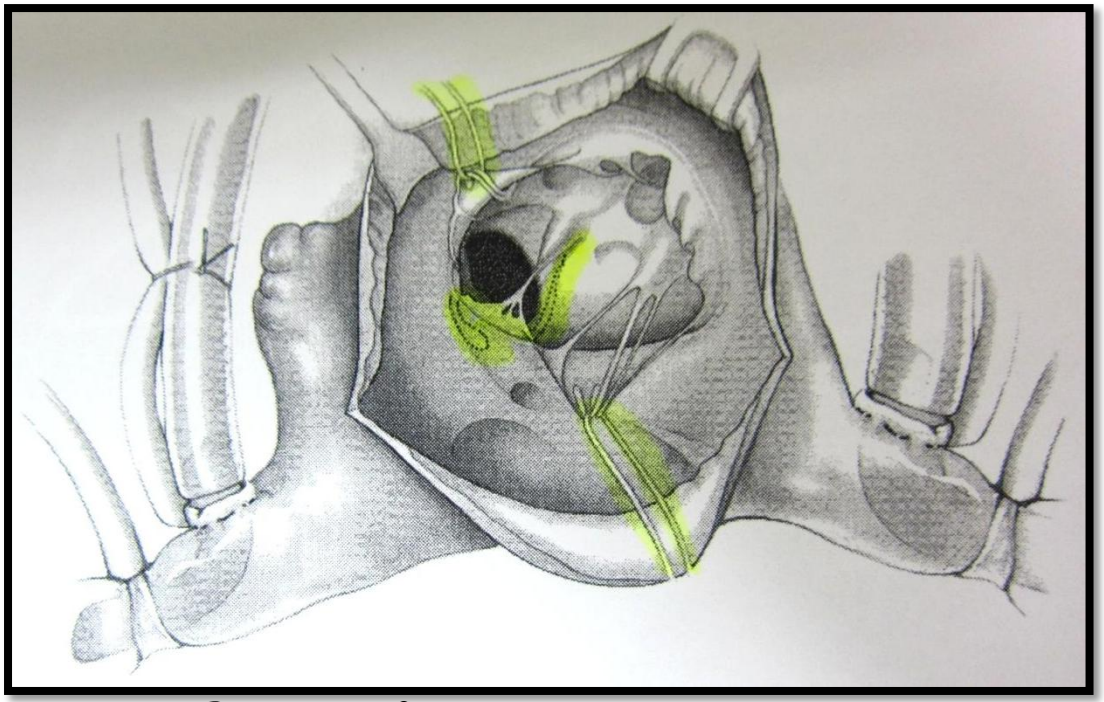


VSD

- **Coexisting patent ductus arteriosus**
- It should be occluded with a metal clip before the initiation of CPB to prevent pulmonary overcirculation and suboptimal systemic perfusion

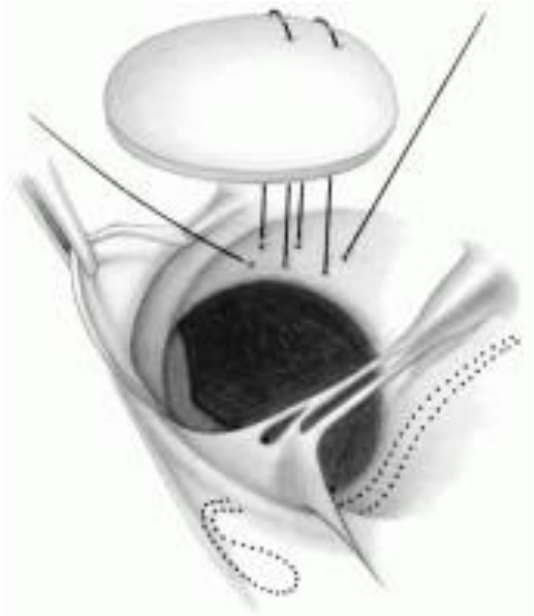
- **SA node injury**
- The SA node is vulnerable to injury from the snare around the SVC

VSD



- **Technique for closure**
- The anterior leaflet of the TV is retracted with a 6-0 prolene suture or small vein tractor to expose the defect and its margins for identification

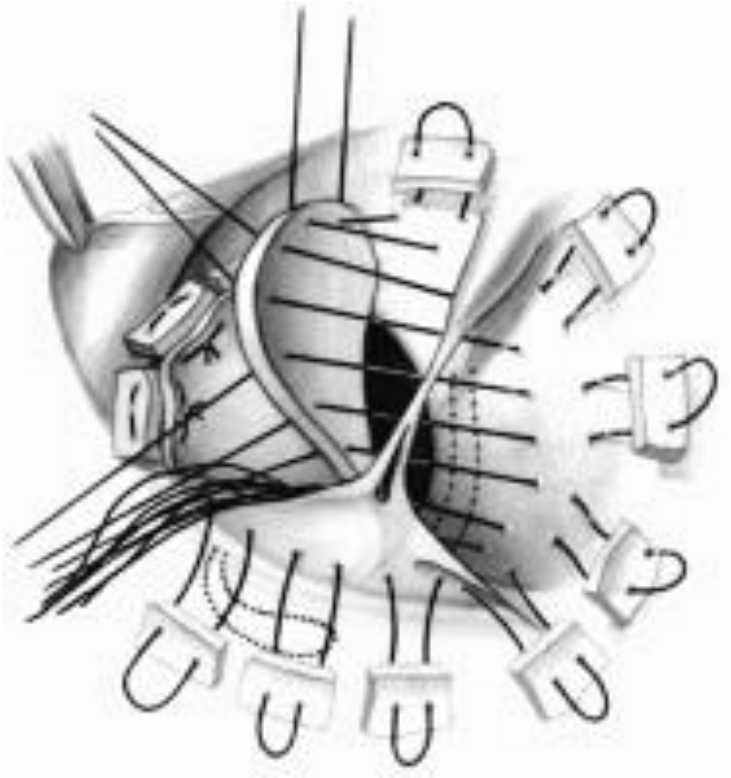
VSD



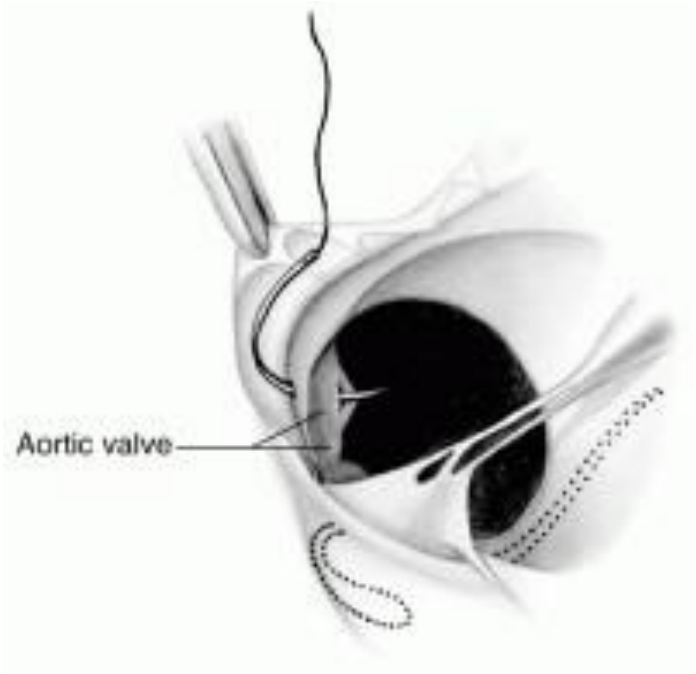
- **Continuous suture technique**
- The suturing is continued in a counterclockwise direction along the superior rim

VSD

- Buttressing the sutures

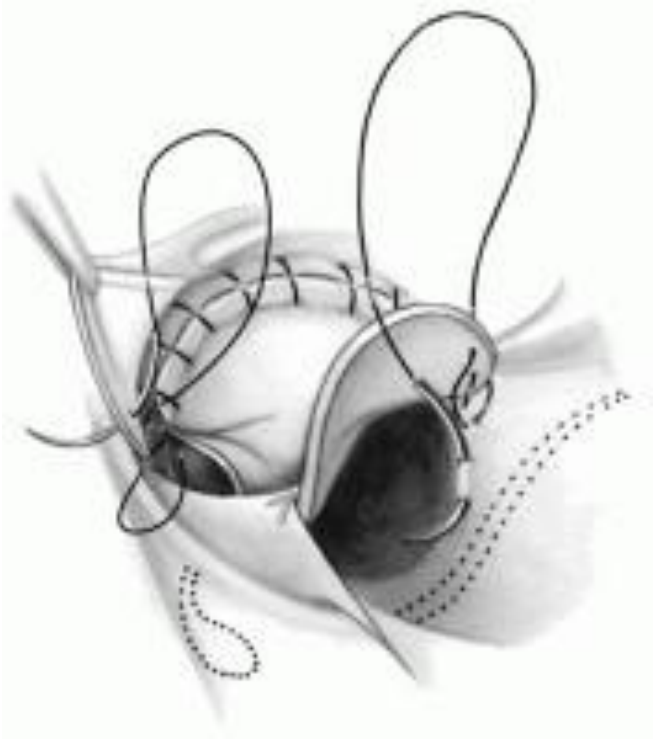


VSD



- **Injury to the aortic valve**
- The aortic valve leaflets are immediately below the superior margin of the defect and can be punctured during suturing if deep bites are taken in this area

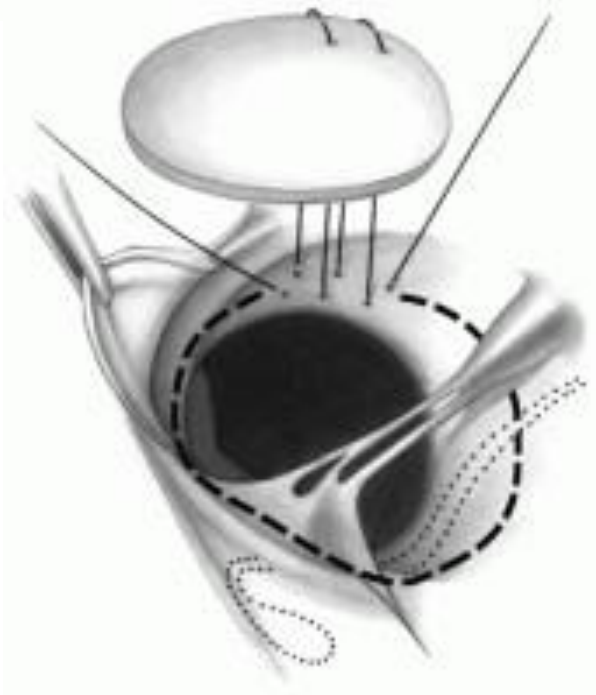
VSD



- **Transitional sutures**
- A transitional stitch incorporating the tricuspid leaflet, the rim of the defect, and the patch will ensure a more secure closure

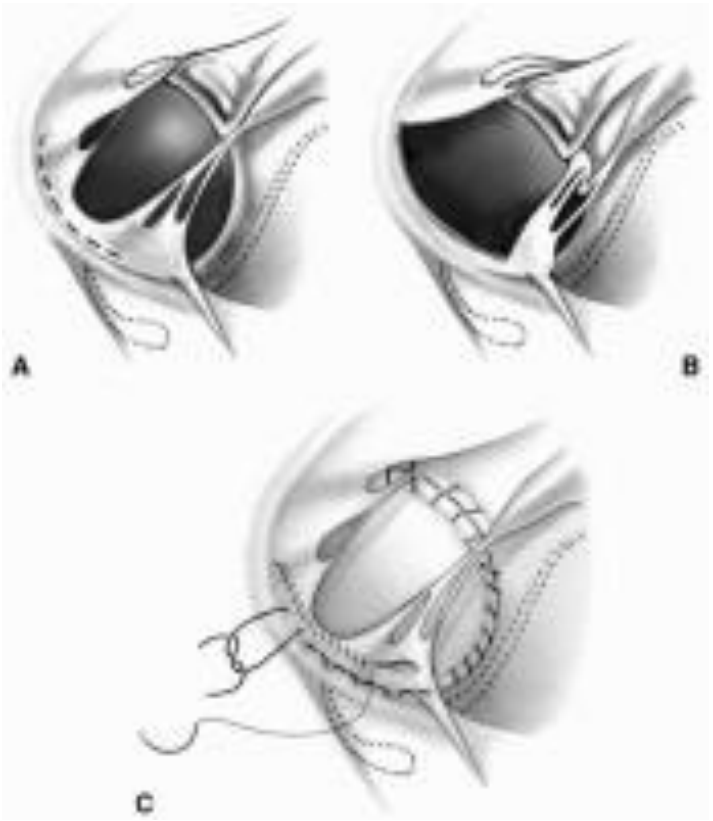
VSD

- Superficial bites that include only endocardium are taken along the inferior rim of the defect, until the tricuspid leaflet is reached
- Alternatively, the other arm of the suture is continued, moving outward to a distance of 3 to 5 mm from the rim of the defect to avoid the underlying conduction tissue



VSD

- **Interference by chordae tendineae and papillary muscles**
- The septal leaflet and a portion of the anterior leaflet of the TV may be detached, leaving a 2- to 3-mm rim of tissue along the annulus
- The leaflets are resutureed to the rim of leaflet tissue along the annulus with a 6-0 or 7-0 prolene suture



VSD

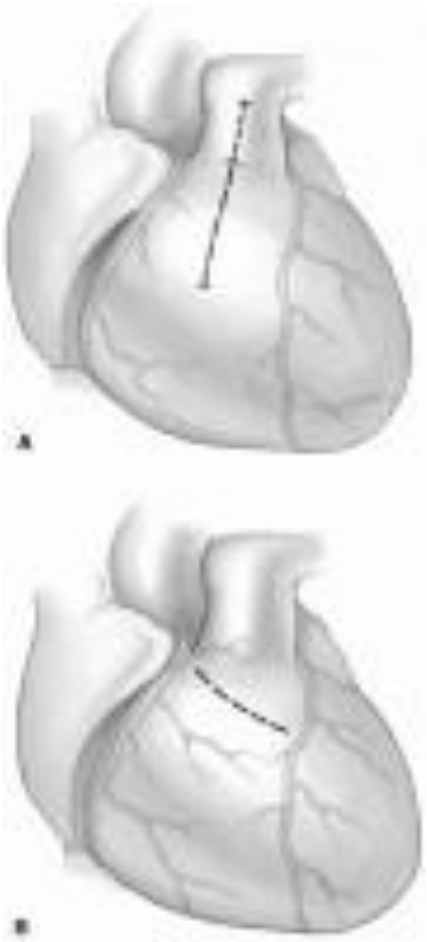
- **Prevention of tricuspid insufficiency**
- Incorporation of excessive leaflet tissue in the suture line results in tricuspid insufficiency
- Should not exceed a distance of 2mm from the tricuspid annulus

VSD

- **Tricuspid valve repair**
- Often one or two interrupted 6-0 prolene sutures are used to approximate the anterior and septal leaflets and/or septal and posterior leaflets to ensure a competent tricuspid valve (commissural valvuloplasty)

VSD

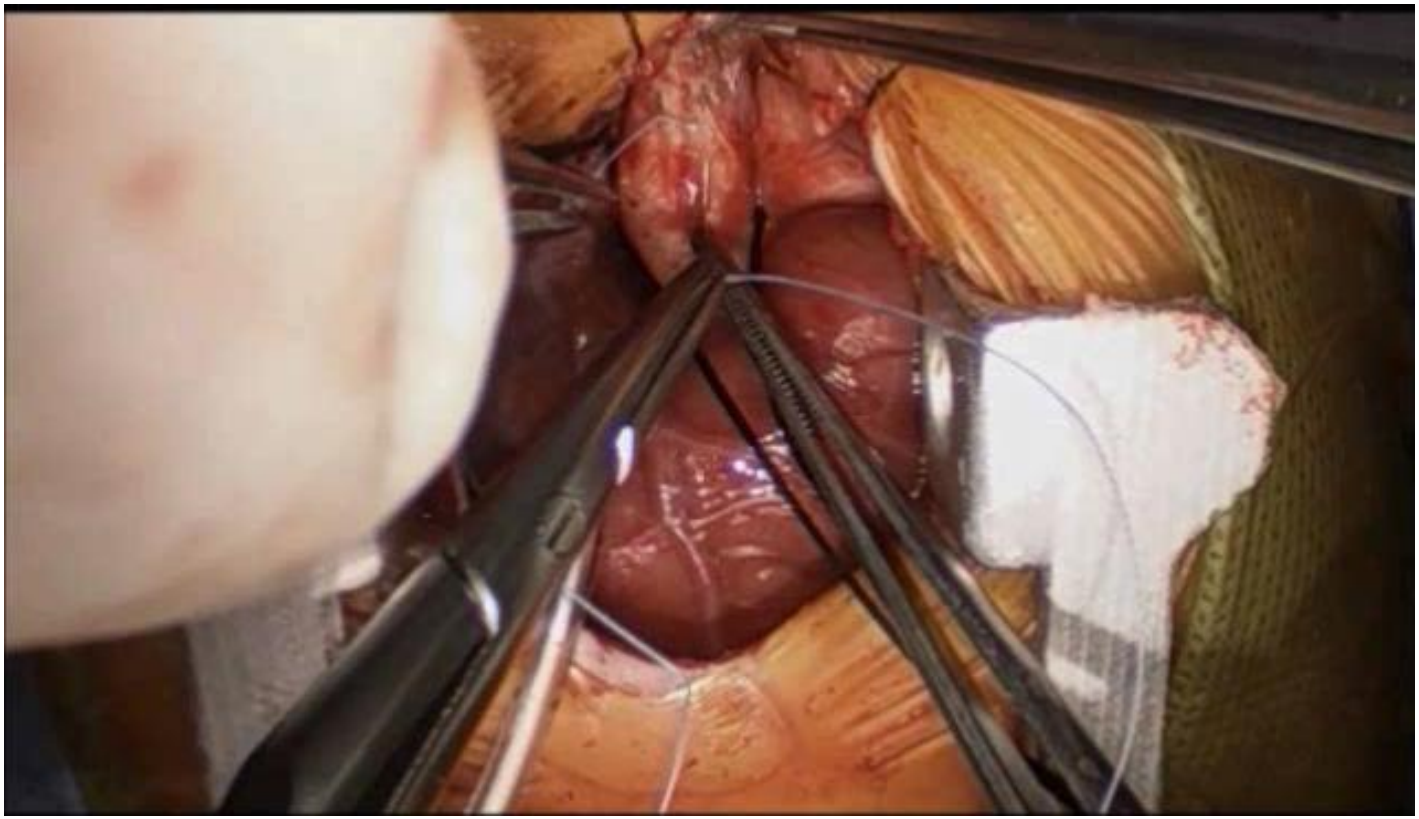
- Transventricular approach to ventricular septal defect



VSD

- **Subarterial ventricular septal defect**
- These defects may be associated with the development of aortic insufficiency
- Even if small, these defects should probably be closed to prevent progression of aortic insufficiency and aortic valve leaflet damage

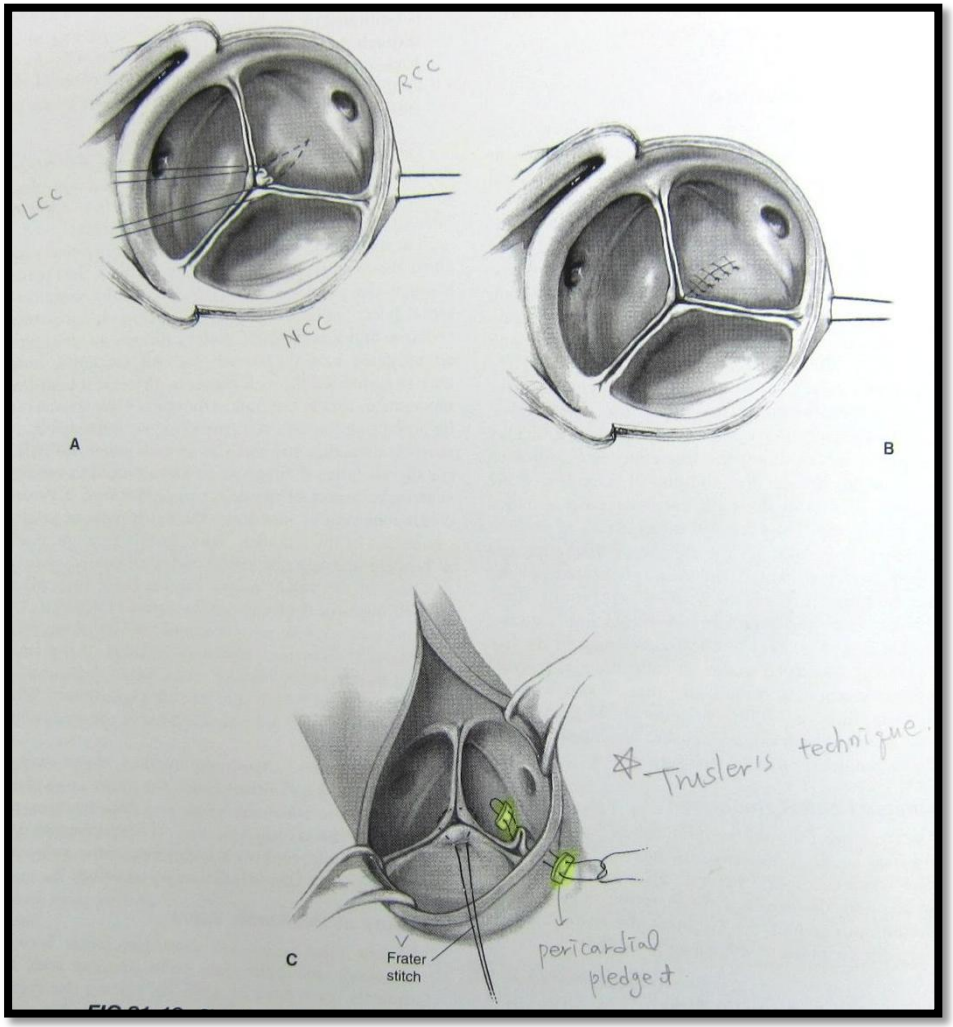
VSD



- **Technique for closure**
- The transpulmonary approach is prefered
- If there is significant aortic insufficiency, the aortic valve should be repaired before the VSD is closed

VSD

- If aortic regurgitation is significant, an oblique aortotomy is performed and cardioplegia is infused directly into the left and right coronary ostia
- Usually the right coronary leaflet is prolapsed and may have excessive length along the free edge



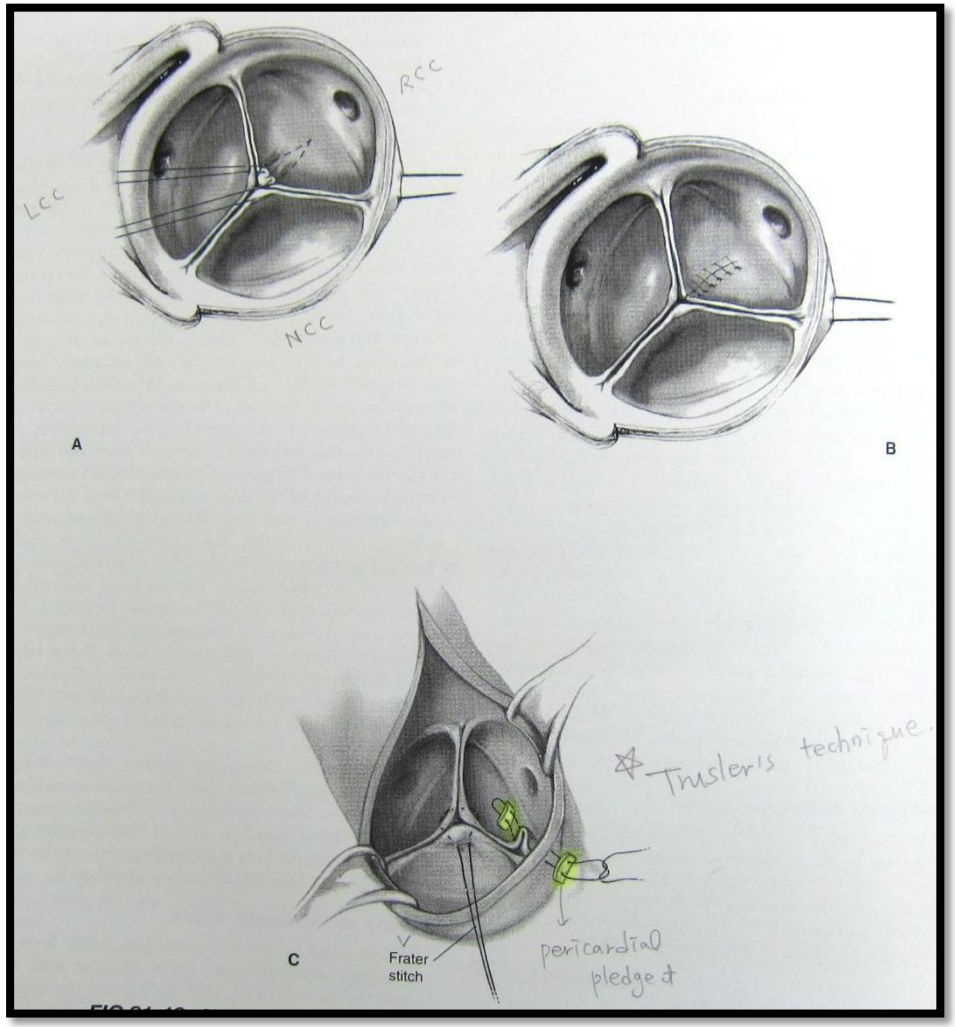
VSD

- **Limited leaflet resection**
- The resection should be somewhat less than the distance between the two stitches so that the free edge is not too short after the repair sutures are tied
- In addition, the depth of the resection should not be more than one-half the height of the cusp to ensure adequate coaptation with the other leaflets

VSD

- **Knots tied on aortic side**
- The leaflet reapproximating sutures must be tied on the aortic side so as not to interfere with coaptation of the cusps

- **Plication of the free edge at the commissure (Trusler's technique)**
- An alternate technique involves folding the excess leaflet tissue at the commissure and attaching it to the aortic wall with one or two mattress sutures of 6-0 prolene reinforced with pericardial pledgets



VSD

- Main pulmonary artery is opened transversely or vertically just above the commissures
- Superiorly, the patch must be secured to annulus of the pulmonary valve
- Intraop. TEE should confirm a competent aortic valve & pulmonary valve and complete closure of the ventricular septal defect (and RVOTO)

VSD

- Injury of the aortic valve
- Care must be taken in placing the sutures along the superior aspect of the VSD
- A too deeply placed needle may incorporate the aortic leaflet tissue and result in significant aoritc insufficiency

- Injury to the pulmonary valve

VSD

- **Muscular ventricular septal defects**

- Muscular VSDs have completely muscular margins and may occur anywhere in the muscular septum
- Depending on their location, muscular defects can be approached through the right atrium and/or a right ventriculotomy
- Apical muscular ventricular septal defects can be closed in the cardiac catheterization laboratory using transcatheter closure devices
- Hybrid surgical-catheter techniques
- Preliminary pulmonary artery banding (Swiss-Cheese type VSD, multiple muscular VSD) – staged opeartion

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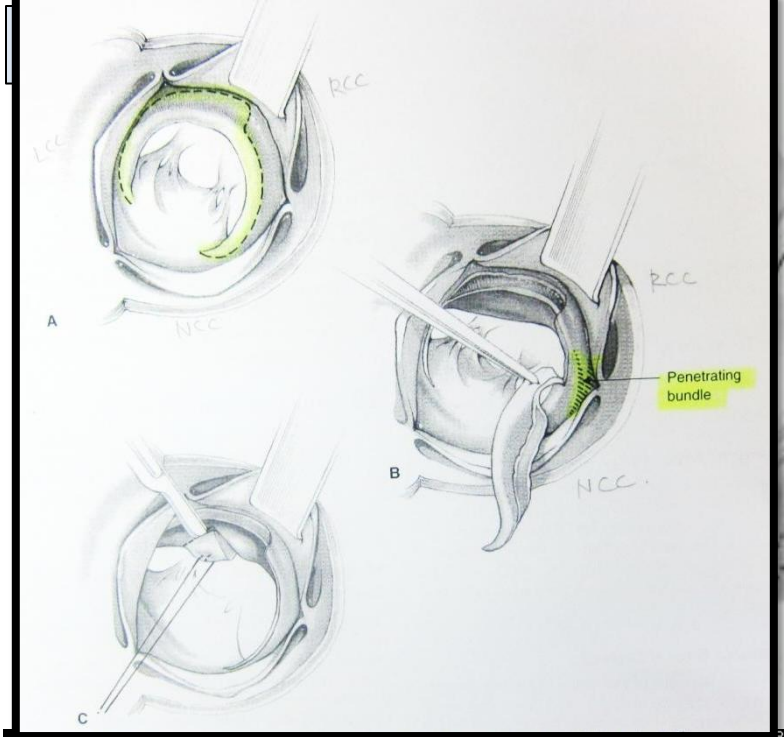

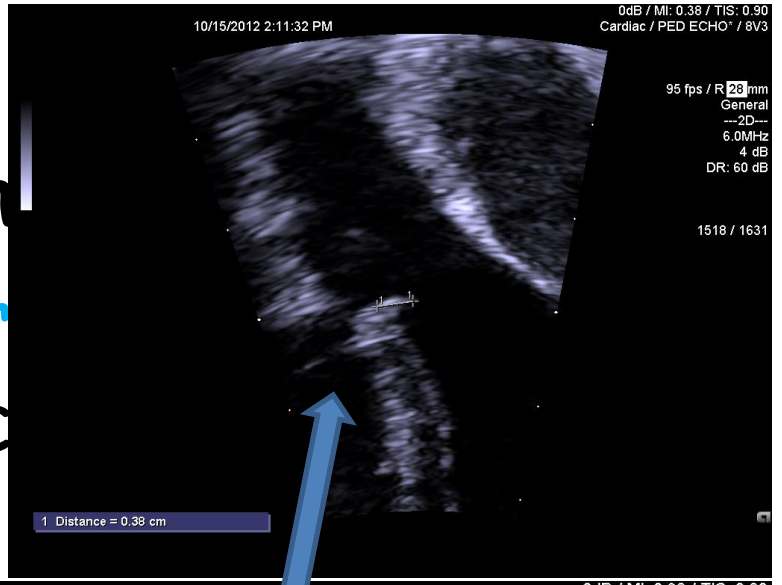

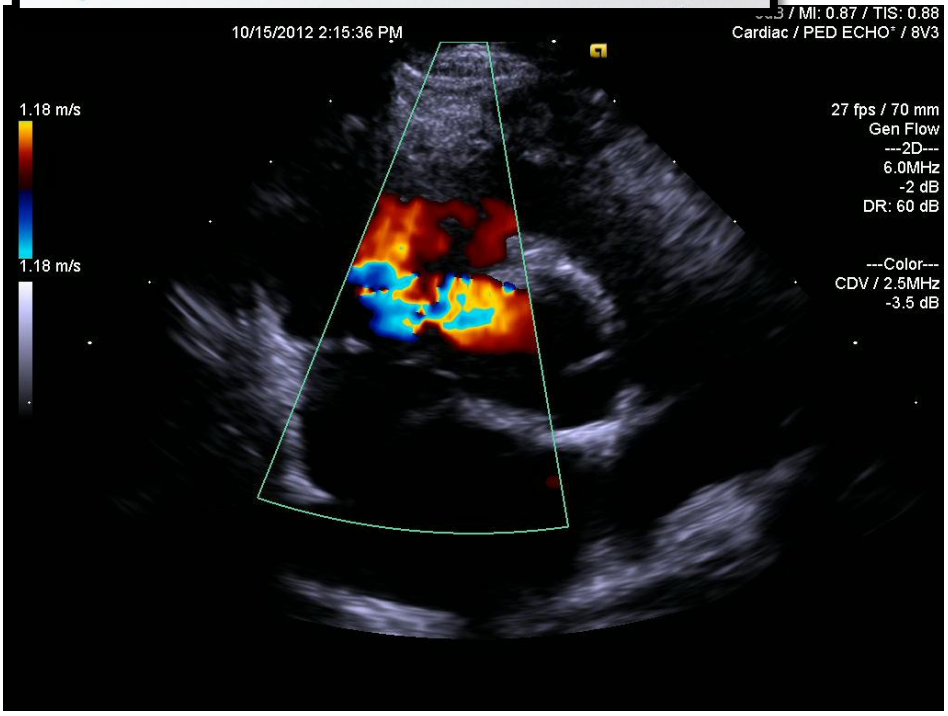

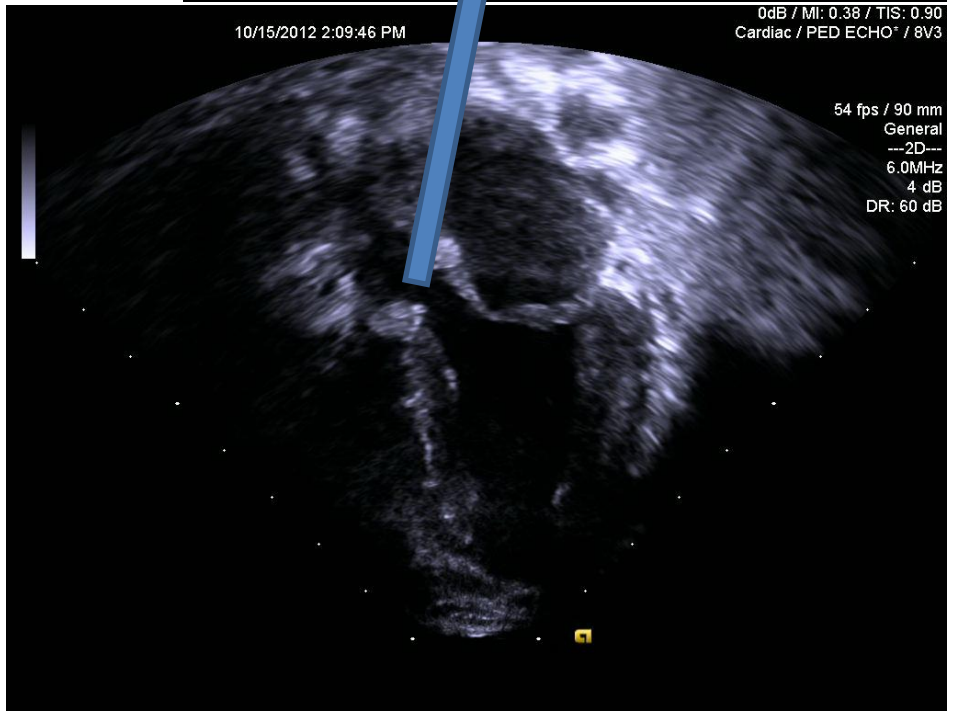

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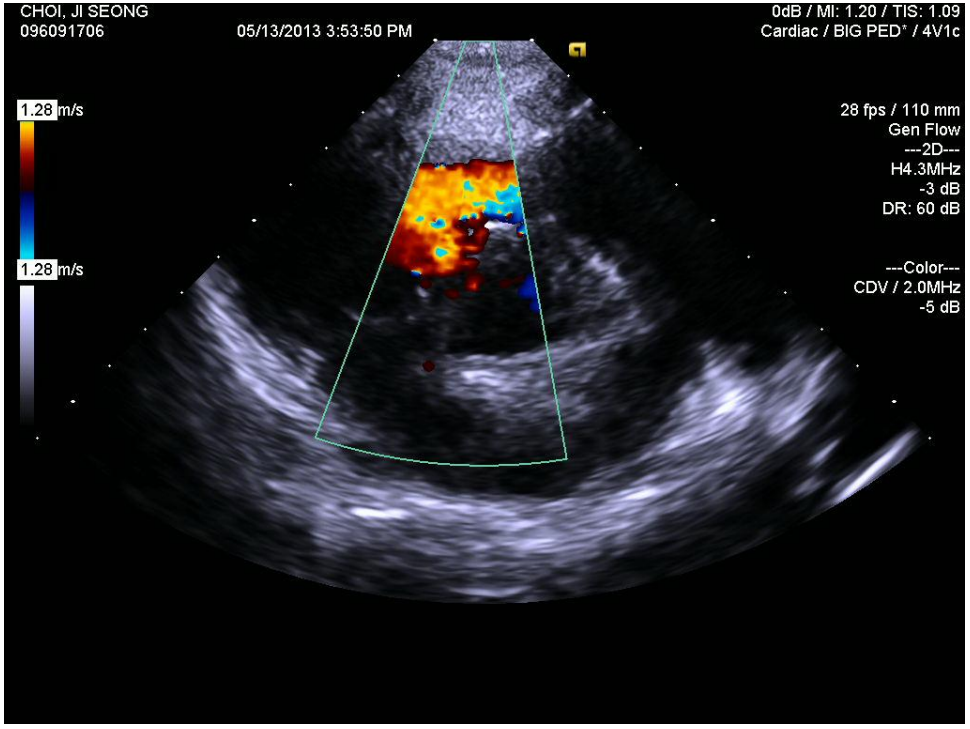
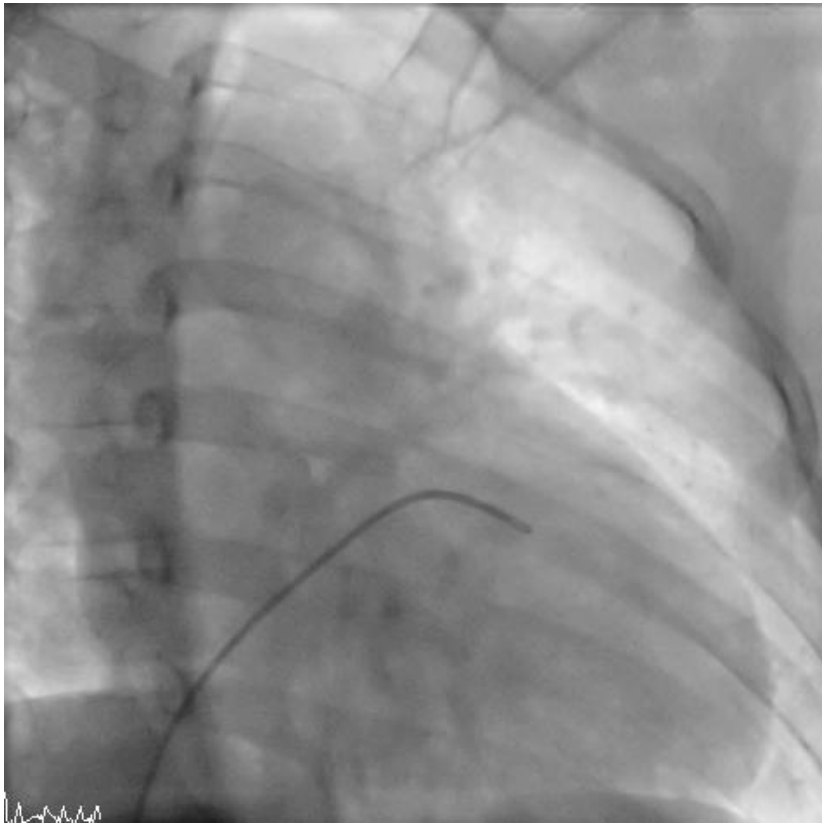
VSD

- **Associated lesions with VSD**
- Right ventricular outflow tract (RVOT) muscle hypertrophy or DCRV (double chambered right ventricle)





VSD

- Op. indications of VSD

- Heart failure, growth retardation, and large VSD with pulmonary hypertension
- Subarterial VSD
- PM VSD with aortic valve prolapse or AR
- RVOT muscle hypertrophy or DCRV (double chambered right ventricle)
- VSD associtated with subaoritc stenosis (LVOTO)
- LV -> RA shunt
- History of infective endocarditis