

The Pericardium

The Pericardium - Importance	
	Limits distention
	Facilitates interaction and coupling of the ventricles / atria
	Facilitates twist and torsion
	Normal amount of pericardial fluid < 50ml

NOTE: The pericardium consist of a visceral and a parietal layer

NOTE: Patients with an open pericardium or chest (cardiac surgery) show an abnormal contractile pattern

Pericardial Effusion

Forms of Pericardial Effusion	
Transudative	Congestive heart failure, myxoedema, nephrotic syndrome
Exudative	Tuberculosis, spread from empyema
Hemorrhagic	Trauma, rupture of aneurysms, malignant effusion, iatrogenic
Malignant	Due to fluid accumulation caused by metastasis, often hemorrhagic


NOTE: Bacterial infection (especially tuberculosis) predisposes to constriction.

NOTE: Exudative effusion is characterized by fibrous strands

Causes of Pericardial Effusion	
Idiopathic	No cause is found despite full diagnostics
Infectious	common in viral infection (direct + immune response)
Iatrogenic	pacemaker, cath. procedures, biopsy, cardiac surgery
Neoplastic	often hemorrhagic, denotes poor prognosis
Myocardial infarction	myocardial rupture, epistenocardic (early) + Dressler syndrome (late)
Renal failure	uremia or dialysis associated
Autoimmune disease	particularly: SLE, rheumatoid. arthritis. , systemic sclerosis
Radiation	20% develop constriction
Rheumatic	usually small PE
Traumatic	contusio cordis or heart / aortic rupture
Endocrine disorder	i.e myxedema
Pulmonary hypertension	the mechanism is unclear (poor prognosis)
Post cardiac surgery	usually hematoma, often localized
Aortic rupture	hemorrhagic effusion! PE in 45% of dissection

NOTE: The incidence of the various causes for pericardial effusion depends on the setting of your lab and in which part of the world you practice (i.e. tuberculosis in developing countries, iatrogenic if interventions and cardiovascular surgery is performed in your center)

NOTE: The cause of effusion often remains unclear because diagnosis would require peri-myocardial biopsy and cyto-, histoimmuno-, microbiological analysis of the fluid

Echo diagnostics of Pericardial Effusion		
	Echo free space in diastole!	Parasternal views
	Apical views (right ventricle!)	Subcostal view

NOTE: The pericardium is highly reflective in echocardiography

Facts		
	Large Effusion	Regional Effusion
	neoplastic	postoperative
	uremic	trauma
	tuberculosis	purulent
	myxedema	

NOTE: Talk to the patient. A thorough history often helps to figure out the cause of effusion

Differential Diagnosis		
Pleural effusion	Epicardial fat	
Pericardial cyst	Ascites	

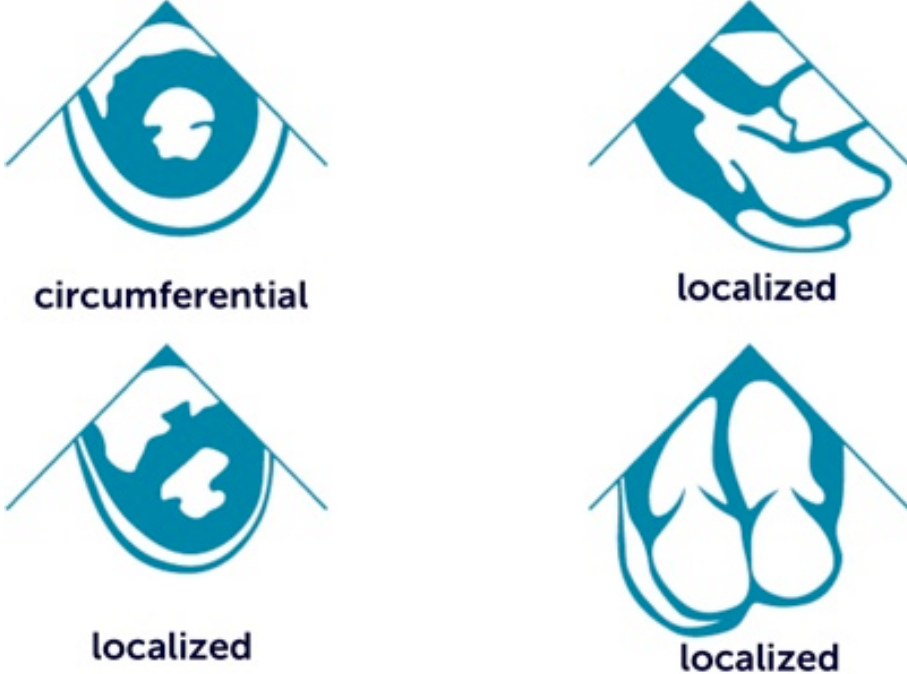
NOTE: Pericardial effusions are anterior of the descending aorta, pleural effusions posterior.

NOTE: If you are still not sure let the patient sit up and image the pleura (from the back). There you will see if a pleural effusion is present or not

DD: Epicardial Fat		
	Absence posterior	Normal motion of pericardium
	Low intensity echos	Absence above the RA in 4Ch view + subcostal view

NOTE: Epicardial fat is common in obese patients, diabetes, atrial fibrillation and CAD. Epicardial fat is better visible if PE is present!

Location of Pericardial Effusion




circumferential **localized**

localized **localized**

NOTE: Localized effusions occur in the setting of fibrinous- and iatrogenic (haemorrhagic) PE


Quantification of Pericardial Effusion


Small	< 10mm
Moderate	10 - 20mm
Large	> 20mm
Very large	> 30mm + compression






NOTE: The separation of pericardial layers can be detected in echocardiography, if the pericardial fluid exceeds 15–35 ml

NOTE: There are usually regional differences in the extend of pericardial effusion. Follow up of PE requires the same views to be used. Always measure at the same region and also assess PE visually!

Quantification of Volume	
	<p>D'Cruz - Formula: Volume of a prolate ellipsoid</p>
	<p>$(\pi \times \frac{4}{3} \times L/2 \times D1/2 \times D2/2)$</p>
<p>Subtract the volume derived by tracing the cardiac contour from the volume derived by tracing the epicardial contour (+ pericardial effusion). The difference is the volume of the pericardial effusion.</p>	
<p>NOTE: Volume quantification is best performed from a subcostal view</p>	

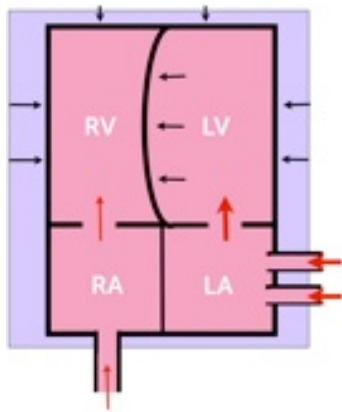
Importance of Echo in Pericardial Effusion		
Make the diagnosis	Cause?	
Hemodynamic importance	Direct pericardiocentesis	
<p>NOTE: Always look for other echo features which can explain the cause for effusion (i.e. MCI, pulmonary hypertension, endo-myocarditis)</p>		

Tamponade

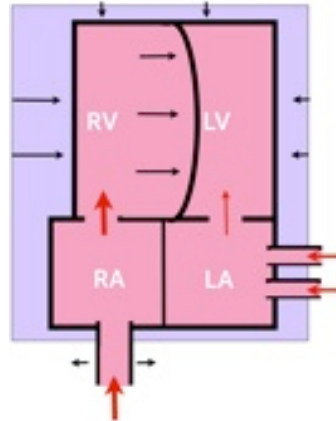
Definitions		
		
Intrapericardial fluid	„Stiff“ pericardial sack	„Stiff“ pericardial sack + fluid

NOTE: Tamponade, constriction and effusive constriction share many common features. Tamponade is a medical emergency, and occurs if fluid accumulates rapidly

Pathophysiology of Tamponade - Interventricular Interdependence



Tamponade – Expiration



Tamponade - Inspiration

NOTE: In tamponade systemic venous return is shifted towards inspiration. The heart can not adapt to the increase in volume of the right heart during diastole, especially during inspiration. To accommodate the volume the septum shifts to the left (septal shift) during inspiration

Hallmarks of Tamponade

Systemic venous return shifted to inspiration	Impaired filling of LV during inspiration
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Interventricular interdependence


Diagnosis – Clinical Signs

Pain	Tachycardia
Dyspnea	Edema
Shock	Low blood pressure




NOTE: Echocardiography is important for the diagnosis of tamponade, but tamponade is also a clinical diagnosis!


Triggers of Tamponade in Chronic PE		
	Hypovolemia - Low pressure tamponade	Paroxysmal tachyarrhythmia
	Intercurrent pericarditis	

Echo signs of Tamponade		
RA/LA collapse	RV/LV collapse	
Dilated IVC + hepatic veins	Swinging heart	
Septal shift towards LV during inspiration	Fluctuations of MV-inflow > 30% (cave: Afib, heart motion)	
Large fluctuations of TV inflow	PW Doppler hepatic vein flow	
<p>NOTE: Use multiple views to assess septal shift and use respiratory curves</p>		
<p>NOTE: Tamponade is often a „staged“ process. It can also occur gradually.</p>		

Pericardial Constriction

Pericardial constriction - Characteristics		
	Pericardial calcification / fibrosis / scarring	Subacute / chronic disease
	NORMAL systolic function	Impaired filling!!!
	Venous distention	Edema
	Hepatomegaly	Ascites

Causes of Pericardial Constriction	
Inflammation (bacterial / tuberculosis)	Radiation
Post cardiac surgery	Connective tissue disease
Idiopathic	




NOTE: Patients with radiation associated constriction have a poor prognosis!

Types of Constriction	
Annular form	Left-sided form
Right-sided form	Global form + myocardial atrophy
Global form + perimyocardial fibrosis	Restrictive CMP

NOTE: Constriction can be localized but it usually leads to an impairment of biventricular filling!


Echo features of Pericardial Constriction	
Dilated IVC / hepatic veins	Predominant forward flow in early diastole
Augmentation of forward flow during inspiration	Expiratory flow reversal hepatic veins
Septal bounce	Distorted heart contour
Poor image quality	Rather small ventricle/ atria





NOTE: To confirm constriction it is sometimes necessary to use hemodynamic catheter studies (dip and plateau pressure drop between the LV and RV during inspiration)


NOTE: Use a respiratory curve on your echo to time events. In my experience the easiest and best way to diagnose constriction is by displaying inspiratory septal shift (septal bounce). This can be done in any view that depicts the IVS


Other Diseases of the Pericardium

Pericardial Cyst		
Benign tumor	6% of mediastinal masses and 33% of mediastinal cysts	
Failure of fusion of mesenchymal lacunae that form the pericardial sac		
Usually asymptomatic	Unilocular /multilocular	
Right cardiophrenic angle		
NOTE: Pericardial cysts can be quite large and are often first suspected in a chest X-ray		

Differential Diagnosis: Pericardial Cyst		
	Localized pericardial effusion	Hepatic / renal / mediastinal cyst
	Echinococcal cyst	Diaphragmatic hernia
	Atrial diverticula	Aneurysmatic vessels
NOTE: Use Doppler or contrast to determine if flow is present within the echo-free structure. There is no blood flow in cysts!		

Malignant Disease of the Pericardium		
Primary malignancy	Metastasis	
Pericardial carcinosis	Pericardial involvement is rather frequent (8-15%) in malignant disease	
Often associated with pericardial effusion	Hallmark = pericardial effusion	
NOTE: Symptomatic pericardial effusion in malignancy has a poor prognosis!! (median survival = 4 months). Not all patients with pericardial effusion and malignancy have a malignant involvement in pericardial disease.		

Congenital Absence of the Pericardium		
	1/10.000 autopsies	Partial left /right or total
	Asymptomatic or chest pain	Higher risk for traumatic dissection
	Herniation strangulation	
<p>NOTE: Consider absence of the pericardium in funny shaped ventricles with abnormal contractile motion</p>		

Echofeatures of Congenital Absence of the Pericardium		
Displacement of the heart	Excessive cardiac motion	
Abnormal septal motion	Enlargement of the LAA	
<p>NOTE: Use MRI and CT to confirm the diagnosis</p>		