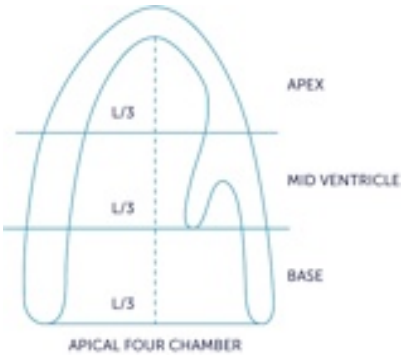
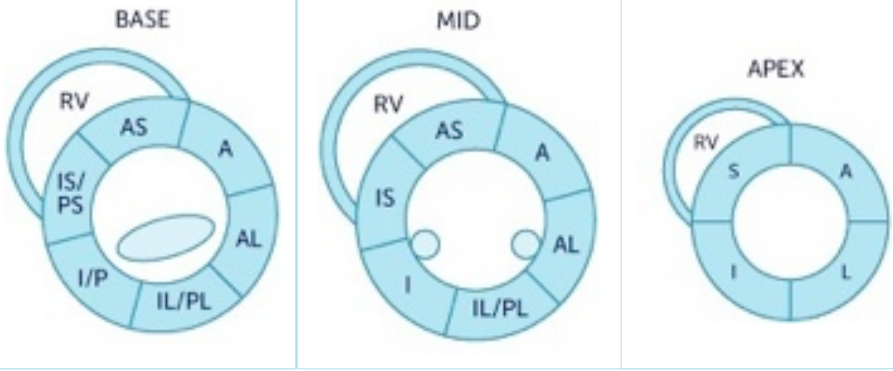
Segmental Approach

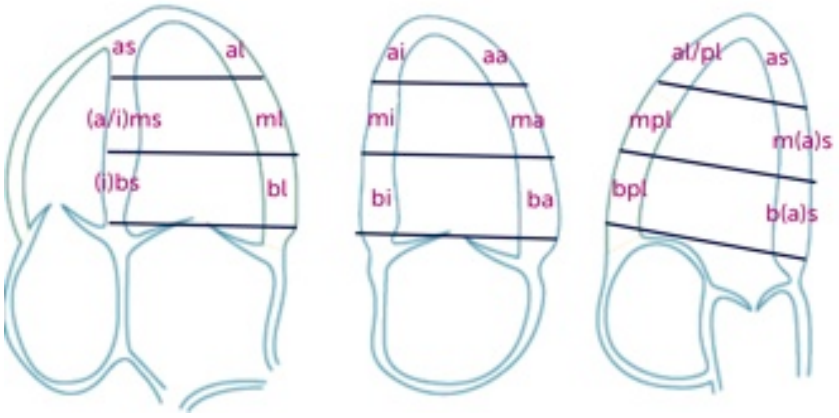
Definition of Segments



For the assessment of wall motion abnormalities, the left ventricle is divided into basal (6), mid (6) and distal or apical (4) segments.

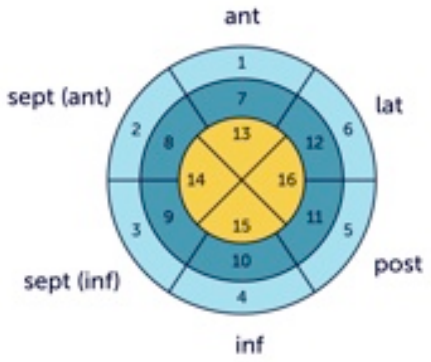


Subdivision of the corresponding short axis view (SAX). Note that the basal and mid SAX consist of 6 segments while the apical SAX has only 4 segments (16 segment model).

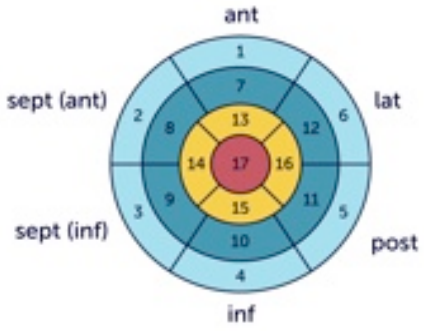


Definition of the individual segments in the apical views. Note that the inferior portion of the basal septum is visible in the 4ch view.

Bulls Eye Representation

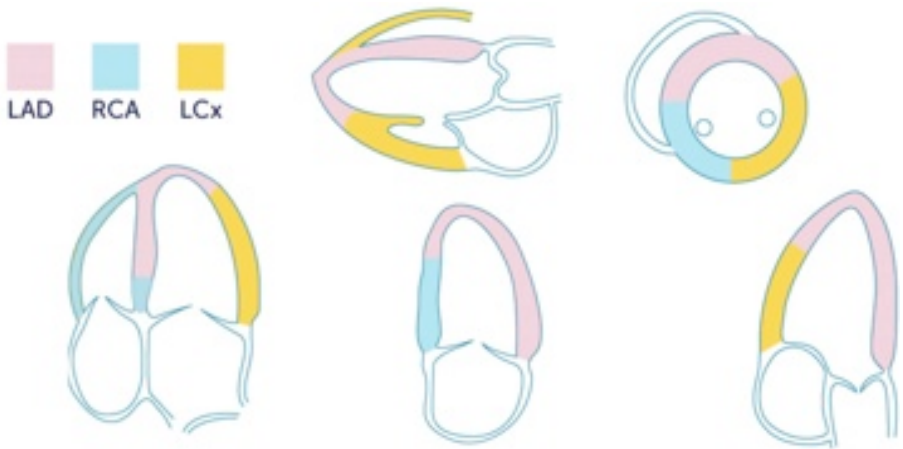


16 segment model



17 segment model (supraapical cap)

Coronary Supply



NOTE: In left dominant perfusion the posterior lateral wall and even large portions of the inferior wall are supplied by the LCx. In right dominant perfusion the RCA supplies the posterolateral wall in addition to the inferior segments.

NOTE: The RV is supplied by RCA branches!

Wall Motion Abnormalities

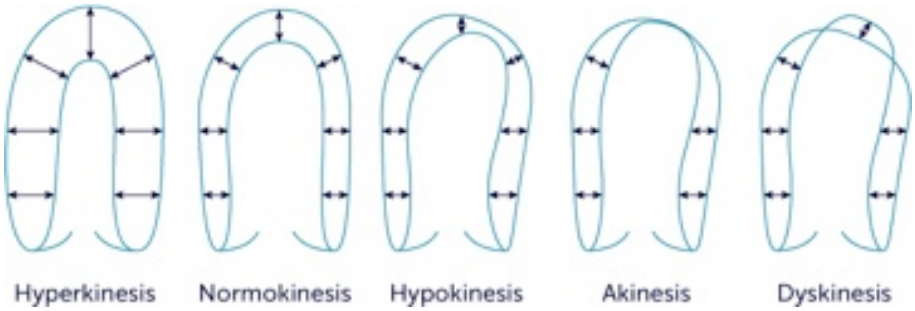
What Are We Looking For?

- Wall thickening
- Myocardial thickening
- Wall motion
- Hinge points
- Ventricular geometry
- Echogenicity

NOTE: LV contrast study improves endocardial border detection

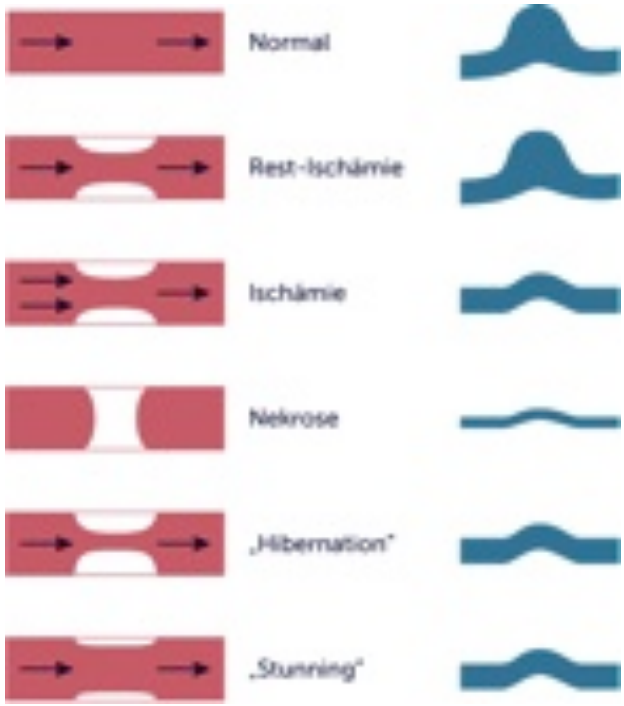
NOTE: Try your best to get the best image quality possible. This is what counts most when you are looking for regional wall motion abnormalities

Wall Motion Abnormalties



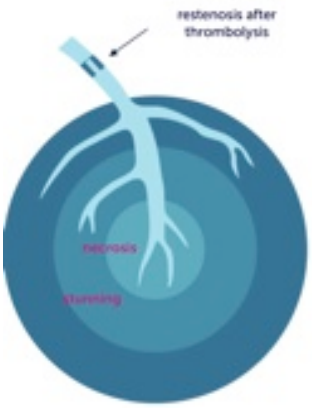
NOTE: If possible compare wall motion with a reference segment!

Wall Motion in Ischemic Conditions

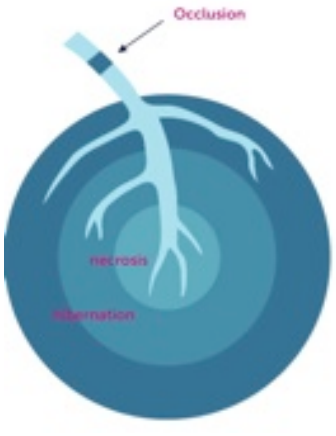


NOTE: Ischemia, hibernation and stunning are all characterized by hypo / akinesia AND preserved wall thickness!

Conditions of Perfusion

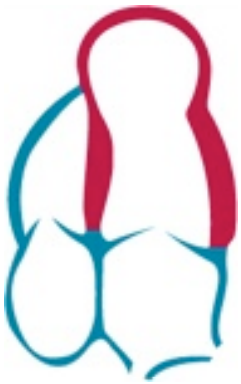


Stunning: reversible reduction of function of heart contraction after reperfusion



Hibernating: Downregulation of myocardial function to match chronic reduced blood flow

Remodeling		
	Progressive LV dilatation	**NOTE:** Predisposing factors for remodeling are large infarcts (ant. > inf.), mitral regurgitation and elevated afterload (hypertension, AS)
	Eccentric LV hypertrophy	
	Distortion of geometry	
	Hypokinesia of normally perfused segments	
	More MR	

Aneurysm		
	Definition: Abnormal widening of all myocardial layers during diastole	**NOTE:** There is no risk of rupture in chronic aneurysms.
	Elevated risk of thrombi	
	Increased risk of heart failure	
	Apical aneurysm are best visible in 2ch and atypical views (avoid "foreshortening")	
	Slow flow phenomenon within the aneurysm often present	

Myocardial Tissue following Acute Coronary Syndrome

	
Transmural scar: akinesia, dyskinesia, aneurysm, thinning, bright echo	**Subendocardial scar**: hypokinesia, thickness is normal/mildly thinned
	
Transmural scar + viability: akinesia + hypokinesia of neighboring segments	**Viable myocardium** (Acute ischemia/ hibernation/stunning): hypokinesia, akinesia, wall thickness preserved

NOTE: The degree of wall motion abnormalities depends on the transmurality of the infarct. You can have various different wall motion abnormalities (akinesia, hypokinesia, aneurysm, scars)

Quantification of LVF in CAD

Simpson method	Visual assessment
Wall motion scoring	Centerline
3D methods	Endocardial contour enhancement (contrast)

NOTE: The Simpson method DOES NOT account for regional wall motion abnormalities in the postero-lateral and all anterior septal segments (segments seen in the apical long axis view)

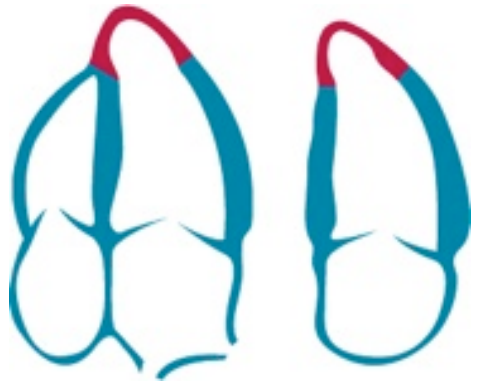
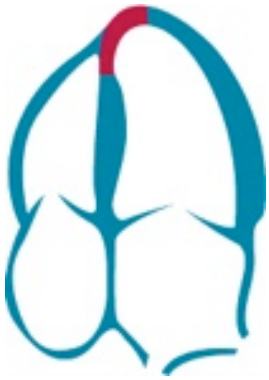
Problem Zones (Regions Difficult to Image)	

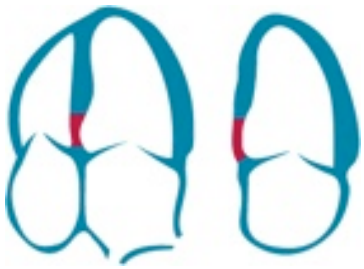
Region	Solution
Supraapical	- avoid foreshortening - move transducer more lateral + image towards the apex - use 2ch view
Lateral	- rotate 4ch view clockwise - move transducer more medial
Basal inferior	- passive or active motion? - hinge points? - wall thickness

Conditions which Mimic CAD		
Dyssynchrony / Pacemaker	Left bundle branch block	
Sarcoid heart disease	Abnormal septal motion	
Myocarditis	Cardiomyopathy	

Tako-Tsubo Cardiomyopathy — Stress-Induced CMP		
	Transient left ventricular apical dysfunction/ballooning	More common in: postmenopausal women
	Catecholamines involved	T-wave inversions
	Reversible	NO coronary obstruction
NOTE: More subtle forms may also exist		

Patterns of Myocardial Infarction

Supraapical Infarct	Distal Septum Infarct
	
LAD (distal, mid., prox.), small supraapical aneurysm, low remodeling risk	LAD (distal,mid., prox.), low remodeling risk
NOTE: Supraapical and distal septal infarcts can also occur in proximal LAD occlusion after rapid reperfusion.	

Proximal LAD Type AMI	Small Basal Inferior Infarct
	
LAD (before 1st septal branch, left main), always remodeling, poor prognosis	RCA, difficult region to interpret, low remodeling risk

Inferior Infarct	Infero-Posterior Infarct
	
RCA, low-moderate remodeling risk	RCA (dominant) or Cx (large, prox.), moderate remodeling risk

Posterolateral Infarct	Infero-Posterior-Lateral Infarct
	
CX, RCA, moderate remodeling risk	Dominant RCA, CX (large, prox.), high remodeling risk
NOTE: Inferior / posterior / postero-lateral infarcts pose an elevated risk for restrictive MR!	

Lateral Infarct	
	**NOTE:** When assessing the patterns of myocardial infarction, always consider the possibility of multiple / sequential infarcts!
CX, LAD (diagonal branch, difficult to interpret, low remodeling risk	
NOTE: Always consider that patients can have multiple infarcts/scars in several territories	

Complications

Overview		
	**Acute / Subacute**	
	Cardiogenic shock	Thrombus formation (acute)
	Myocardial rupture	Right ventricular infarction
	Papillary muscle rupture	Ischemic VSD
	Chronic	
	„Remodeling" chronic heart failure	Right heart failure
	Thrombus formation (late)	Mitral regurgitation
NOTE: Perform serial echo exams after infarction. It will help you to detect potential complications earlier and assess the risk for complications		

Pseudoaneurysm		
Short, narrow neck (diameter < 50% of the fundus diameter)	Outer walls formed by pericardium and mural thrombus	
Hematoma	Often pericardial effusion	
NOTE: Risk of secondary perforation!!		

Myocardial Rupture		
	Mortality 95%	5 - 25% of deaths from MCI
	Also small infarcts	Tamponade
	Hematopericardium	**Urgent surgery!!**

Ischemic VSD	
Incidence 0.5-1%	50% lethal
Within 4-5 days	Risk factors (hypertension, 1st MCI)
Echo Features	
LV volume overload	Disrupted/spliced IVS
Color doppler	CW doppler

NOTE: Most common site of rupture is the distal anterior septum (ant MCI) followed by the basal inferior septum (Inf. MCI)

NOTE: Ischemic VSDs are rarely a simple hole in the septum but rather the result of splicing of the IVS.

Papillary Muscle Rupture		
	Incidence 1%	Posteromedial PM more common
	5% of deaths from MCI	Mortality 70%
	Also small infarcts	
	Echo Features	
	Severe MR	Flail papillary muscle
	Hyperdynamic LV	Low vel. MR signal
	Pulmonary hypertension	Dilated pulm. veins

NOTE: Often difficult TTE assessment (tachycardia, pulmonary edema, lack of distinct MR jet due to large regurgitant orifice and low flow velocity MR) — Perform TEE!!

RV Infarction	
30 - 50% of inf. MCI	Poorer prognosis
Posterior wall, post. septum	Usually prox. RCA (Cx possible)
Echo Features	
Dilated RV	Wall motion abnormalities (inferior)
Reduced RVF	Dilated VCI

NOTE: Look at regional and global RV function in EVERY patient with inferior MCI

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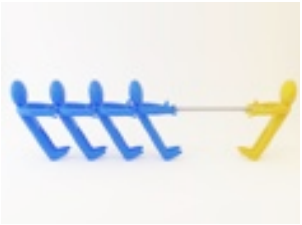
Mural Thrombus		
	Thrombogenicity of infarct tissue	Low flow state in infarcted area
	Incidence 20% (large MCI 60%)	Usually apex (aneurysm)
	Systemic embolism 2%	Small thrombi difficult to detect
	Echo Evaluation	
	Visible in > 1 plane	Mobility (risk of embolus)
	Echogenicity (fresh/old)	Size (treatment monitoring)
NOTE: Often difficult to distinguish thrombi from prominent apical trabecula. Use LV contrast!!		

Mitral Regurgitation in CAD — Mechanism	
Annular dilatation	
Leaflet restriction	
Rupture of papillary muscle (acute)	
NOTE: Restriction of the posterior leaflets a frequent finding in patients with inferior infarcts (regional remodeling of the inferior wall). Restriction of both leaflets is often a consequence of global remodeling (and usually combined with annular dilatation)!	

Diagnosis of Posterior Leaflet Restriction	
Increase in tenting area	"Y" position of anterior to posterior leaflet
Jet origin further within the ventricle	Immobility of the posterior leaflet
Posterior jet direction	