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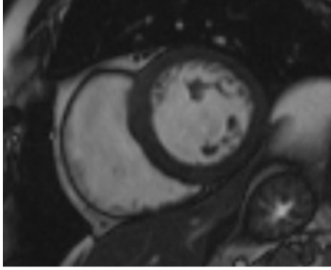
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- Nomenclature, Anatomy
- Imaging by Echo & other modalities
- Pathophysiology

**Pericardial and Epicardial Fat (EF)**

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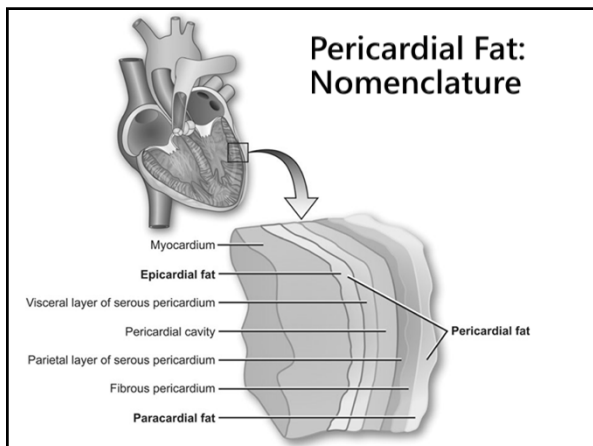
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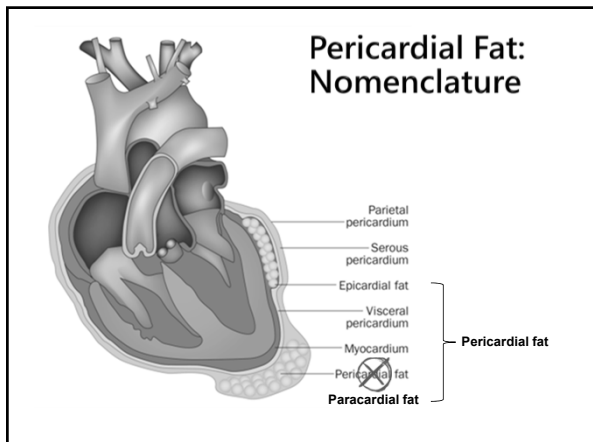
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### Epicardial Fat: Anatomy

- Visceral fat depot with same origin as intra-abdominal fat
- Produced by epicardium
- Most abundant location:
  - base of the heart
  - AV and interventricular grooves
  - LV apex
  - Coronary arteries & veins
  - RV, esp free wall

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**A.** Coronal section of heart showing abundant epicardial fat in the right AV sulcus where a cross-section of the RCA is seen (arrow). The RV free wall also contains a variable amount of epicardial fat that helps outline the pericardium. Note abundance of paracardial fat at the angle between the pericardium and diaphragm anteriorly.

**B.** Parietal pericardium is well delineated by the pericardial fat on the anterior diaphragmatic surface and epicardial fat over the RV.

**C.** The LV contains little epicardial fat, resulting in poor visualization of the pericardium in this area on imaging.

Klein. J Am Soc Echocardiogr 2013  
ASE Clinical Recommendations for Multimodality CV Imaging of Patients with Pericardial Disease

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### Epicardial Fat: Functions

- Mechanical: Protects coronary arteries, veins, lymphatics, nerves
- Thermogenic: brown fat
- Metabolic
  - In contact with myocardium, coronaries, sharing same microcirculation and direct cross-talk
  - Unique transcriptome enriched in genes for ECM remodeling, inflammation, immune signaling, thrombosis and apoptosis
  - Fatty acid metabolism
  - Very active endocrine organ: proinflammatory and anti-inflammatory adipokines, cytokines, fibrokinases

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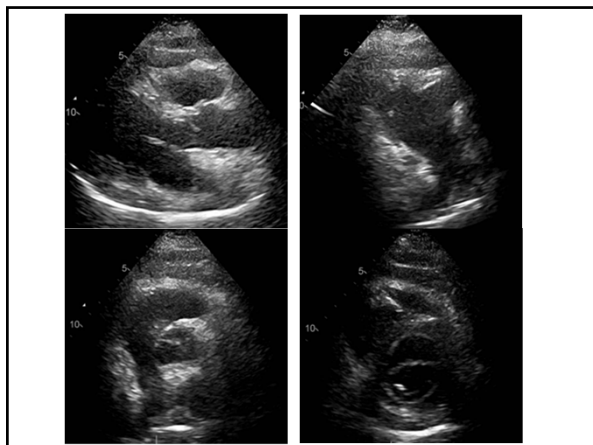
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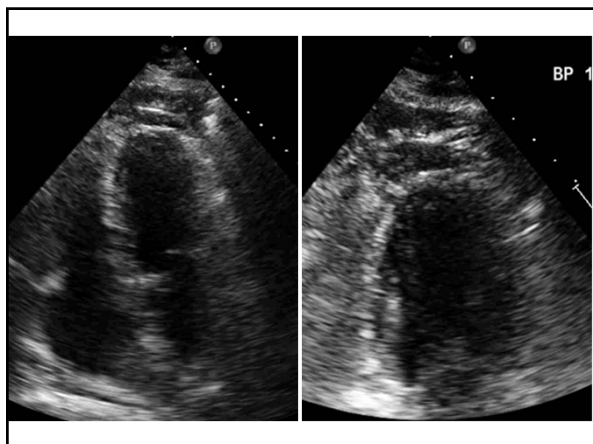
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### Measuring Epicardial Fat: Echo

- PLAX: RV free wall @ end-systole along midline of ultrasound beam, perpendicular to aortic annulus
- PSAX: as above, perpendicular to IVS at chordae/pap muscle tip
- Median values: 7mm (men) , 6mm (women)
- High risk: 9.5mm (men), 7.5mm (women)

Iacobellis *J Am Soc Echocardiogr.* 2009

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### Epicardial Fat: Regression with Rx

Current Opinion in Pharmacology

Echocardiographic epicardial fat thickness as therapeutic target. Echocardiographic epicardial fat can serve as marker of visceral fat changes during pharmaceutical or lifestyle interventions targeting the adipose tissue. These images show a significant and rapid decrease of epicardial fat thickness (yellow filling between white arrows), after 12 weeks on Liraglutide treatment in a type 2 diabetic patient (Iacobellis G, et al. abstract 104 LB, 75th American Diabetes Association (ADA) Meeting, June 5-8, 2015, Boston, MA, USA).

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### Epicardial Fat: CT

Thin pericardium separates fat layers

Gaborit. Compr Physiol 2017

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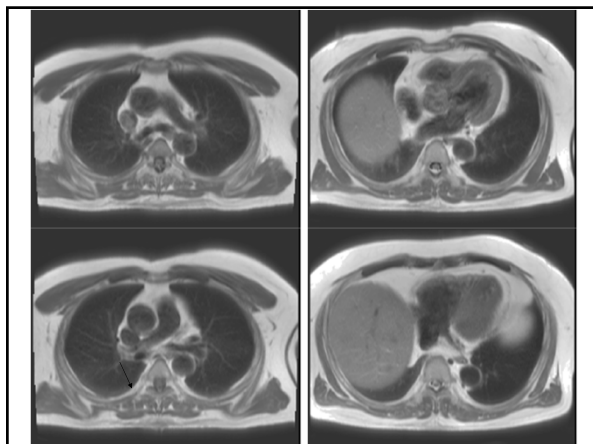
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**Epicardial Fat: CMR**

Areas traced for each slice are summed and multiplied by slice thickness for fat volume

- Epicardial fat (C-B)
- Paracardial fat (D-C)

Gaborit. Compr Physiol 2017

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**↑ Epicardial Fat: Associations**

- Coronary artery disease
- Atrial fibrillation
- Metabolic syndrome
- Insulin resistance
- Type 2 diabetes
- Hypertension
- Obesity
- Obstructive sleep apnea
- Fatty liver (NAFLD)
- .....etc

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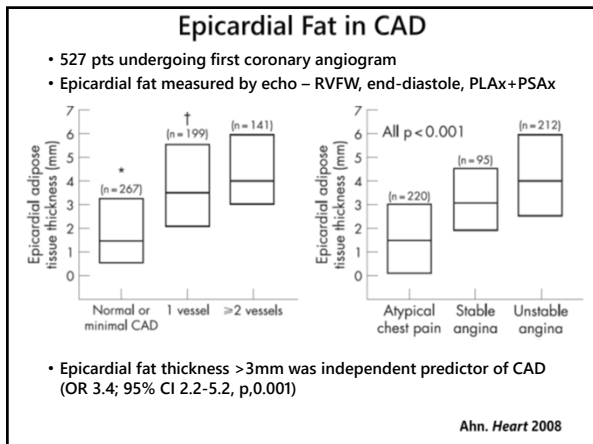
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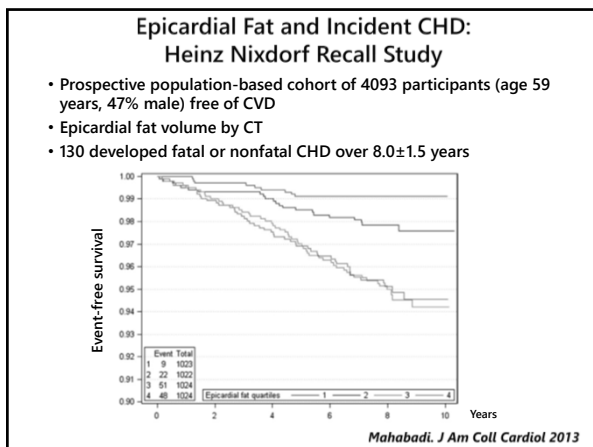
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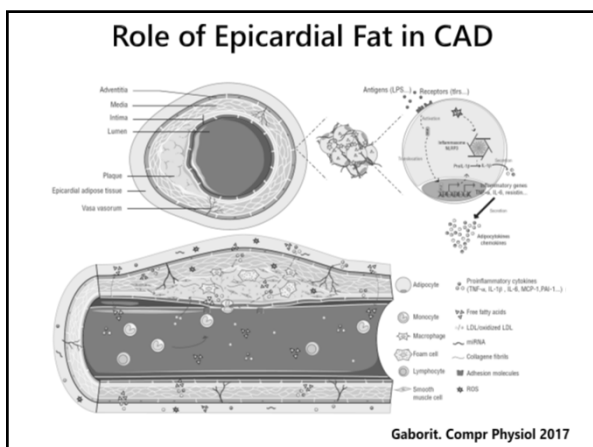
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### Epicardial Fat in Atrial Fib

**Peri-atrial fat on CMR**

**Direct infiltration of adipocytes within human atrial myocardium**

**Epicardial adipose tissue**

**Adipocyte hypertrophy, tissue growth**

**LA pressure, stretch and wall stress**

**Adipocyte infiltration**

**Fibrosis**

**Inflammation**

**Oxidative stress**

**Adipokines: Adiponectin, Leptin, TNF- $\alpha$ , MCP-1**

**Angiotensin II, IGF-1, IL-6, IL-10, IL-1 $\beta$ , IL-18, IL-17, IL-22, IL-27, IL-33, IL-36, IL-38, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-11, IL-12, IL-13, IL-14, IL-15, IL-16, IL-17, IL-18, IL-19, IL-20, IL-21, IL-22, IL-23, IL-24, IL-25, IL-26, IL-27, IL-28, IL-29, IL-30, IL-31, IL-32, IL-33, IL-34, IL-35, IL-36, IL-37, IL-38, IL-39, IL-40, IL-41, IL-42, IL-43, IL-44, IL-45, IL-46, IL-47, IL-48, IL-49, IL-50, IL-51, IL-52, IL-53, IL-54, IL-55, IL-56, IL-57, IL-58, IL-59, IL-60, IL-61, IL-62, IL-63, IL-64, IL-65, IL-66, IL-67, IL-68, IL-69, IL-70, IL-71, IL-72, IL-73, IL-74, IL-75, IL-76, IL-77, IL-78, IL-79, IL-80, IL-81, IL-82, IL-83, IL-84, IL-85, IL-86, IL-87, IL-88, IL-89, IL-90, IL-91, IL-92, IL-93, IL-94, IL-95, IL-96, IL-97, IL-98, IL-99, IL-100**

**ROS**

**Atrial myocardium**

**Structural remodeling**

**Electrical remodeling**

**Cardiac autonomic system activation**

**Atrial fibrillation**

Gaborit. Compr Physiol 2017

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### Epicardial Fat in Atrial Fib

- 273 pts: 76 in sinus rhythm, 126 paroxysmal AF, 71 persistent AF
- Epicardial fat volume using CT

**Association independent of age, sex, BMI, HTN, DM, LAE, LVEF, VHD**

Al Chekakie. J Am Coll Cardiol 2010

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### Epicardial Fat and Prevalent AF: Framingham Study

- 3217 participants (mean age, 51 $\pm$ 10 yrs; 48% women)
- MDCT for epicardial, intrathoracic and visceral adipose tissue volumes
- 54 had confirmed diagnosis of AF

	Age/sex adjusted	P	AF risk factor adjusted	P	BMI adjusted	P
Epicardial	1.30	0.02	1.28	0.03	1.28	0.04
Intrathoracic	1.12	0.41	1.13	0.40	1.09	0.61
Visceral fat	0.84	0.97	0.82	0.82	0.83	0.34

Thanassoulis. Circ Arrhythm Electrophysiol. 2010

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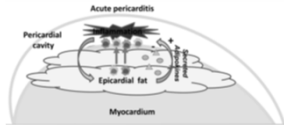
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### Epicardial Fat & Pericardial Disease

- Mimics pericardial effusion

	EAT	Effusion
Location	Anterior	Posterior
Lucency	Stippled, may be brighter than myocardium	Echolucent
Motion	With myocardium	None

- Mimics masses
- May cause constriction?
- May ↑ risk of recurrent pericarditis




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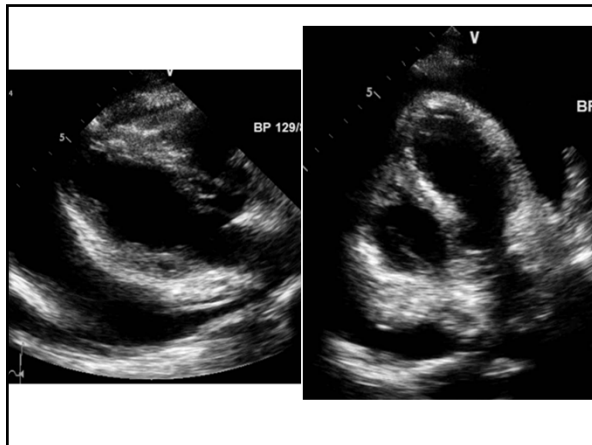
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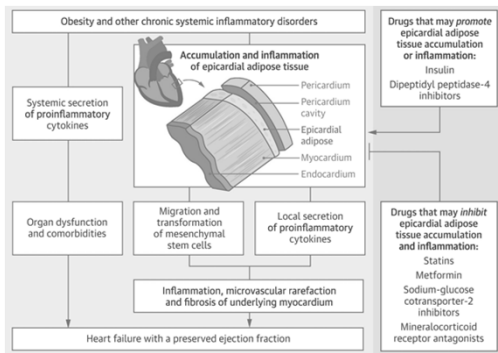
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### Role of EAT in HFPEF



Packer. J Am Coll Cardiol 2018

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### Conclusions

- Epicardial fat is an active organ with a unique physiological relevance because of anatomic proximity myocardium and coronary arteries.
- Biomarker of ↑ risk for multiple metabolic and CV conditions, and has prognostic value
- Can be imaged by Echo but more adequately by CT or CMR
- Modifiable and potentially a Rx target

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