Management of Pericardial Effusion

The Role of Echocardiography in Establishing the Indications and the Selection of the Approach for Drainage

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Introduction

Pericardial effusion represents accumulation of fluid in the pericardial space either as transudate (hydropericardium), exudate, pyopericardium or hemopericardium. Large pericardial effusions are most common with neoplastic, tuberculous, cholesterol, uremic pericarditis, myxedema, and parasitoses [1]. Large pericardial effusions that develop slowly can be surprisingly asymptomatic, while rapidly accumulating smaller effusions can present with tamponade. Cardiac tamponade is the hemodynamic consequence of cardiac compression due to increased intrapericardial pressure caused by effusion accumulation. The aim of this slide presentation is to review indications, timing, and selections of the most appropriate approach for management of pericardial effusion, based on echocardiography findings (Slide 1).

Indications for Pericardial Drainage

Pericardial drainage is indicated for clinical tamponade, suspicion of purulent, tuberculous, or neoplastic pericarditis, or for patients symptomatic despite 1-week medical treatment [2]. Due to the high incidence of tamponade in the follow-up, drainage is also indicated in patients with effusions > 20 mm, measured in diastole in echocardiography. Pericardial drainage may not be necessary when the effusion is small and resolving spontaneously or under anti-inflammatory treatment (Slides 2 to 4). In chronic effusions causing no hemodynamic compromise pericardiocentesis is indicated, if additional diagnostic procedures are available (e.g., pericardial fluid and tissue analyses, pericardioscopy, and epicardial/pericardial biopsy) to reveal the etiology of the disease and permit further causative therapy [2–7].

Contraindications to Drainage of Pericardial Effusion

Aortic dissection is a major contraindication to pericardiocentesis. Relative contraindications include uncorrected coagulopathy, anticoagulant therapy, thrombocytopenia < 50,000/mm^3, small, posterior, and loculated effusions. In acute traumatic hemopericardium and purulent pericarditis surgical drainage is more appropriate (Slide 4).

The Role of Echocardiography in the Decision-Making

Echocardiography promptly and reliably confirms the presence and hemodynamic impact of pericardial effusion. The separation of pericardial layers can be detected when the pericardial fluid exceeds 15–35 ml. The size of pericardial effusions can be graded as: (1) small (echo-free space in diastole < 10 mm), (2) moderate (at least > 10 mm posteriorly), (3) large (> 20 mm), or (4) very large (> 20 mm and compression of the heart). In hemodynamically significant effusion and cardiac tamponade echocardiography may reveal diastolic collapse of the anterior right ventricular (RV) free wall (Slide 5), right atrial (RA) collapse (Slide 6), left atrial (LA) and rarely left ventricular (LV) collapse, increased LV diastolic wall thickness, "pseudohypertrophy", "swinging heart" (Slide 6), and dilatation with a lack of physiological 50% collapse in inspirium of the inferior caval vein (VCI).

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Sensitivity and specificity of echocardiography findings in cardiac tamponade were investigated in 50 patients with large pericardial effusions that underwent cardiac catheterization during pericardiocentesis (Slide 7) [8]. Diagnosis of cardiac tamponade was established only if both clinical (jugular venous distension, tachycardia, hypotension, pulsus paradoxus) and hemodynamic signs were present (elevation and equilibration of intrapericardial and RA pressures), which was fulfilled in 8/50 patients (16%). The average volume of pericardial effusion evacuated by pericardiocentesis in patients with tamponade was larger but not significantly different in comparison to patients without tamponade (725 ± 344 vs. 649 ± 421 ml). Among the investigated RA collapse and sustained VCI congestion had 100% sensitivity, but low specificity. RV diastolic collapse and "swinging heart" had high sensitivity, but low specificity. By contrast, LA collapse was highly specific, but had low sensitivity, with a positive predictive value of 42.9%. Sudden leftward motion of the interventricular septum (IVS) was the only parameter with both high sensitivity and specificity (positive predictive value 80%) for the diagnosis of cardiac tamponade.

In cardiac tamponade, Doppler echocardiography demonstrates an increase of tricuspid flow and a decrease of mitral flow during inspiration (Slide 8). The reverse process occurs in expiration. Systolic and diastolic flows are reduced in systemic veins in expirium and reverse flow with atrial contraction is increased. Pronounced respiratory variations of color M-mode Doppler flow propagation velocity (Vp) are also evident in the setting of cardiac tamponade.

Surgical Drainage or Pericardiocentesis?

Pericardiocentesis is less invasive than surgical drainage and is the procedure of choice in the large majority of patients (Slide 9). However, if the heart cannot be reached by a needle or catheter, surgical drainage is required, usually through a subcostal incision. Furthermore, surgical drainage is desirable in patients with intrapericardial bleeding and in those with clotted hemopericardium or thoracic conditions that make pericardiocentesis difficult or ineffective. Open surgical drainage has the potential benefit of resecting a portion of the anterior central diaphragm and creating a chronically open channel between the pericardium and peritoneum. The open approach also allows the surgeon to break up loculations with a finger or a suction device and place a large drainage tube, which is especially important in purulent pericarditis (Slide 10). In the large study by McDonald et al. [9], long-term survival of patients undergoing surgical pericardial drainage was approximately equal to that in patients undergoing pericardiocentesis and catheter drainage (Slide 11). However, surgical patients had significantly less recurrences. Nevertheless, this study included only patients undergoing catheter pericardial drainage for a rather short time. If extended pericardial drainage is applied after pericardiocentesis (mean duration of drainage 2 ± 3 days [range 1–13 days]), then its efficacy is much higher [9]. Slide 12 is demonstrating the increase in utilization of pericardiocentesis with extended catheter drainage in contrast to the decrease of the need for surgical procedures over time at the Mayo Clinic [10].

Subxiphoid or Apical Approach?

Approach to pericardial effusion should be selected according to the distribution of pericardial effusion in echocardiography. If the effusion is equally large in the apical position and in front of the right ventricle from the subxiphoid view, both apical and subxiphoid approach can be attempted, according to the operator's preference (Slide 13). However, if the effusion is significantly asymmetrically distributed, it should be approached from the side where the accumulation of fluid is largest (Slide 14). Importantly, the patient's position should be the same while performing echocardiography and afterwards during pericardiocentesis.

In the emergency setting, if echocardiography is available, urgent pericardiocentesis can be safely and successfully performed using the intercostal approach. If the patient's clinical status is rapidly deteriorating, diagnosis of the cardiac tamponade is certain but no echocardiography or fluoroscopic guidance can immediately be provided, pericardiocentesis should be performed with no further delay using the subxiphoid approach. A pigtail catheter should be inserted for drainage of the effusion, but if such is not available in the emergency setting, a standard 7-F central venous catheter can be used instead.

Do We Need Any Imaging for Guidance of Pericardiocentesis?

Pericardiocentesis was performed for decades as a "blind" procedure with a high incidence of complication including mortality that was higher than for any other procedure in interventional cardiology. Introduction of

echocardiography as well as fluoroscopy guidance (Slide 15) significantly decreased complications, and except in very rare cases, practically eliminated mortality. Currently, echocardiography is wide available and except in very rare urgent cases with clear diagnosis pericardiocentesis should not be attempted before seeing the current echocardiography findings. This is essential regardless of the technique selected for further pericardial drainage.

Advantages and Disadvantages of Fluoroscopy Versus Echocardiography Guidance

Pericardiocentesis guided by fluoroscopy is performed in the cardiac catheterization laboratory with ECG and systemic blood pressure monitoring. The subxiphoid approach has been used most commonly, with a long needle with a mandrel (Tuohy or thin-walled 18-gauge) directed toward the left shoulder at a 30° angle to the skin (Slide 9). This route is extrapleural and avoids the coronary, pericardial, and internal mammary arteries. The operator intermittently attempts to aspirate fluid and injects small amounts of contrast. Lateral angiographic view provides the best visualization of the puncturing needle and its relation to the diaphragm and the pericardium (Slide 16).

In contrast to echocardiography guidance it is an advantage of fluoroscopy that the actual time point of entering the pericardial space with the needle can be visualized, and the position of the guide wire can be checked in several angiographic projections. If hemorrhagic fluid is freely aspirated, a few milliliters of the contrast medium may be injected under fluoroscopic observation. The appearance of sluggish layering of the contrast medium inferiorly indicates that the needle is correctly positioned. A soft J-tip guide wire is introduced and, after dilatation, exchanged for a multiholed pigtail catheter. If the guide wire was erroneously placed intracardially, this can be recognized before insertion of the dilator and drainage catheter. Additional advantage of fluoroscopy-guided pericardiocentesis is that cardiac catheterization laboratory is providing hemodynamic monitoring of the procedure (Slide 17) and exclusion of effusive-constrictive pericarditis (Slide 18) [11]. Furthermore, if pericardial biopsy is indicated, the procedure can be immediately continued after pericardiocentesis and effusion drainage (Slide 19) [3–7].

By contrast, echo-guided pericardiocentesis has an excellent profile in simplicity, safety, and efficacy. Importantly, the procedure is less expensive, less time-consuming, and the technology and trained personnel are more widely available (Slide 20).

References

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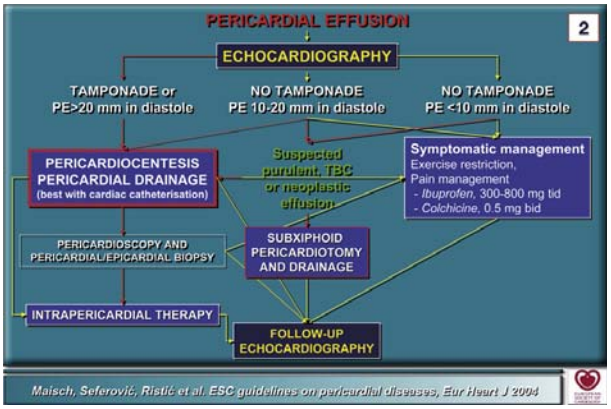
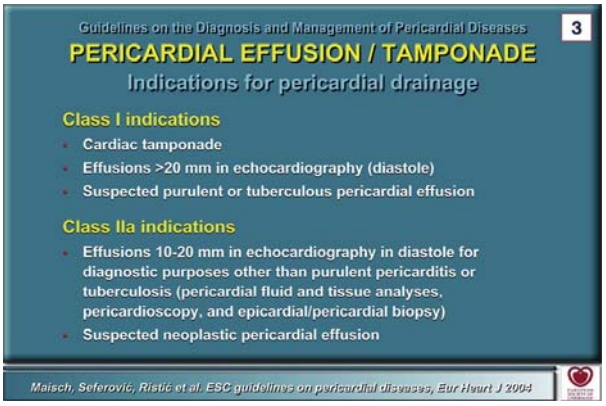
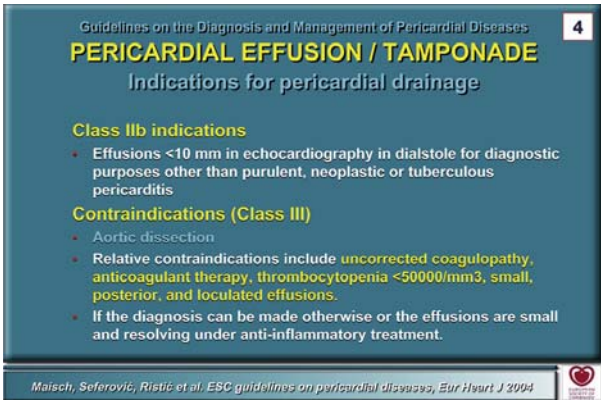
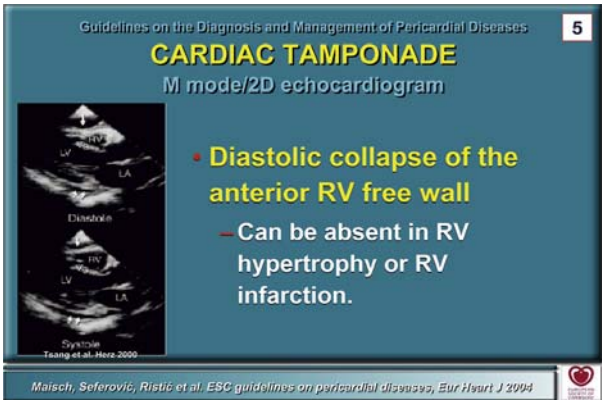
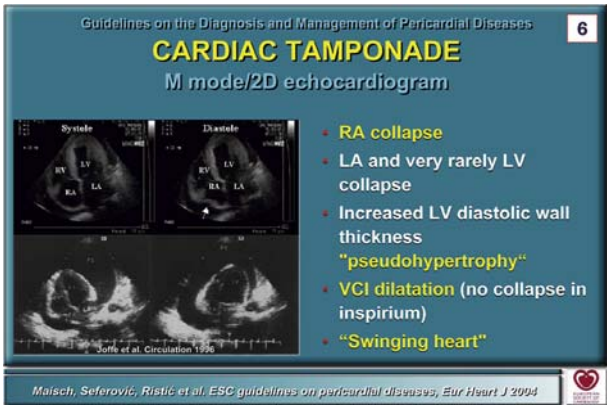
Echocardiography in the management of pericardial effusion
1
TREATMENT OPTIONS
WHO ?
WHEN ?
HOW ?
PERICARDIOCENTESIS
SURGICAL PERICARDIOTOMY
PERCUTANEOUS BALLOON PERICARDIOTOMY
PERICARDIECTOMY

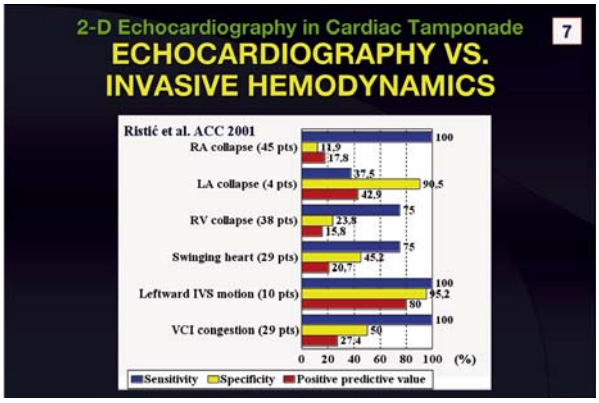

PERICARDIAL EFFUSION
2
ECHOCARDIOGRAPHY
TAMPONADE or PE>20 mm in diastole
NO TAMPONADE PE 10-20 mm in diastole
NO TAMPONADE PE <10 mm in diastole
PERICARDIOCENTESIS PERICARDIAL DRAINAGE (best with cardiac catheterisation)
Suspected purulent, TBC or neoplastic effusion
Symptomatic management
Exercise restriction,
Pain management
- Ibuprofen, 300-800 mg tid
- Colchicine, 0.5 mg bid
PERICARDIOSCOPY AND PERICARDIAL/EPICARDIAL BIOPSY
SUBXIPHOID PERICARDIOTOMY AND DRAINAGE
INTRAPERICARDIAL THERAPY
FOLLOW-UP ECHOCARDIOGRAPHY
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

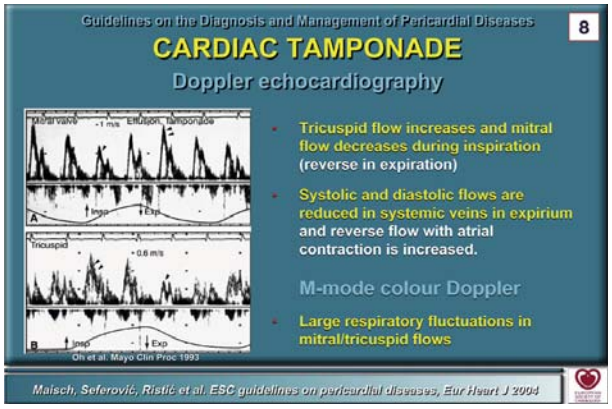

Guidelines on the Diagnosis and Management of Pericardial Diseases
3
PERICARDIAL EFFUSION / TAMPONADE
Indications for pericardial drainage
Class I indications
Cardiac tamponade
Effusions >20 mm in echocardiography (diastole)
Suspected purulent or tuberculous pericardial effusion
Class IIa indications
Effusions 10-20 mm in echocardiography in diastole for diagnostic purposes other than purulent pericarditis or tuberculosis (pericardial fluid and tissue analyses, pericardioscopy, and epicardial/pericardial biopsy)
Suspected neoplastic pericardial effusion
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

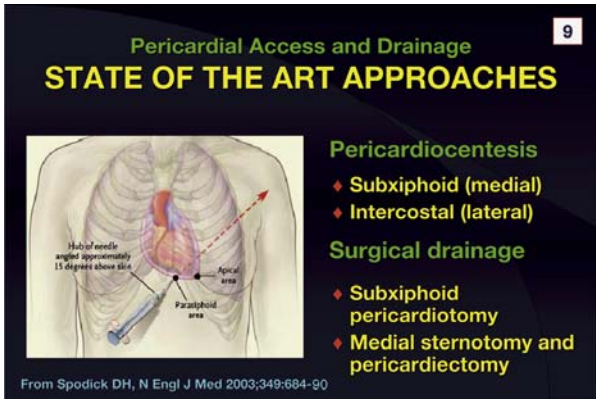

Guidelines on the Diagnosis and Management of Pericardial Diseases
4
PERICARDIAL EFFUSION / TAMPONADE
Indications for pericardial drainage
Class IIb indications
Effusions <10 mm in echocardiography in dialstole for diagnostic purposes other than purulent, neoplastic or tuberculous pericarditis
Contraindications (Class III)
Aortic dissection
Relative contraindications include uncorrected coagulopathy, anticoagulant therapy, thrombocytopenia <50000/mm3, small, posterior, and loculated effusions.
If the diagnosis can be made otherwise or the effusions are small and resolving under anti-inflammatory treatment.
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

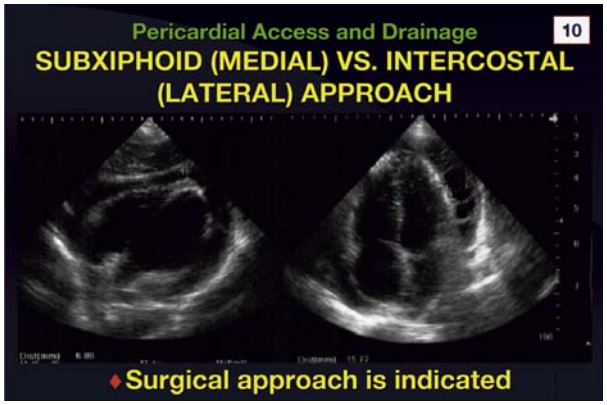

Guidelines on the Diagnosis and Management of Pericardial Diseases
5
CARDIAC TAMPONADE
M mode/2D echocardiogram
Diastole
Systole
Tsang et al. Herz 2000
Diastolic collapse of the anterior RV free wall
Can be absent in RV hypertrophy or RV infarction.
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

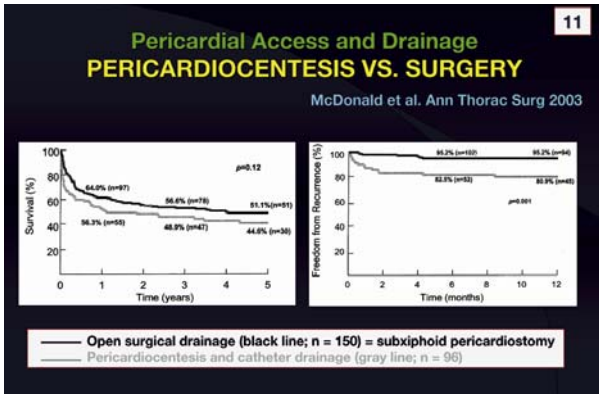

Guidelines on the Diagnosis and Management of Pericardial Diseases
6
CARDIAC TAMPONADE
M mode/2D echocardiogram
Systole
Diastole
Joffe et al. Circulation 1996
RA collapse
LA and very rarely LV collapse
Increased LV diastolic wall thickness "pseudohypertrophy"
VCI dilatation (no collapse in inspirium)
"Swinging heart"
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

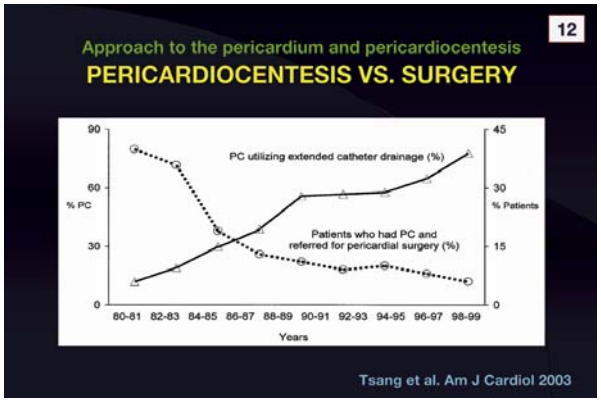

2-D Echocardiography in Cardiac Tamponade
7
ECHOCARDIOGRAPHY VS. INVASIVE HEMODYNAMICS
Ristić et al. ACC 2001
RA collapse (45 pts)
LA collapse (4 pts)
RV collapse (38 pts)
Swinging heart (29 pts)
Leftward IVS motion (10 pts)
VCI congestion (29 pts)
11.9
17.8
100
37.5
90.5
42.9
75
23.8
15.8
75
45.2
20.7
100
95.2
80
100
50
27.4
0 20 40 60 80 100 (%)
Sensitivity
Specificity
Positive predictive value

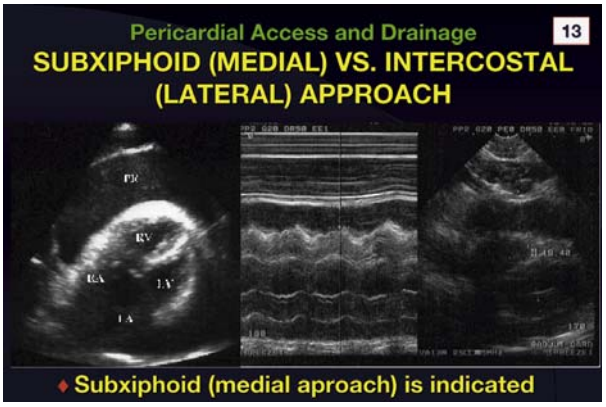

Guidelines on the Diagnosis and Management of Pericardial Diseases
8
CARDIAC TAMPONADE
Doppler echocardiography
Tricuspid flow increases and mitral flow decreases during inspiration (reverse in expiration)
Systolic and diastolic flows are reduced in systemic veins in expirium and reverse flow with atrial contraction is increased.
M-mode colour Doppler
Large respiratory fluctuations in mitral/tricuspid flows
Oh et al. Mayo Clin Proc 1993
Maisch, Seferović, Ristić et al. ESC guidelines on pericardial diseases, Eur Heart J 2004

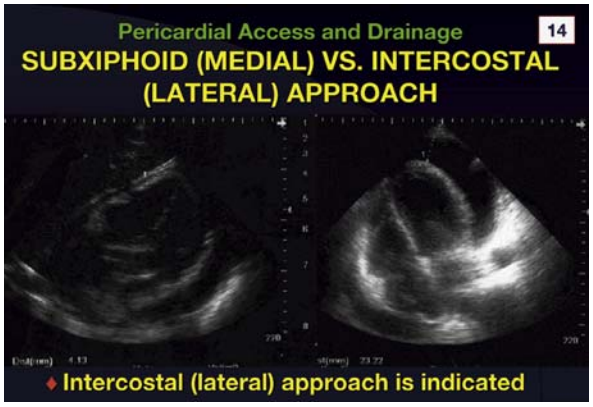

Pericardial Access and Drainage
9
STATE OF THE ART APPROACHES
Pericardiocentesis
Subxiphoid (medial)
Intercostal (lateral)
Surgical drainage
Subxiphoid pericardiotomy
Medial sternotomy and pericardiectomy
From Spodick DH, N Engl J Med 2003;349:684-90

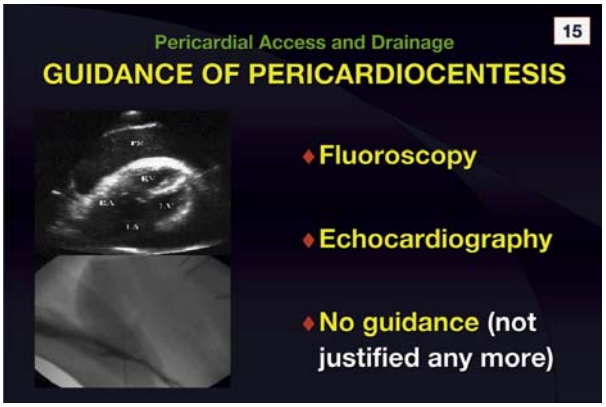

Pericardial Access and Drainage
10
SUBXIPHOID (MEDIAL) VS. INTERCOSTAL (LATERAL) APPROACH
Surgical approach is indicated

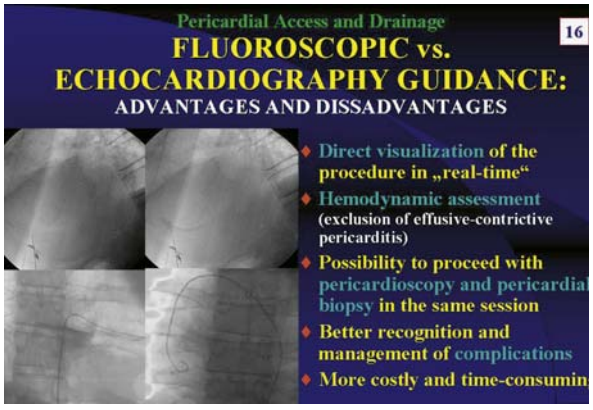

Pericardial Access and Drainage
11
PERICARDIOCENTESIS VS. SURGERY
McDonald et al. Ann Thorac Surg 2003
Survival (%)
Time (years)
Freedom from Recurrence (%)
Time (months)
Open surgical drainage (black line; n = 150) = subxiphoid pericardiostomy
Pericardiocentesis and catheter drainage (gray line; n = 96)

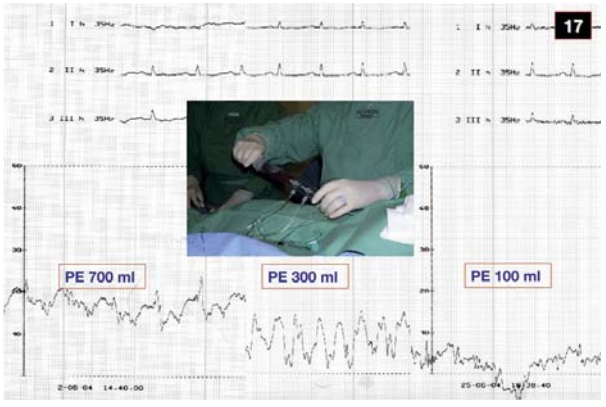

Approach to the pericardium and pericardiocentesis
12
PERICARDIOCENTESIS VS. SURGERY
PC utilizing extended catheter drainage (%)
Patients who had PC and referred for pericardial surgery (%)
% PC
% Patients
80-81 82-83 84-85 86-87 88-89 90-91 92-93 94-95 96-97 98-99
Years
Tsang et al. Am J Cardiol 2003

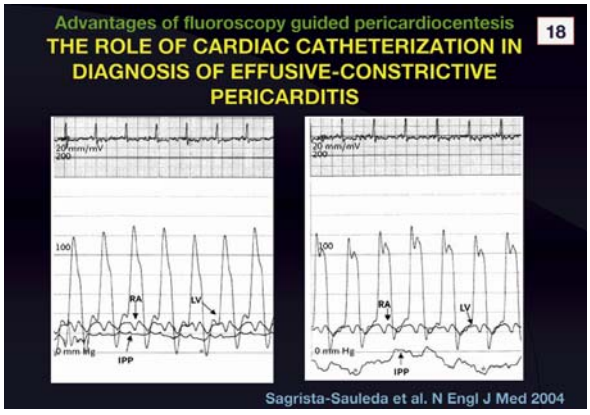

Pericardial Access and Drainage
13
SUBXIPHOID (MEDIAL) VS. INTERCOSTAL (LATERAL) APPROACH
RV
RA
LV
LA
Subxiphoid (medial aproach) is indicated

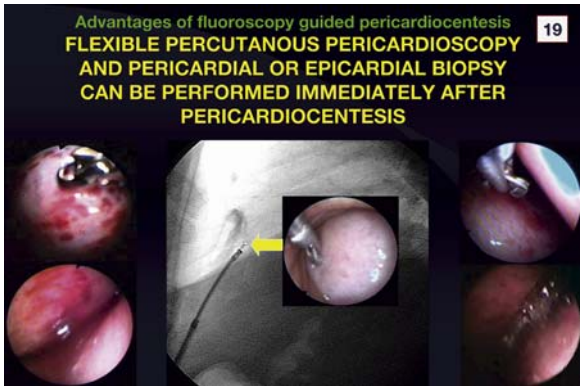

Pericardial Access and Drainage
14
SUBXIPHOID (MEDIAL) VS. INTERCOSTAL (LATERAL) APPROACH
Intercostal (lateral) approach is indicated

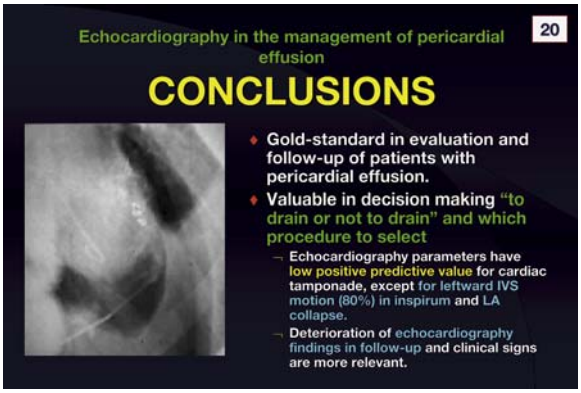

Pericardial Access and Drainage
15
GUIDANCE OF PERICARDIOCENTESIS
Fluoroscopy
Echocardiography
No guidance (not justified any more)


Pericardial Access and Drainage
16
FLUOROSCOPIC vs. ECHOCARDIOGRAPHY GUIDANCE:
ADVANTAGES AND DISSADVANTAGES
Direct visualization of the procedure in „real-time“
Hemodynamic assessment (exclusion of effusive-contrictive pericarditis)
Possibility to proceed with pericardioscopy and pericardial biopsy in the same session
Better recognition and management of complications
More costly and time-consumin


17
PE 700 ml
PE 300 ml
PE 100 ml


Advantages of fluoroscopy guided pericardiocentesis
18
THE ROLE OF CARDIAC CATHETERIZATION IN DIAGNOSIS OF EFFUSIVE-CONSTRICTIVE PERICARDITIS
RA
LV
IPP
Sagrista-Sauleda et al. N Engl J Med 2004


Advantages of fluoroscopy guided pericardiocentesis
19
FLEXIBLE PERCUTANOUS PERICARDIOSCOPY AND PERICARDIAL OR EPICARDIAL BIOPSY CAN BE PERFORMED IMMEDIATELY AFTER PERICARDIOCENTESIS


Echocardiography in the management of pericardial effusion
20
CONCLUSIONS
Gold-standard in evaluation and follow-up of patients with pericardial effusion.
Valuable in decision making "to drain or not to drain" and which procedure to select
Echocardiography parameters have low positive predictive value for cardiac tamponade, except for leftward IVS motion (80%) in inspirum and LA collapse.
Deterioration of echocardiography findings in follow-up and clinical signs are more relevant.