

ECOCARDIOGRAFIA 2015

XVII CONGRESSO NAZIONALE SIEC

Sonographer Day



“2 D PITFALLS : TANTI ESEMPI DI QUALI
ERRORI VANNO EVITATI NELLA
SCANSIONE”

Napoli, 18 Aprile
Hotel Royal Continental

Chiara
D'Agostino

PITFALLS IN ECOCARDIOGRAFIA

- L'ecocardiografia riveste un ruolo determinante nella diagnostica cardiovascolare non invasiva
- L'esame ecocardiografico è fortemente operatore-dipendente
- Necessità di stabilire un protocollo standard di quantizzazione e tecnica di misurazione

GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

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The rapid technological developments of the past decade and the changes in echocardiographic practice brought about by these developments have resulted in the need for updated recommendations to the previously published guidelines for cardiac chamber quantification, which was the goal of the joint writing group assembled by the American Society of Echocardiography and the European Association of Cardiovascular Imaging. This document provides updated normal values for all four cardiac chambers, including three-dimensional echocardiography and myocardial deformation, when possible, on the basis of considerably larger numbers of normal subjects, compiled from multiple databases. In addition, this document attempts to eliminate several minor discrepancies that existed between previously published guidelines. (*J Am Soc Echocardiogr* 2015;28:1-39.)

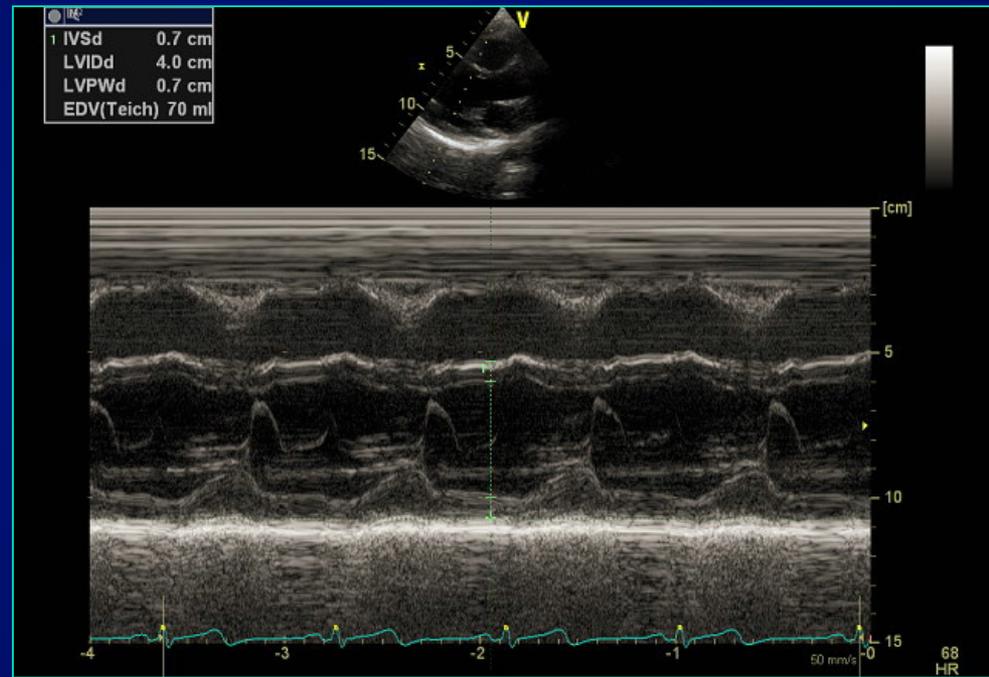
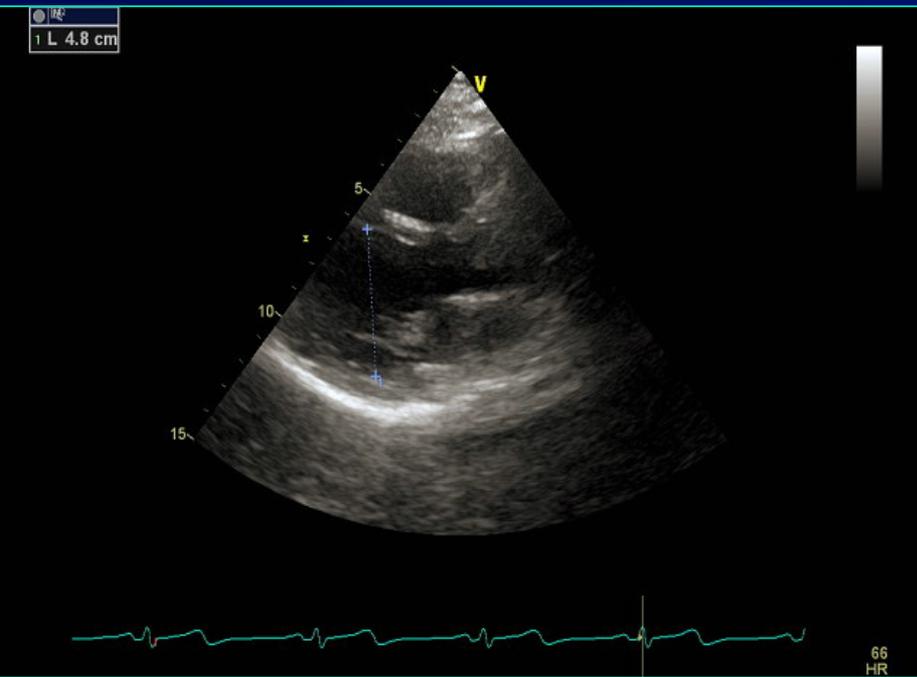
Keywords: Adult echocardiography, Transthoracic echocardiography, Ventricular function, Normal values

PITFALLS IN ECOCARDIOGRAFIA

- **I Pitfalls (dall'inglese “trabocchetti, trappole”) sono in ecocardiografia gli errori di misurazione**
- **Sono molto frequenti nell'esecuzione di un esame ecocardiografico**
- **In molti casi, purtroppo, rappresentano elementi decisivi nella valutazione diagnostica errata di diverse cardiopatie.**



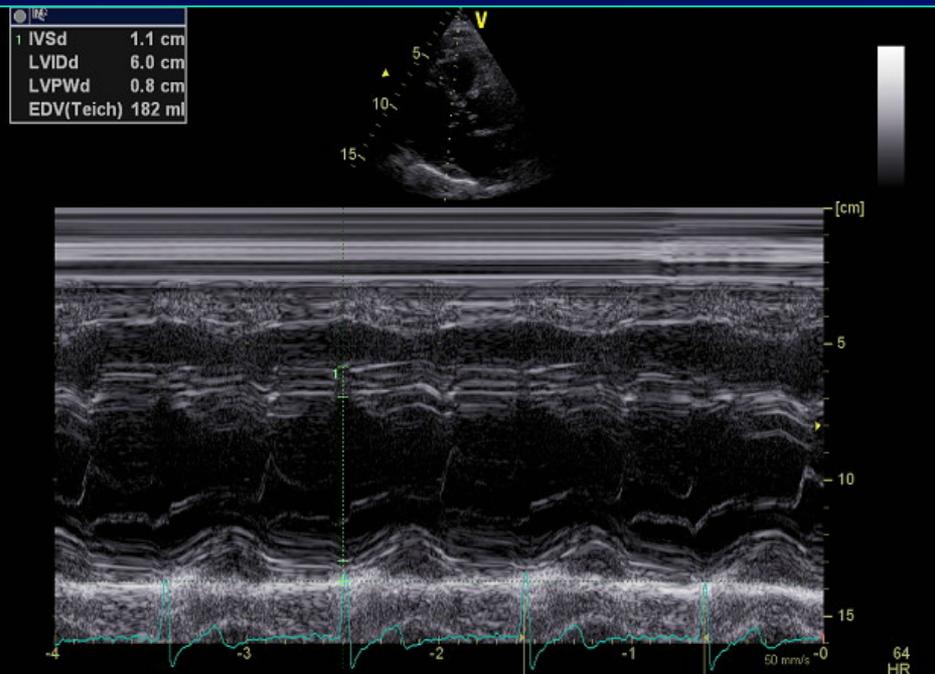
PITFALLS NELLA MISURAZIONE DELLE DIMENSIONI LINEARI DEL VS



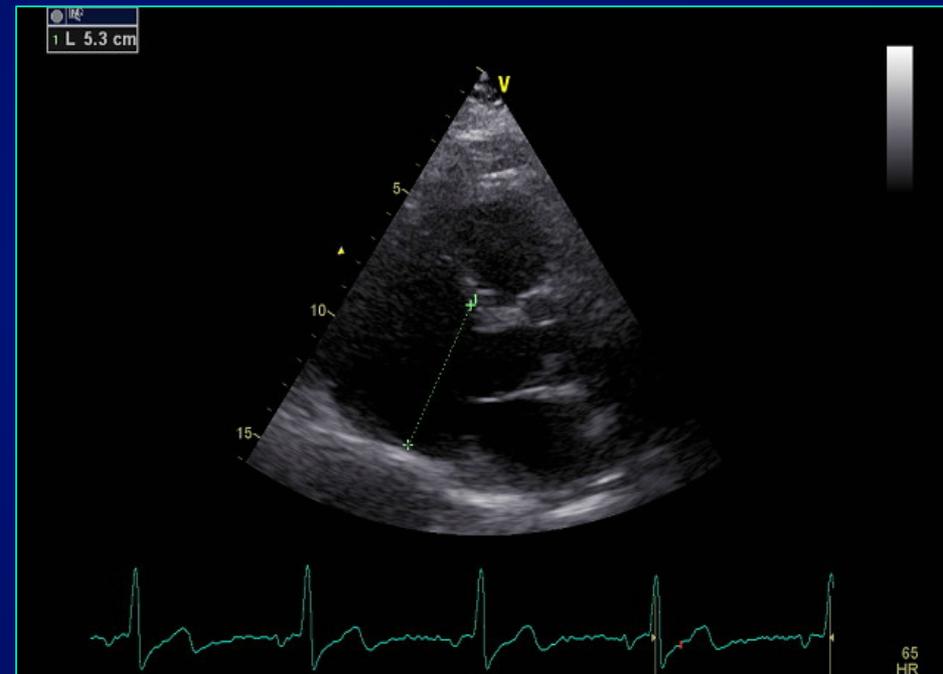
Allineamento scorretto al 2D

Allineamento corretto al
M-MODE

PITFALLS NELLA MISURAZIONE DELLE DIMENSIONI LINEARI DEL VS

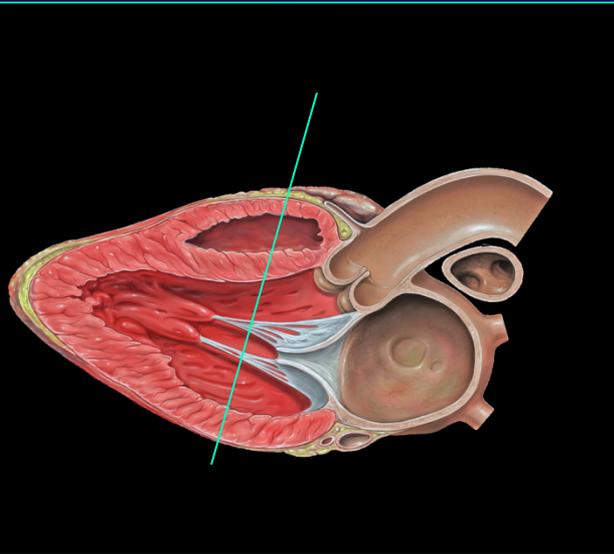


Allineamento scorretto al M-
MODE

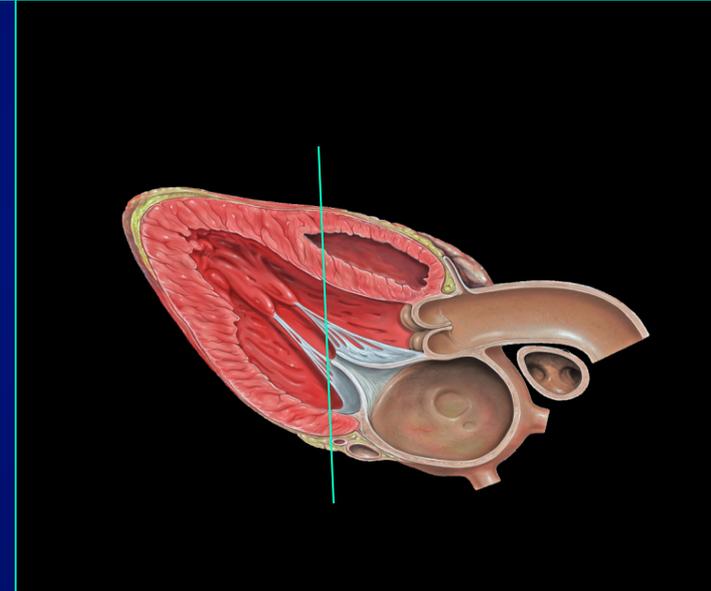


Allineamento corretto al 2D

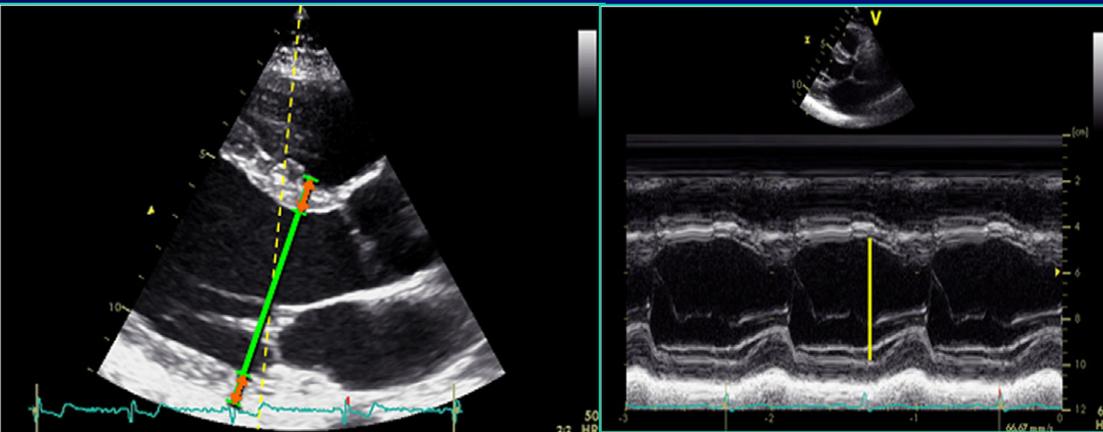
PITFALLS NELLA MISURAZIONE DELLE DIMENSIONI LINEARI DEL VS



- Allineamento parallelo al piano valvolare
- Attraversa gli apici dei lembi valvolari mitralici



- Allineamento obliquo rispetto al piano valvolare



PITFALLS NELLA MISURAZIONE DEL VOLUME DEL VS PER LA VALUTAZIONE DELLA EF

FE Frazione D'Eiezione

Percentuale di volume ematico, espulso dal ventricolo durante la sistole completa, rispetto al volume massimo diastolico.

$$FE = \frac{\text{Volume telediastolico} - \text{Volume telesistolico}}{\text{Volume telediastolico}} \times 100$$

Valori Normali > 55/60%

EF cutoff-values for therapeutic decision making in cardiology

- Surgery in mitral regurgitation → EF <60%
- Surgery in aortic regurgitation → EF <50%
- Medical Tx for heart failure → EF <40%
- Implantation of ICD → EF <35%
- Implantation of CRT → EF <35%

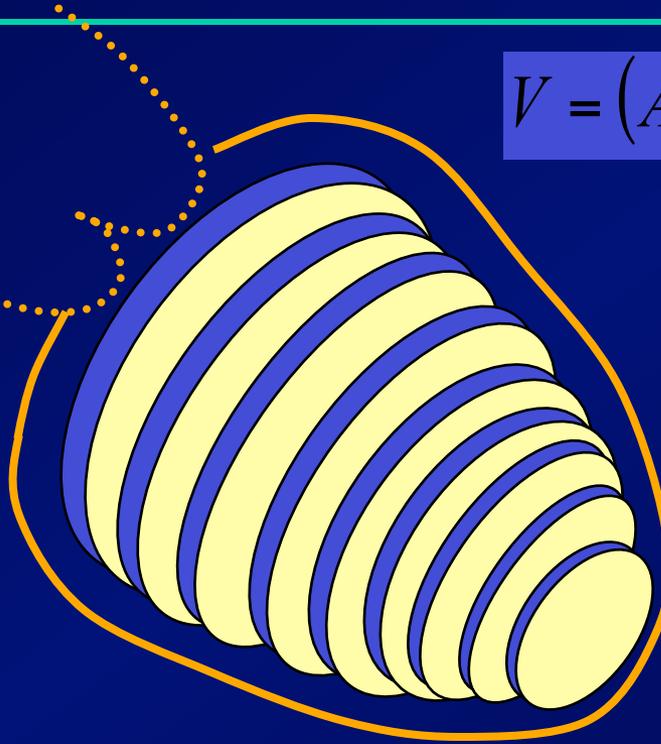
Prof. Dr. H. P. Kühl

PITFALLS NELLA MISURAZIONE DEL VOLUME DEL VS PER LA VALUTAZIONE DELLA EF

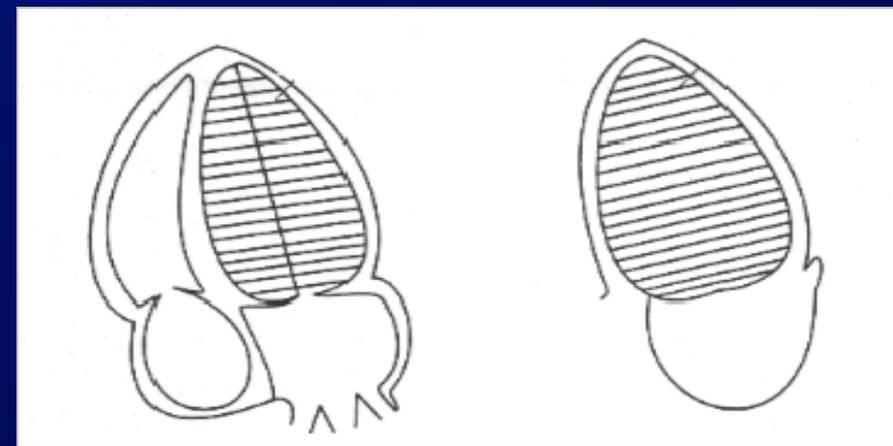
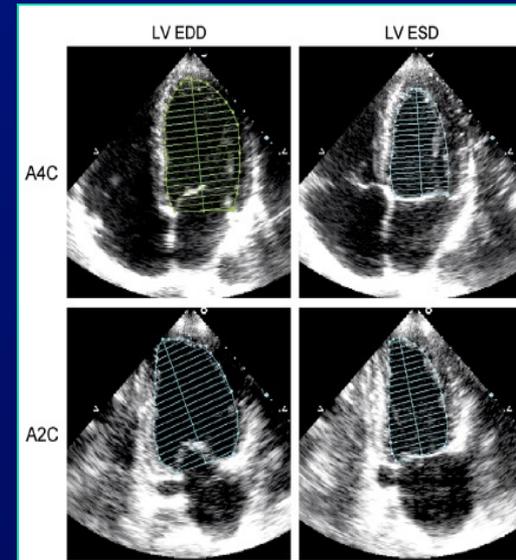
Simpson's Rule

- Il volume totale è calcolato come la sommatoria dei volumi di una serie di sezioni cilindriche sovrapposte di forma simile. Il calcolo si basa sulla sommatoria di venti sezioni.

- Questo metodo non richiede assunzioni teoriche sulla forma del ventricolo ed è utilizzabile anche in ventricoli con geometria deformata per la presenza di estese anomalie cinetiche o di aneurismi

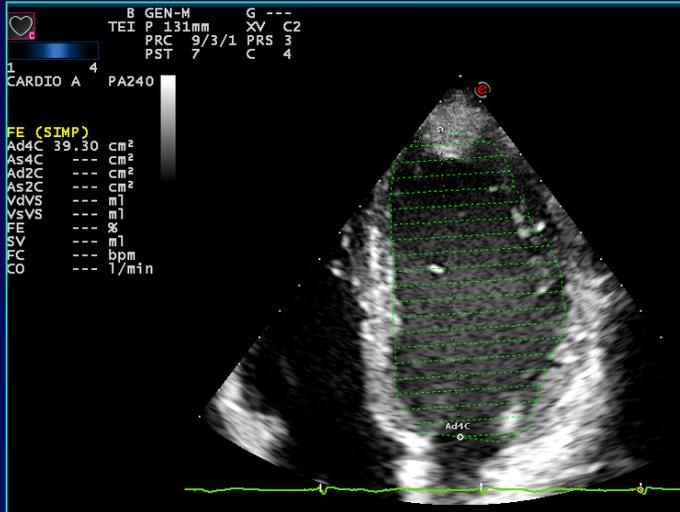


$$V = (A_1 + A_2 + A_3 \dots + A_n) \times H$$

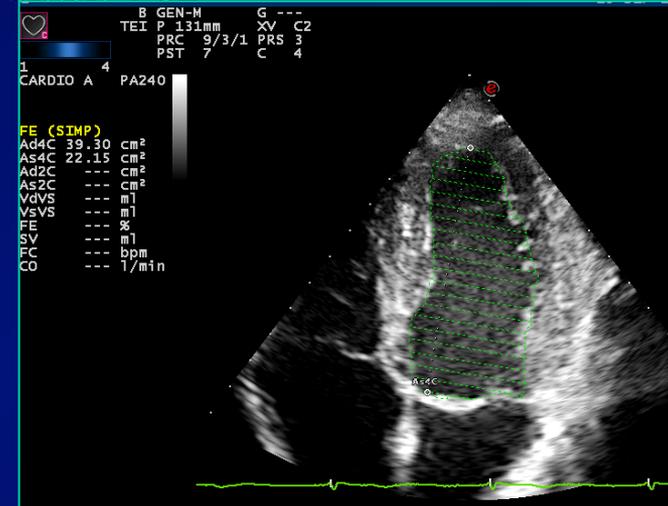


PITFALLS NELLA MISURAZIONE DEL VOLUME DEL VS PER LA VALUTAZIONE DELLA EF

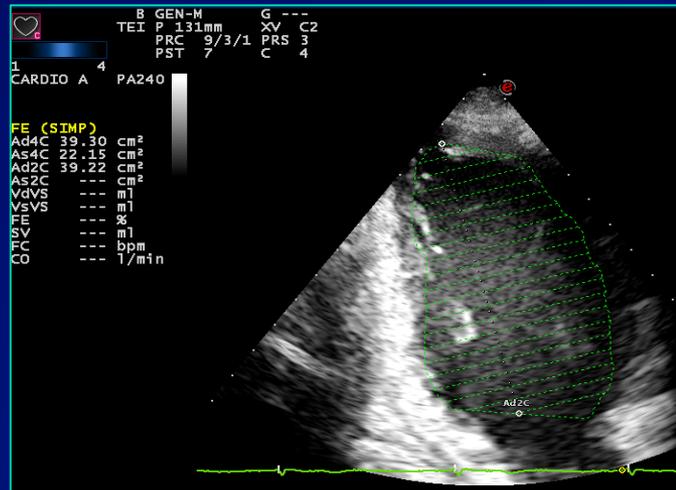
Diastole 4 Ch



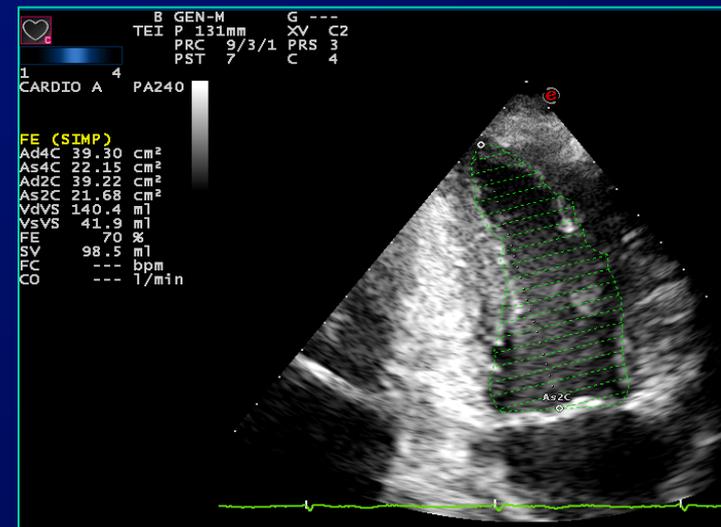
Sistole 4 Ch



Diastole 2 Ch

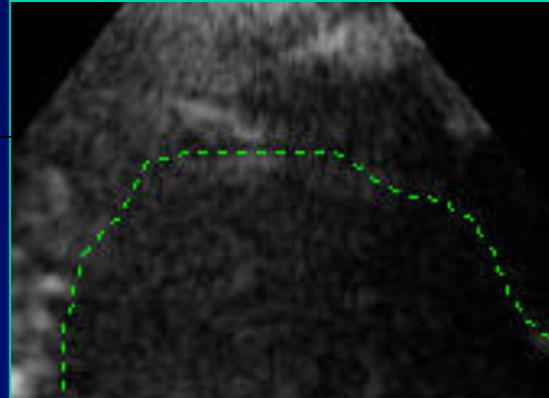
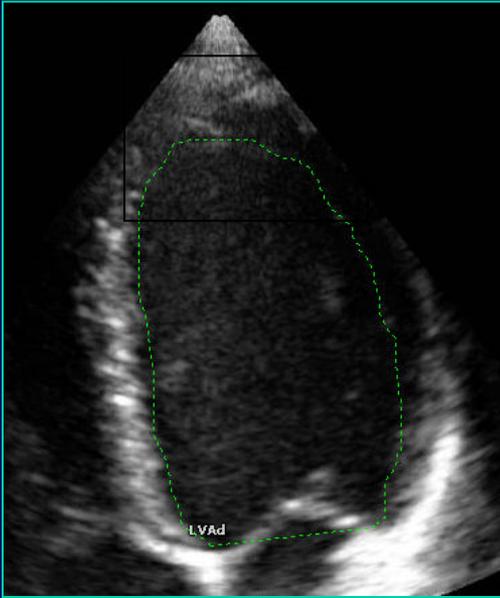


Sistole 2 Ch



PITFALLS NELLA MISURAZIONE DEL VOLUME DEL VS PER LA VALUTAZIONE DELLA EF

Un pixel può fare la differenza? 1 Pixel = 0.33 mm.



EDVol=126 or 132 ml ?

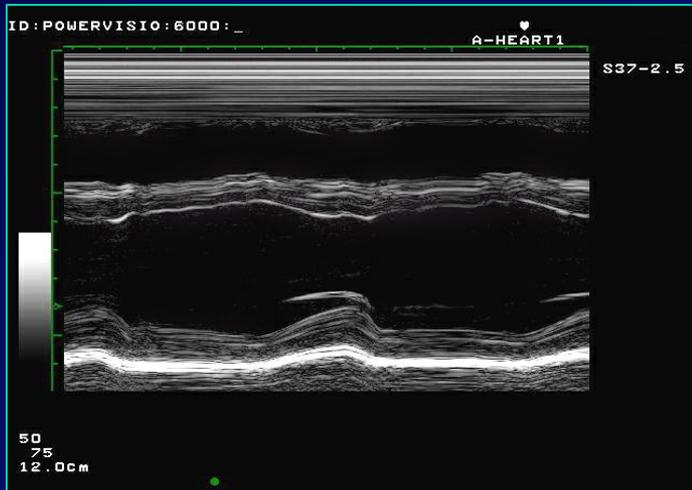
ESVol=61 or 58 ml ?

$$EF = \frac{126 - 61}{126} = 52\%$$

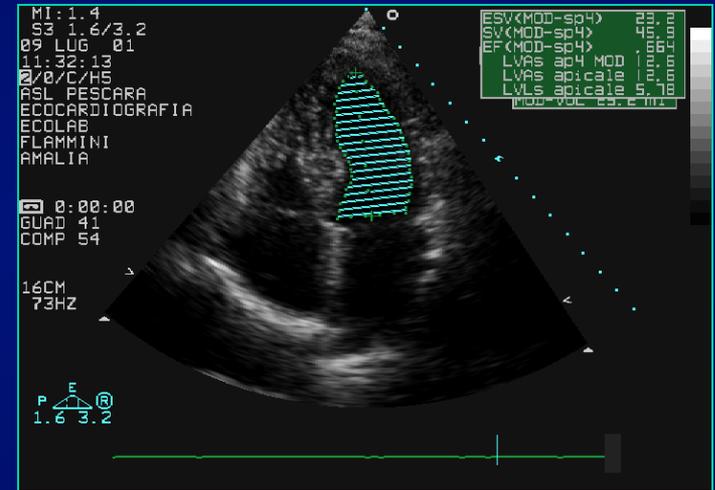
$$EF = \frac{132 - 58}{132} = 56\%$$

PITFALLS NELLA MISURAZIONE DEL VOLUME DEL VS PER LA VALUTAZIONE DELLA EF

Rilevanza clinica delle variazioni



Δ DTSVS >10%



Δ FEVS >0.10

VOLUMI VENTRICOLARI

VARIABILITA' INTRAOSSERVATORE
VARIABILITA' INTEROSSERVATORE

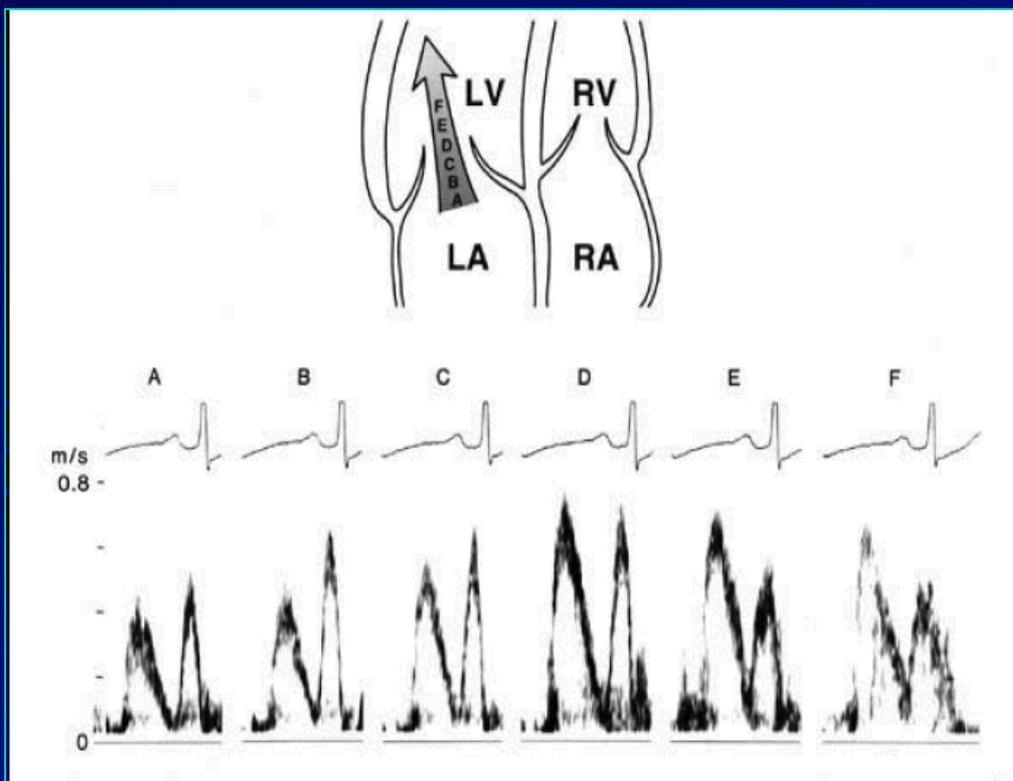
4 a 6 %

8.5% VTD 16,5% VTS

Una VARIAZIONE 15% per VTS
25% per VTD
10 PUNTI per FE

è necessaria per considerare la variazione di rilevanza clinica

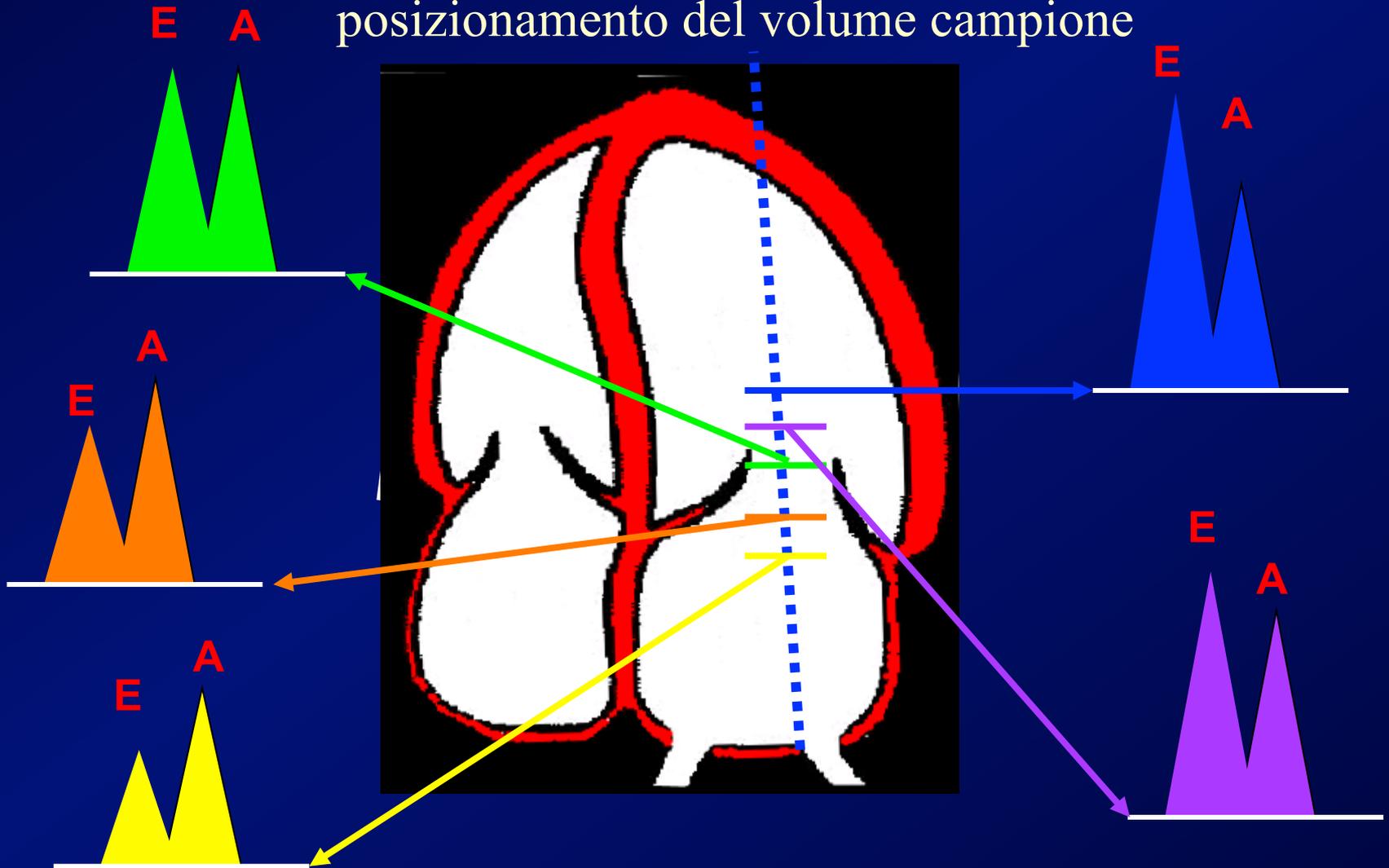
PITFALLS NELLA REGISTRAZIONE DEL FLUSSO TRANSMITRALICO PER LA VALUTAZIONE DELLA FUNZIONE DIASTOLICA



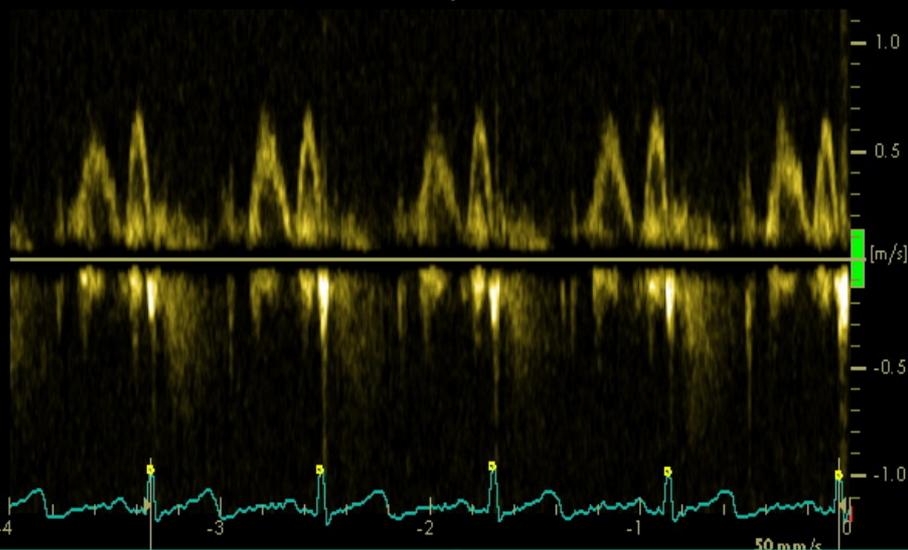
- A - volume campione sull'annulus della mitrale
- B;C - volume campione fra il corpo dei lembi valvolari
- D - volume campione fra i margini o apici dei lembi mitralici
- E;F - volume campione all'interno della cavità ventricolare al di sotto dei margini liberi della mitrale

PITFALLS NELLA REGISTRAZIONE DEL FLUSSO TRANSMITRALICO PER LA VALUTAZIONE DELLA FUNZIONE DIASTOLICA

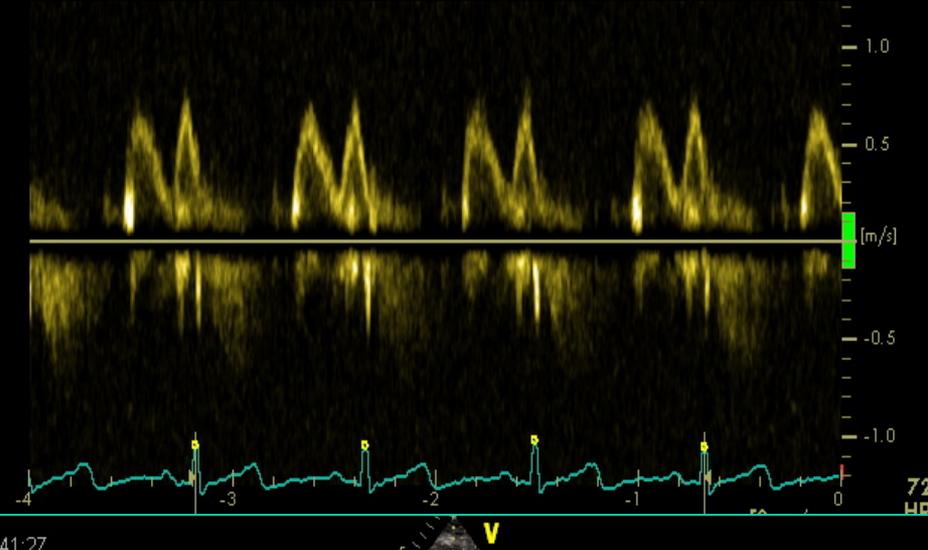
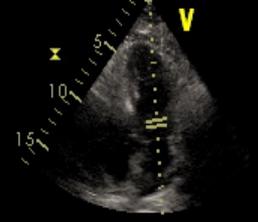
Flusso transmitralico: variazione a seconda del posizionamento del volume campione



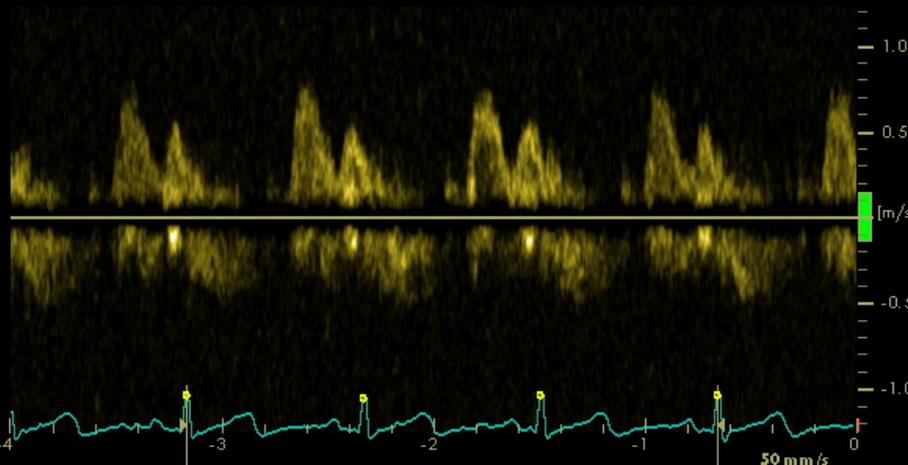
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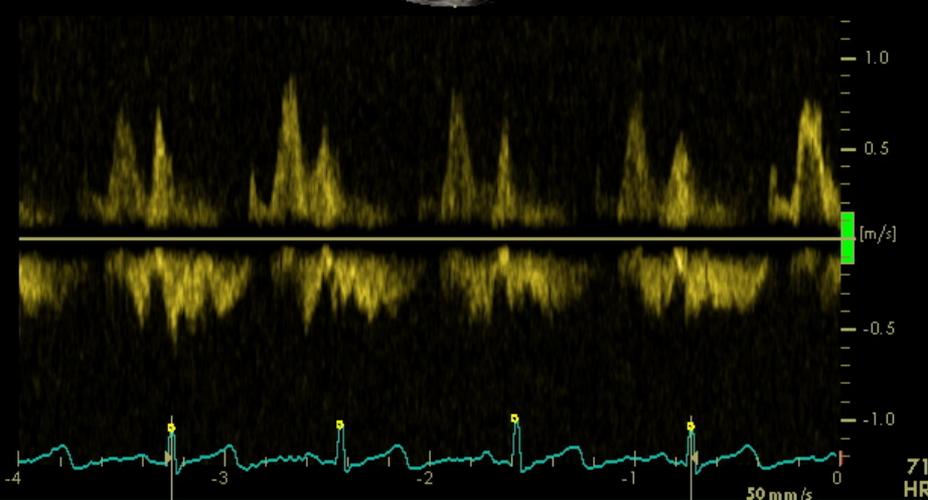
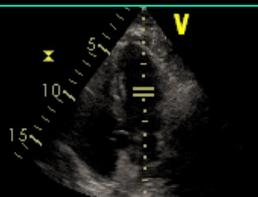
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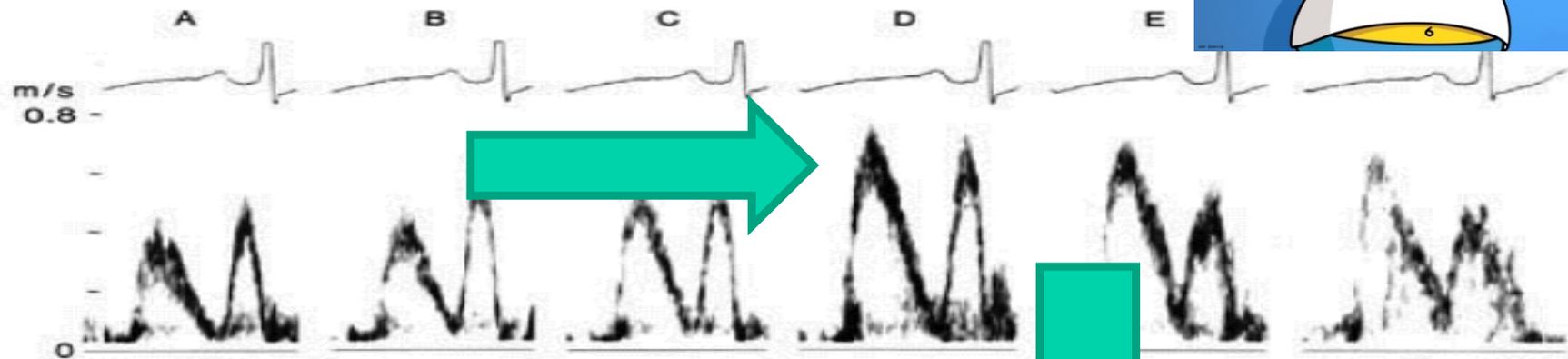
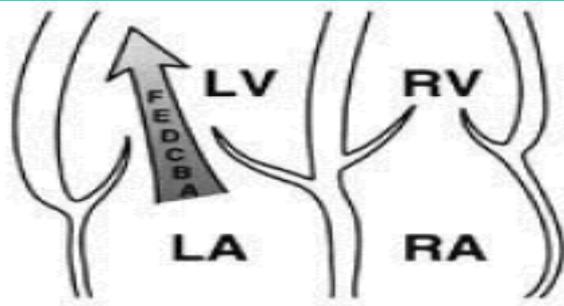


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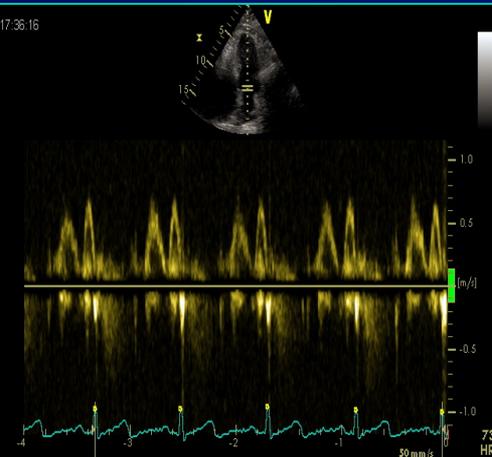


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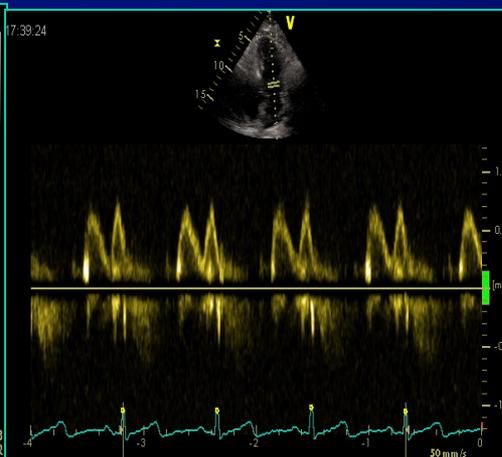




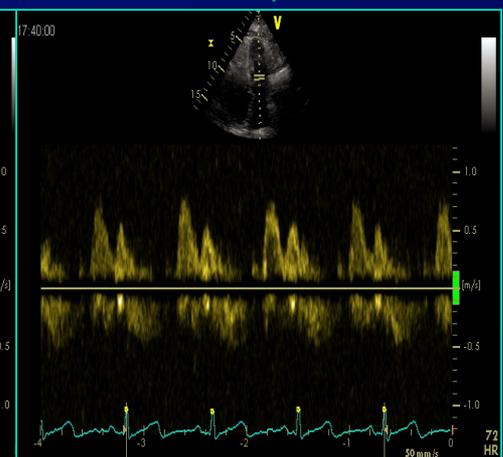
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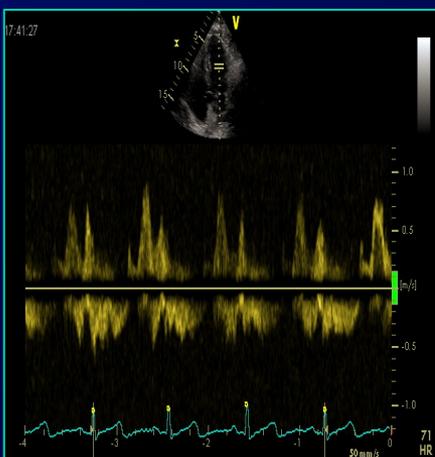
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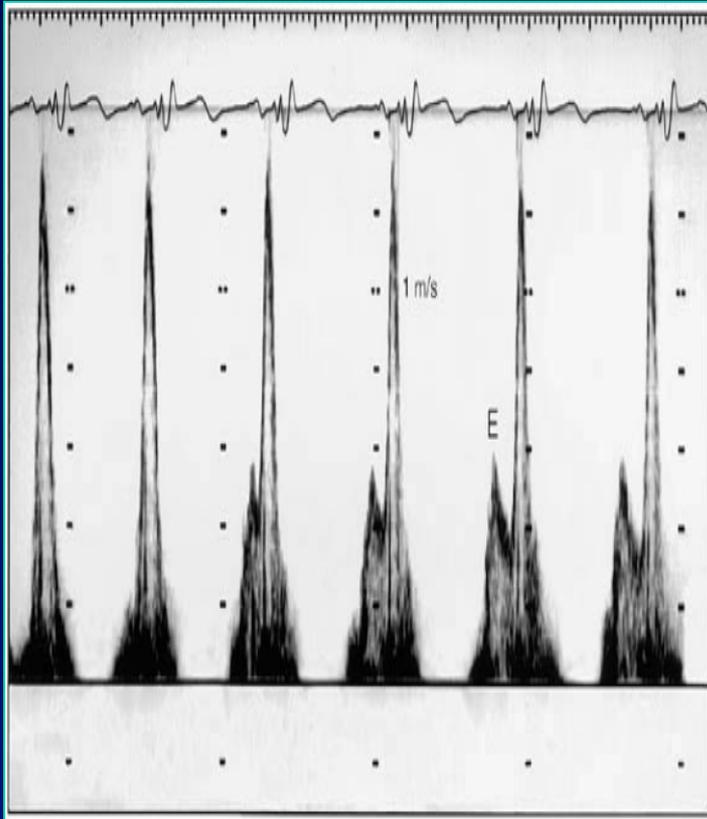
17:40:00



17:41:27



Altri fattori che possono influenzare la registrazione del pattern flussimetrico transmitralico



FREQUENZA

Table 1 Normal values for Doppler-derived diastolic measurements

Measurement	Age group (y)			
	16-20	21-40	41-60	>60
IVRT (ms)	50 ± 9 (32-68)	67 ± 8 (51-83)	74 ± 7 (60-88)	87 ± 7 (73-101)
E/A ratio	1.88 ± 0.45 (0.98-2.78)	1.53 ± 0.40 (0.73-2.33)	1.28 ± 0.25 (0.78-1.78)	0.96 ± 0.18 (0.6-1.32)
DT (ms)	142 ± 19 (104-180)	166 ± 14 (138-194)	181 ± 19 (143-219)	200 ± 29 (142-258)
A duration (ms)	113 ± 17 (79-147)	127 ± 13 (101-153)	133 ± 13 (107-159)	138 ± 19 (100-176)
PV S/D ratio	0.82 ± 0.18 (0.46-1.18)	0.98 ± 0.32 (0.34-1.62)	1.21 ± 0.2 (0.81-1.61)	1.39 ± 0.47 (0.45-2.33)
PV Ar (cm/s)	16 ± 10 (1-36)	21 ± 8 (5-37)	23 ± 3 (17-29)	25 ± 9 (11-39)
PV Ar duration (ms)	66 ± 39 (1-144)	96 ± 33 (30-162)	112 ± 15 (82-142)	113 ± 30 (53-173)
Septal e' (cm/s)	14.9 ± 2.4 (10.1-19.7)	15.5 ± 2.7 (10.1-20.9)	12.2 ± 2.3 (7.6-16.8)	10.4 ± 2.1 (6.2-14.6)
Septal e'/a' ratio	2.4*	1.6 ± 0.5 (0.6-2.6)	1.1 ± 0.3 (0.5-1.7)	0.85 ± 0.2 (0.45-1.25)
Lateral e' (cm/s)	20.6 ± 3.8 (13-28.2)	19.8 ± 2.9 (14-25.6)	16.1 ± 2.3 (11.5-20.7)	12.9 ± 3.5 (5.9-19.9)
Lateral e'/a' ratio	3.1*	1.9 ± 0.6 (0.7-3.1)	1.5 ± 0.5 (0.5-2.5)	0.9 ± 0.4 (0.1-1.7)

ETA'

PITFALLS NELLA MISURAZIONE DELL'AREA DELL'ATRIO SINISTRO

- Finestra acustica non adeguata (bordo endocardico non facilmente distinguibile)
- Bassa risoluzione parete laterale
- Inclusione nel calcolo dell'area dell'imbocco dell'auricola
- Inclusione nel calcolo dell'area dello sbocco delle vene polmonari

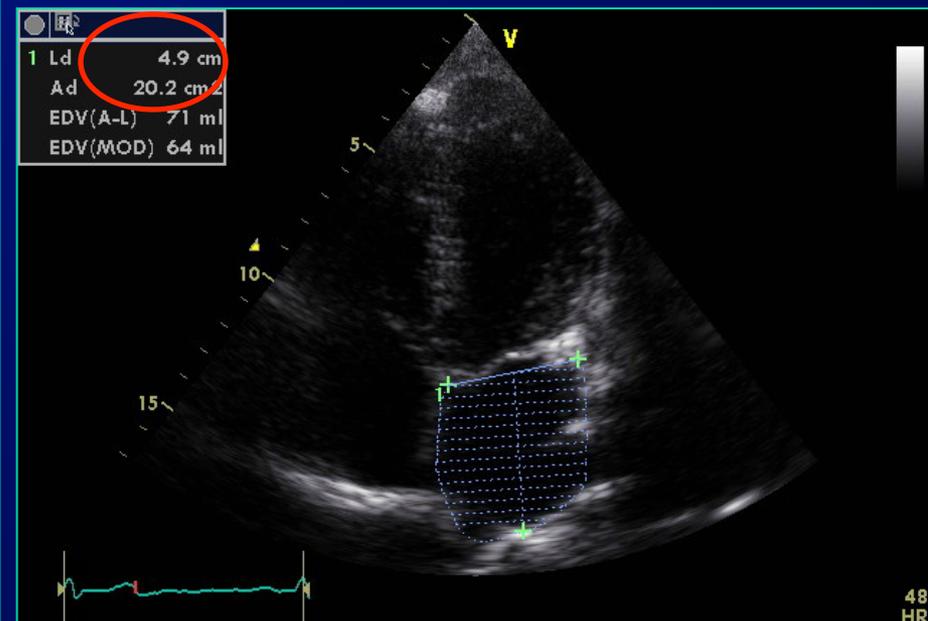
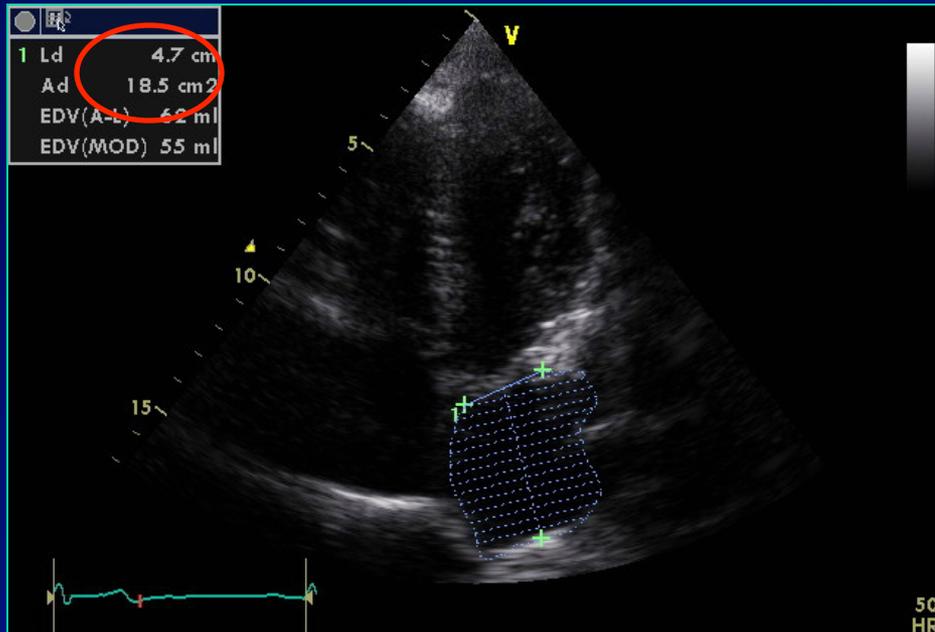
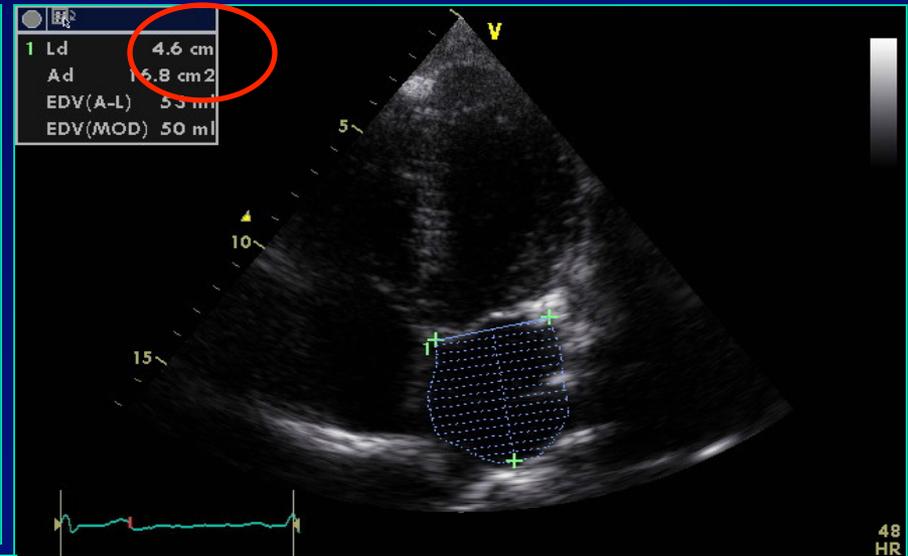
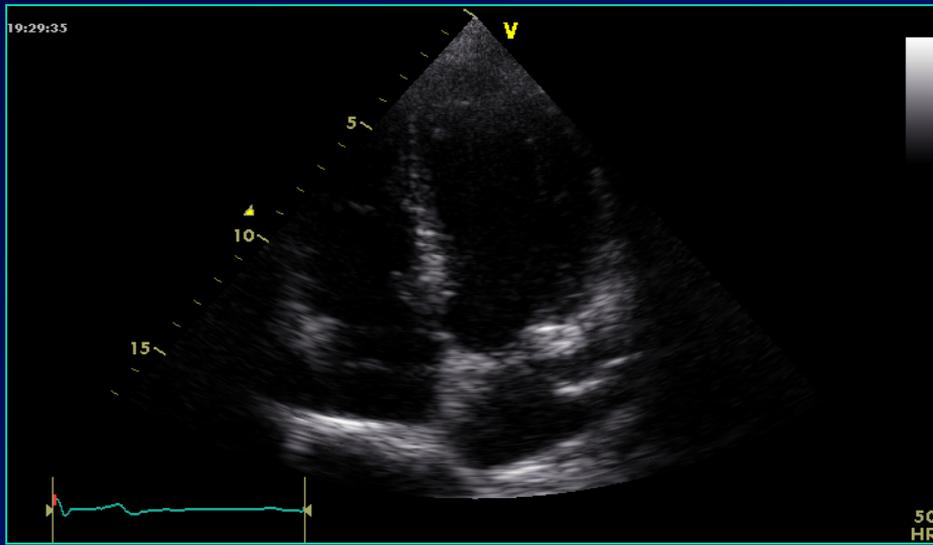
LA area (4ch-2D)



End-systole



PITFALLS NELLA MISURAZIONE DELL'AREA DELL'ATRIO SINISTRO



PITFALLS NELLA MISURAZIONE DELL'AREA DELL'ATRIO SINISTRO

Valori di riferimento per l'area dell'atrio sinistro

Recommendations for chamber quantification[☆]

Roberto M. Lang, Michelle Bierig, Richard B. Devereux, Frank A. Flachskampf*, Elyse Foster, Patricia A. Pellikka, Michael H. Picard, Mary J. Roman, James Seward, Jack Shanewise, Scott Solomon, Kirk T. Spencer, Martin St. John Sutton, William Stewart

Eur J Echocardiography (2006) 7, 79–108



EUROPEAN SOCIETY OF CARDIOLOGY®

Table 9 Reference limits and partition values for left atrial dimensions/volumes

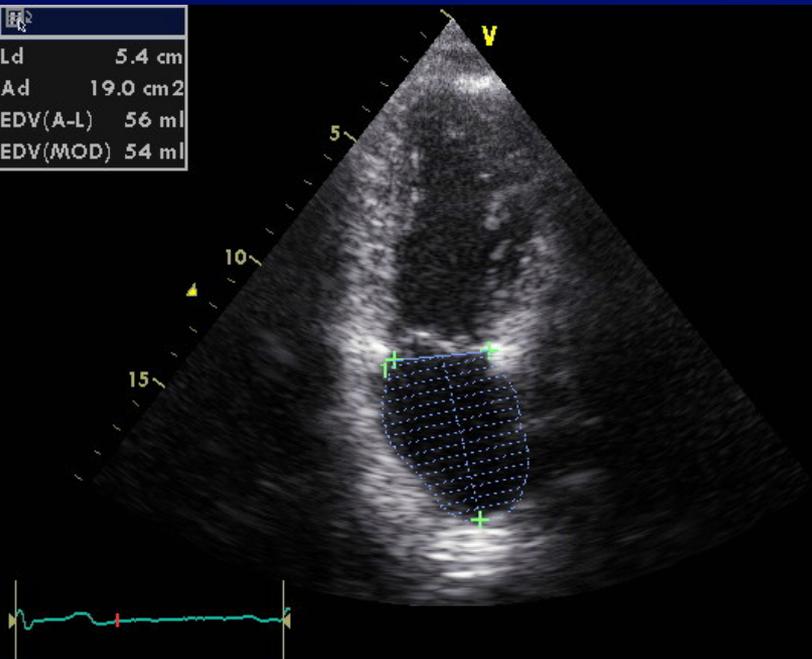
	Women			
	Reference Range	Mildly Abnormal	Moderately Abnormal	Severely Abnormal
Atrial area LA area (cm ²)	<20	20–30	30–40	>40
	Men			
	Reference Range	Mildly Abnormal	Moderately Abnormal	Severely Abnormal
Atrial area LA area (cm ²)	≤20	20–30	30–40	>40

PITFALLS NELLA MISURAZIONE DEL VOLUME DELL'ATRIO SINISTRO (METODO DEI DISCHI BIPLANO)

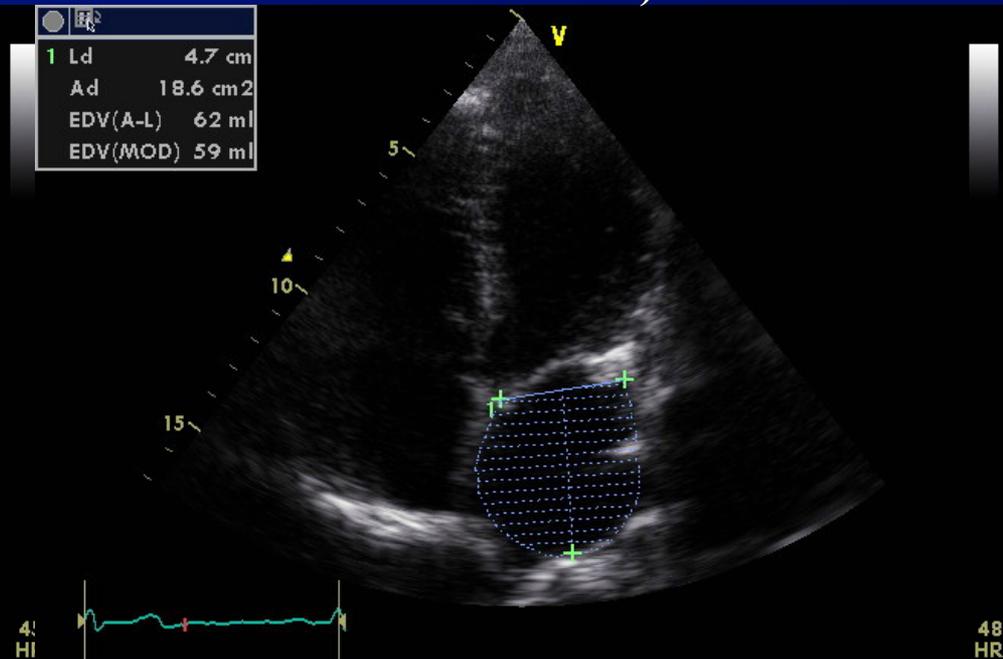
$$\pi / 4(h) \Sigma (D1)(D2)$$

1. Si basa sull'assunzione che il modello geometrico del VS sia ugualmente valido
2. L'algoritmo di Simpson divide l'AS in una serie di dischi ovali sovrapposti
3. Il volume è dato dalla somma del volume di ogni disco (massimo volume atriale sn)

1 Ld	5.4 cm
Ad	19.0 cm ²
EDV(A-L)	56 ml
EDV(MOD)	54 ml



1 Ld	4.7 cm
Ad	18.6 cm ²
EDV(A-L)	62 ml
EDV(MOD)	59 ml



Normali valori dell'atrio sinistro

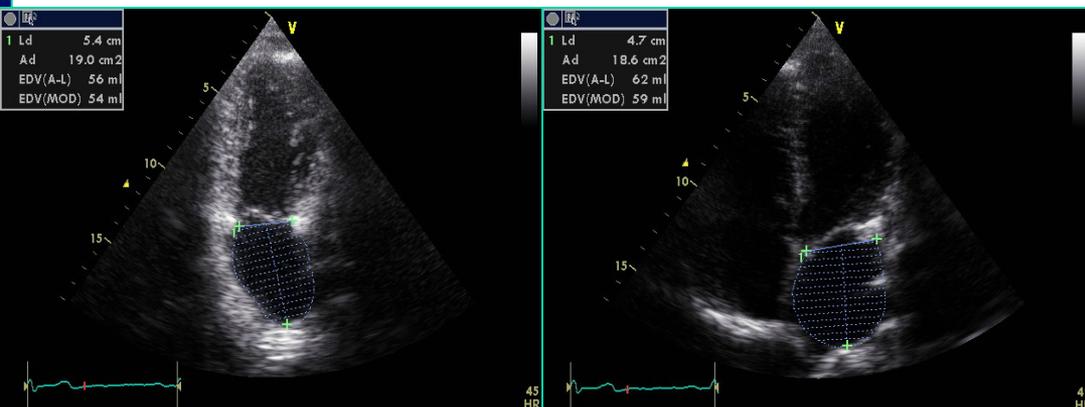
Supplemental Table 9 Normal values of LA size

	Women	Men
AP dimension (cm)	2.7–3.8	3.0–4.0
AP dimension index (cm/m ²)	1.5–2.3	1.5–2.3
A4C area index (cm ² /m ²)	9.3 ± 1.7	8.9 ± 1.5
A2C area index (cm ² /m ²)	9.6 ± 1.4	9.3 ± 1.6
A4C volume index MOD (mL/m ²)	25.1 ± 7.2	24.5 ± 6.4
A4C volume index AL (mL/m ²)	27.3 ± 7.9	27.0 ± 7.0
A2C volume index MOD (mL/m ²)	26.1 ± 6.7	27.1 ± 7.9
A2C volume index AL (mL/m ²)	28.0 ± 7.3	28.9 ± 8.5

PITFALLS NELLA MISURAZIONE DEL VOLUME DELL' ATRIO SINISTRO (REGOLA DEL SIMPSON BIPLANO)

Table 1. Critical Elements and Common Pitfalls for Accurate Measurement and Interpretation of Maximum LA Volume*

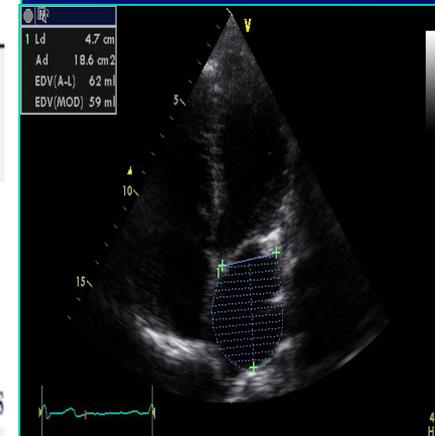
Step	Common Limitations/Errors	Suggestions
A. Optimize LA image quality	Atria are located in the far field of the apical views. Reduction of <u>lateral resolution</u> may result in apparently thicker LA walls.	Not improved by modifying the gain settings: Increase in gain will further reduce LA lumen size Decrease in gain may lead to image "drop out" and difficulties in planimetry of LA area Use high resolution sample box to increase pixel density and facilitate accurate tracing of the endocardial border Capture at least five beats for each cine loop to maximize likelihood of obtaining adequate image quality
B. Obtain maximal LA size	LA is foreshortened	Modify transducer angulation or location (place the transducer <u>one intercostal space lower</u>) until LA image is optimized and not foreshortened If discrepancy in the two lengths measured from the orthogonal planes is <u>>5 mm</u> , acquisition should be repeated until the discrepancy is reduced



PITFALLS NELLA MISURAZIONE DEL VOLUME DELL' ATRIO SINISTRO (REGOLA DEL SIMPSON BIPLANO)

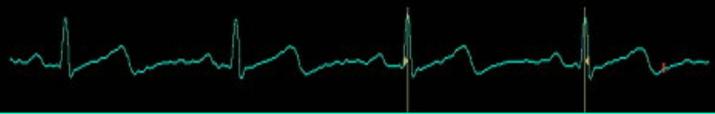
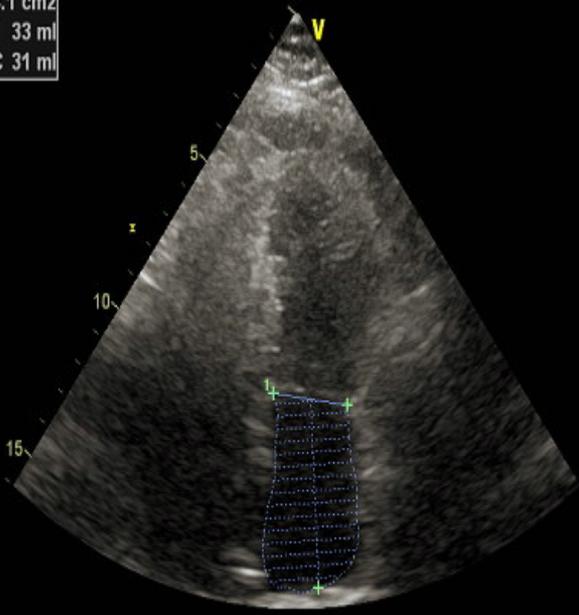
Table 1. Critical Elements and Common Pitfalls for Accurate Measurement and Interpretation of Maximum LA Volume*

Step	Common Limitations/Errors	Suggestions
C. Timing of maximum LA size	Correct frame for measurement is not selected	Choose frame just before mitral valve opening
D. LA area planimetry	<u>LA border is inconsistently defined</u>	Consistently adhere to convention: Inferior LA border— <u>plane of mitral annulus (not the tip of leaflets)</u> <u>Exclude atrial appendage and confluences of pulmonary veins</u>
E. Long-axis LA length	LA long axis is inconsistently delineated	Consistently adhere to convention: Inferior margin—midpoint of mitral annulus plane Superior (posterior) margin—midpoint of posterior LA wall
F. Interpretation	Qualitative categorization of LA size	LA volume <u>indexed to body surface area</u> is optimally interpreted as a continuous variable (using a reference point of $22 \pm 5 \text{ ml/m}^2$ as "normal")



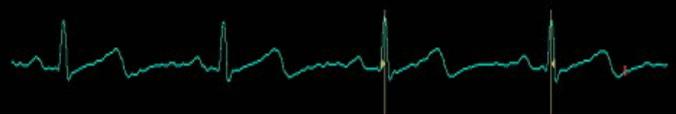
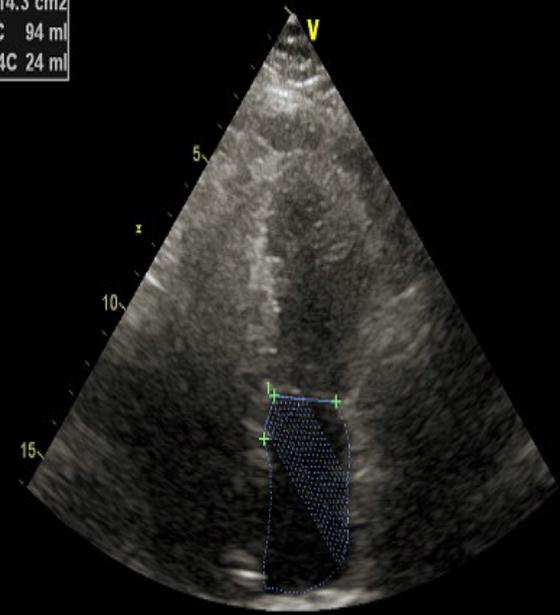
Errore nel posizionamento del diametro supero-inferiore dell'atrio sinistro

● 102
i LALd A4C 5.1 cm
LAAAd A4C 14.1 cm²
LAEDV A-L A4C 33 ml
LAEDV MOD A4C 31 ml



68
HR

● 102
i LALd A4C 1.8 cm
LAAAd A4C 14.3 cm²
LAEDV A-L A4C 94 ml
LAEDV MOD A4C 24 ml

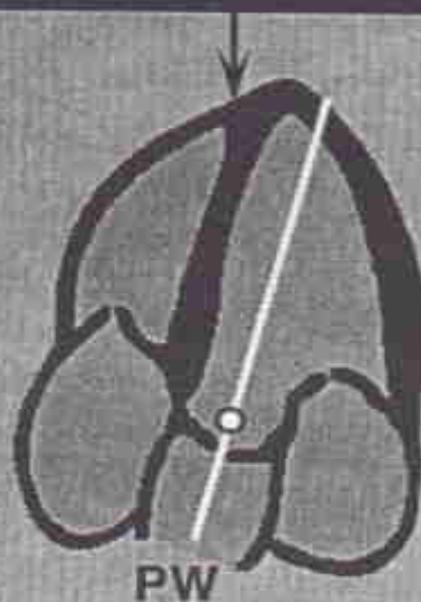
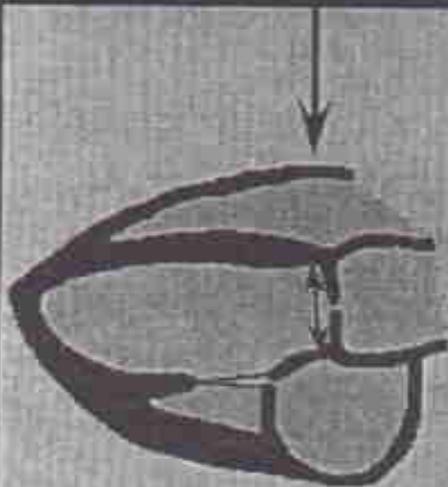


68
HR

PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

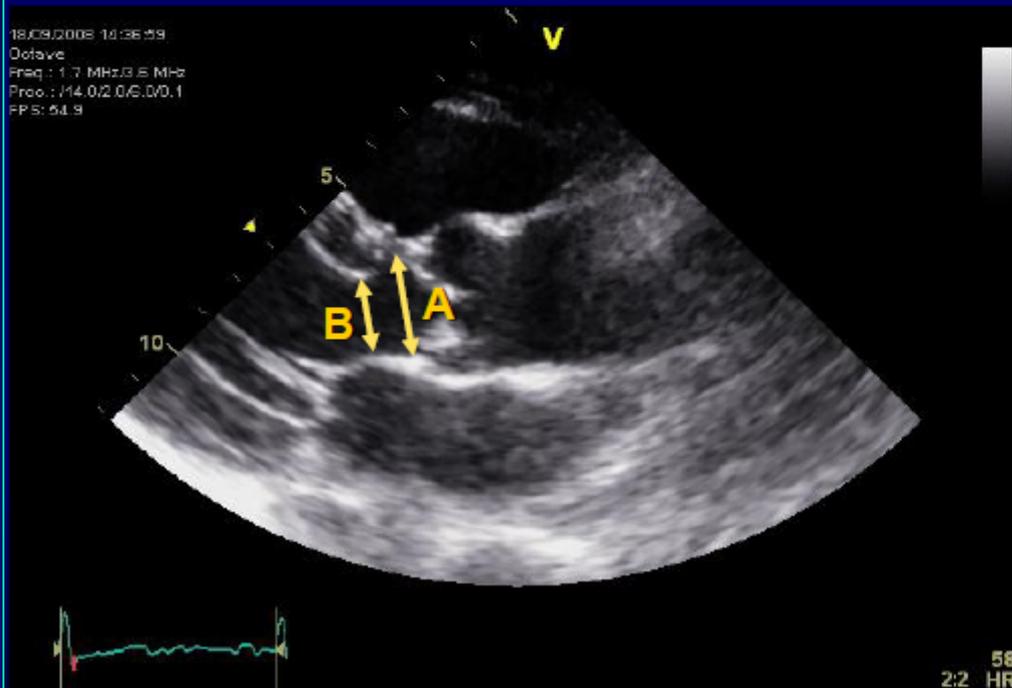
Aortic Valve Area Continuity Equation

$$(0.785 \times \text{LVOT Diameter}^2 \times \text{LVOT VTI}) \div \text{AV VTI}$$



PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

Estimation of aortic valve area source of errors: CSA



CSA: geometrical assumptions

A: LVOT 23 mm ϕ AVA: 1.2 cm²

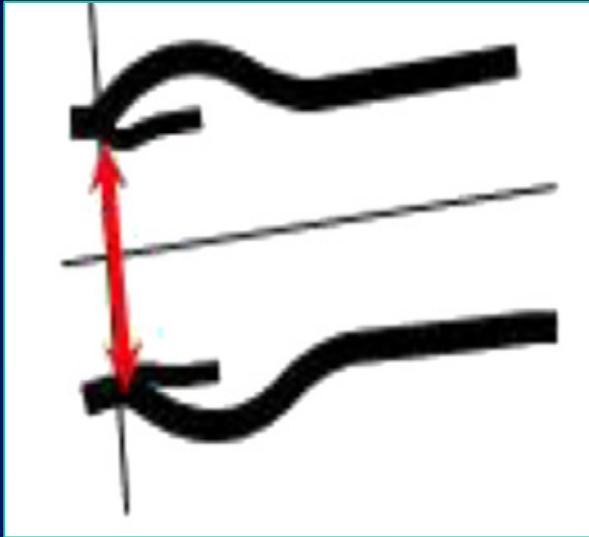
B: LVOT 18 mm ϕ AVA: 0.96 cm²

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Normali Cut-Off

	Mean gradient	Valve area	AVA/BSA
Mild AS	<25 mmHg	>1.5 cm ²	>0.9 cm ² /m ²
Moderate AS	25–39 mmHg	1.0–1.5 cm ²	0.6–0.9 cm ² /m ²
Severe AS	≥40 mmHg	<1.0 cm ²	<0.6 cm ² /m ²

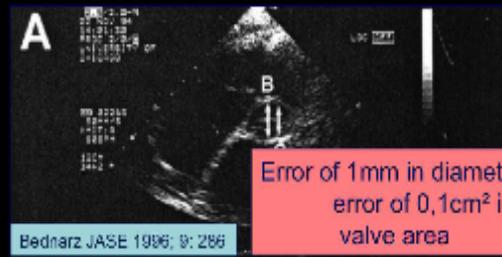
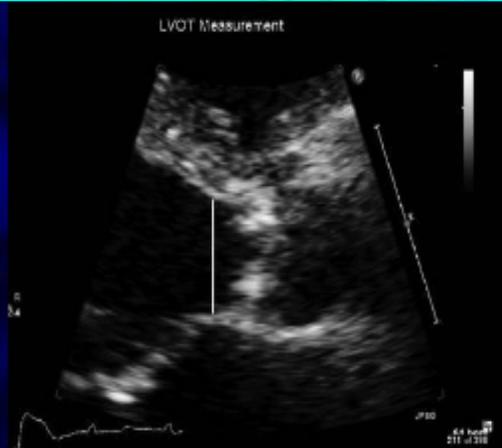
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Data element	Recording	Measurement
LVOT diameter	<ul style="list-style-type: none">• 2D parasternal long-axis view• Zoom mode• Adjust gain to optimize the blood tissue interface	<ul style="list-style-type: none">• Inner edge to inner edge• Mid-systole• Parallel and adjacent to the aortic valve or at the site of velocity measurement (see text)• Diameter is used to calculate a circular CSA

PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

..come evitare gli errori !!!



Bednarz JASE 1986; 9: 286

- Off-axis measurement underestimation of LVOT diameter
- Careful angulation of the transducer to find maximal LVOT diameter
- Error in diameter is squared for calculation of cross-sectional area



- Underestimation of diameter-derived LVOT area assuming a circular shape vs direct planimetry by RT3D echo or CT
 - Mean difference : 0.55 – 0.7 cm²
 - Consequence : underestimation of AVA
- (1) Doddamani Echocardiography 2007; 24: 880
(2) Doddamani Int J Cardiovasc Imaging 2009; 25: 175
(3) Halpern AJR 2009; 192: 1686

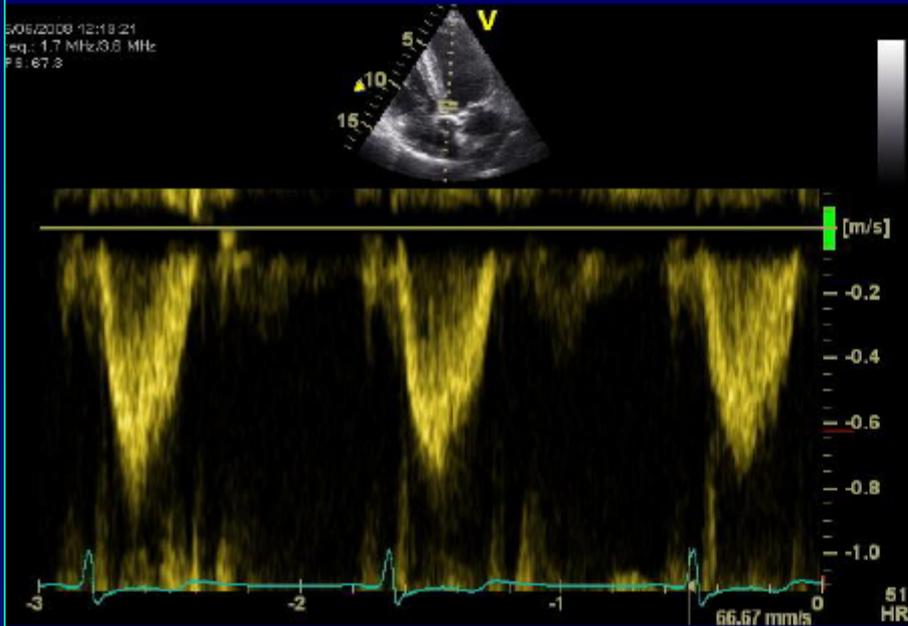
- PS long axis view
- Zoom mode
- Measurement between insertion of leaflets
- From inner edge to inner edge
- Perpendicular to aortic wall
- During early/mid-systole
- Averaging 3-5 beats

LVOT is measured within 0.5 – 1.0cm of the valve orifice

Baumgartner Eur J Echo 2009

PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

Estimation of aortic valve area source of errors: LVOT velocity



Correct positioning of the sample volume → where the CSA is calculated.

Closer to septum → overestimation

Closer to AML → underestimation

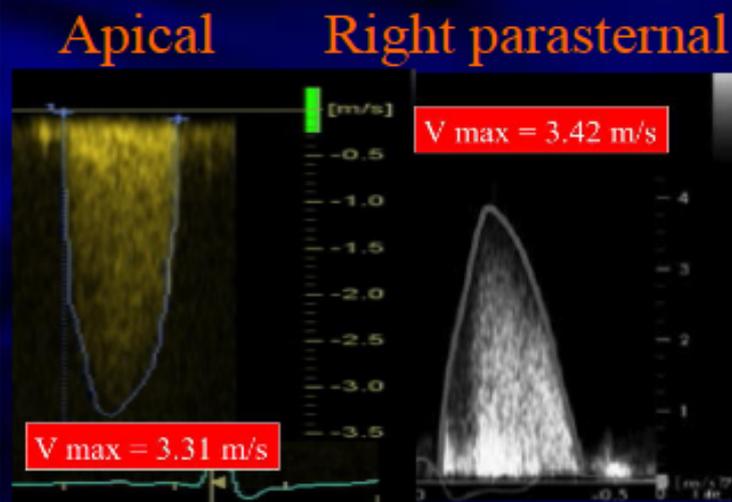
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LVOT velocity

- Pulsed-wave Doppler
- Apical long axis or five-chamber view
- Sample volume positioned just on LV side of valve and moved carefully into the LVOT if required to obtain laminar flow curve
- Velocity baseline and scale adjusted to maximize size of velocity curve
- Time axis (sweep speed) 100 mm/s
- Low wall filter setting
- Smooth velocity curve with a well-defined peak and a narrow velocity range at peak velocity
- Maximum velocity from peak of dense velocity curve
- VTI traced from modal velocity

PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

..come evitare gli errori !!!



Underestimation

- Non parallel alignment between CW Doppler beam and AS jet results in underestimation of AS velocity and gradients
- Use multiple acoustic windows (apical, right parasternal, suprasternal)
- Use the pencil probe
- Report the highest velocity recorded from any window (do not report lower values from other views)
- Report the acoustic window providing the highest velocity (for further examinations)

Overestimation

- Confusion between MR and AS
- Measurement of velocity on a post-extrasystolic beat (or measurement of higher velocity in AF without averaging peak velocities)
- Inclusion in measurement of fine linear signals at the peak of the curve (due to transit time effect and not to be included)
- Pressure recovery (if ascending aorta diameter $< 30\text{mm}$) +++

PITFALLS NELLA VALUTAZIONE DELLA STENOSI AORTICA

AS jet velocity

- CW Doppler (dedicated transducer)
- Multiple acoustic windows {e.g. apical, suprasternal, right parasternal, etc)
- Decrease gains, increase wall filter, adjust baseline, and scale to optimize signal
- Gray scale spectral display with expanded time scale
- Maximum velocity at peak of dense velocity curve
- Avoid noise and fine linear signals
- VTI traced from outer edge of dense signal curve
- Mean gradient calculated from traced velocity curve

44 m/s

44 m/s

20 fps / 160

74 bpm / Gen F

---2D

H4.3M

16

DR: 55

---Color

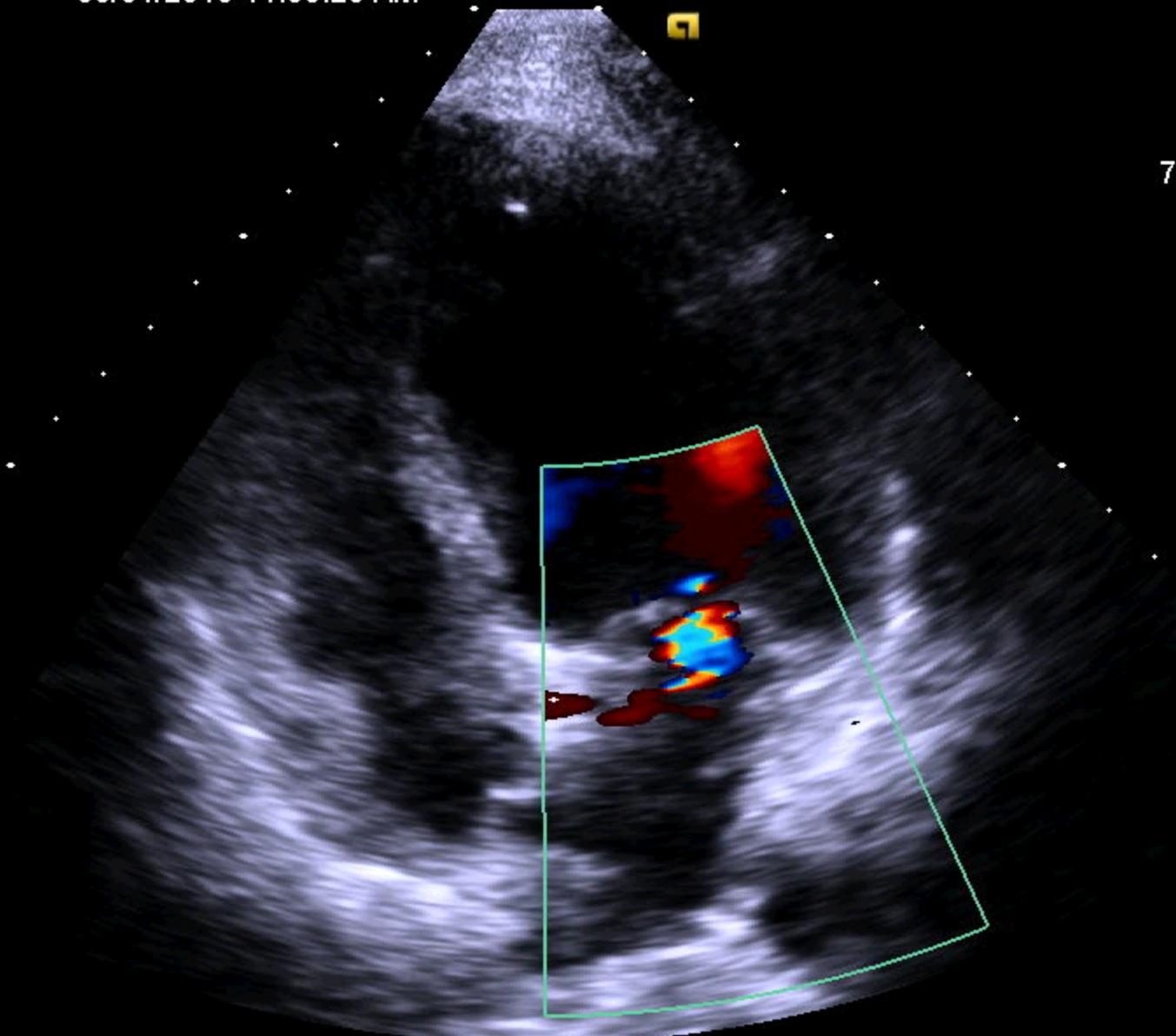
CDV / 3.5M

0



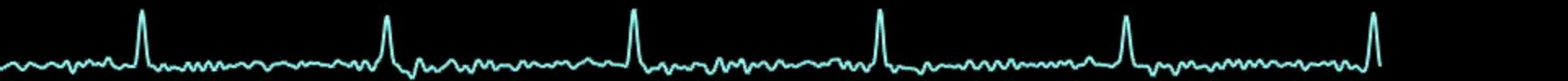
62 m/s

62 m/s



22 fps / 160
72 bpm / Gen F
---2D
H4.3M
16
DR: 55

--Colo
CDV / 2.5M
0



“L’uomo che non
commette mai errori è
l’uomo che non fa”

Grazie per l’attenzione!!

