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## Disclosures



- Still nothing



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## Outline



The Surgical Patient

Advanced Techniques

Why it's tough

In the Pipeline

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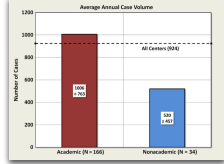


# What kind of patient do we see in the OR?



Multinational Institutional Survey on Patterns of Intraoperative Transesophageal Echocardiography Use in Adult Cardiac Surgery

Heather A. Dobbs, MD,\* Eliot Bennett-Guerrero, MD,\* William White, MPH,\*  
 Stanton K. Sherman, MD, FAHA, FASE,\* Alina Nicorici, MD, FASE,\* J. Maurizio Del Rio, MD,\*  
 Mark Stafford-Smith, MD, FRCC, FASE,\* and Madhav Swaminathan, MD, FASE, FAHA\*  
 Journal of Cardiothoracic and Vascular Anesthesia, Vol 28, No 1 (February), 2014; pp 34-43



- 200 centers
- 27 countries

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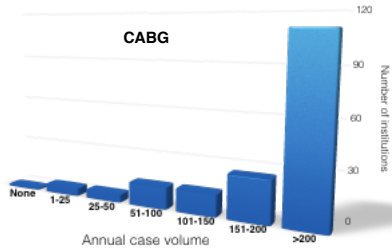
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# What kind of patient do we see in the OR?



Journal of Cardiothoracic and Vascular Anesthesia, Vol 28, No 1 (February), 2014; pp 34-43



- 200 centers
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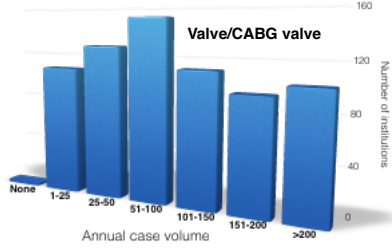
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### What kind of patient do we see in the OR?

Journal of Cardiothoracic and Vascular Anesthesia, Vol 28, No 1 (February), 2014; pp 24-43



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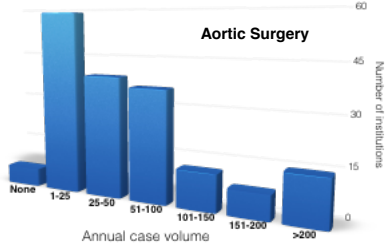
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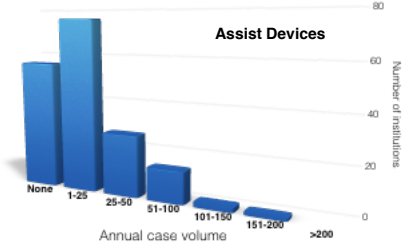
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## What kind of patient do we see in the OR?

Journal of Cardiothoracic and Vascular Anesthesia, Vol 28, No 1 (February), 2014; pp 56-65



- 200 centers
- 27 countries



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## What information is important?

CABG



- LV function pre and post-CPB
- Associated valve lesions
- Structural defects

Valves

Devices

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## What information is important?



CABG



- LV function pre and post-CPB
- Associated valve lesions
- Structural defects

Valves



- Define lesion anatomy and function
- Characterization of repair/replacement
- LV function pre and post-CPB

Devices

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## What information is important?



CABG



- LV function pre and post-CPB
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Valves



- Define lesion anatomy and function
- Characterization of repair/replacement
- LV function pre and post-CPB

Devices



- RV failure prediction
- Device functioning
- RV function post-CPB

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### What information is important?

- CABG**
  - LV function pre and post-CPB
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  - Structural defects
- Valves**
  - Define lesion anatomy and function
  - Characterization of repair/replacement
  - LV function pre and post-CPB
- Devices**
  - RV failure prediction
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### What information is important?

- CABG**
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## What techniques can we use?



3-D

Speckle tracking

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## Case #1



3-D

Speckle tracking

- 72 year old male
- Presents with worsening CHF
- Workup reveals
  - 3 vessel disease
  - Depressed LV function
  - 4+ MR

Mr ABC is a 72yo from XYZ transferred for ischemic cardiomyopathy EF 30-35%, 2v CAD and severe ischemic MR. His workup included echo with EF 30-35%, 4+ MR.

He has mitral annular dilation with resultant poor leaflet coaptation, severe MR. He has what appears to be a codominant system with a visible large OM target, suggestion of PDA and LPL targets that look small. LAD is clean.

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## Case #1

72 year old male

3-D

Presents with worsening CHF

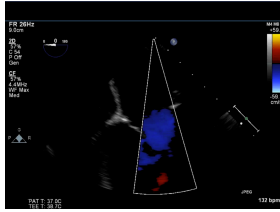
Speckle tracking

Workup reveals

3 vessel disease

Depressed LV function

4+ MR



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## Case #1

72 year old male

3-D

Presents with worsening CHF

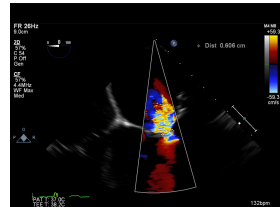
Speckle tracking

Workup reveals

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## Case #1

72 year old male

3-D

Presents with worsening CHF

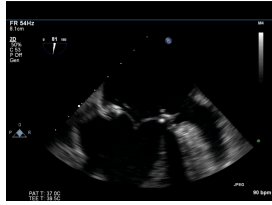
Speckle tracking

Workup reveals

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Depressed LV function

4+ MR



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## Case #1

72 year old male

3-D

Presents with worsening CHF

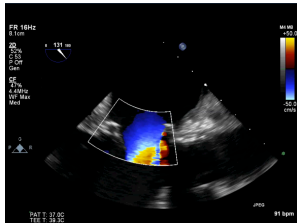
Speckle tracking

Workup reveals

3 vessel disease

Depressed LV function

4+ MR



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## Case #1



3-D

Speckle tracking

- 72 year old male
- Presents with worsening CHF
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Do I need 3D now?

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## Case #1



3-D

Speckle tracking

Eng J, et al. Left ventricular outflow tract obstruction from mitral prosthesis. *Int J Cardiol.* 1991 Mar;30(3):363-4.

Jett GK, et al. Left ventricular outflow tract obstruction following mitral valve replacement: effect of strut height and orientation. *Ann Thorac Surg.* 1986 Sep;42(3):299-303.

Guler N, et al. Left ventricular outflow tract obstruction after bioprosthetic mitral valve replacement with posterior mitral leaflet preservation. *Tex Heart Inst J.* 2006;33(3):399-401.

Tewari P, et al. Left ventricular outflow tract obstruction after mitral valve replacement. *Anesth Analg.* 2008 Jan;106(1):65-6.

Patel H, et al. Left ventricular outflow tract obstruction after bioprosthetic mitral valve replacement with preservation of the anterior leaflet. *Rev Cardiovasc Med.* 2011;12(1):48-51.

Bartolotti U, et al. Fatal obstruction of the left ventricular outflow tract caused by low-profile bioprostheses in the mitral valve position. *Chest.* 1993 Apr;103(4):1288-9.

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## Case #1



Eng J, et al. **Left ventricular outflow tract obstruction** from mitral prosthesis. *Int J Cardiol.* 1991 Mar;30(3):363-4.

3-D

Speckle tracking

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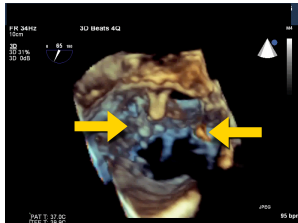
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## Case #1



3-D

Speckle tracking



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## Case #2



3-D

Speckle tracking

- 54 year old male
- Recent onset of CHF symptoms
- Recent development of CHB requiring TV pacing
- Cath - no significant CAD
- TTE - Severe MR with bileaflet prolapse
- Scheduled for MV repair

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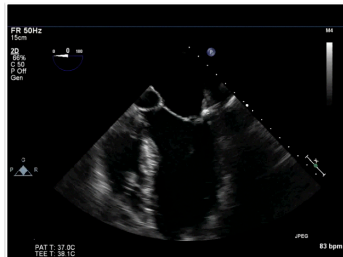
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## Case #2



3-D

Speckle tracking



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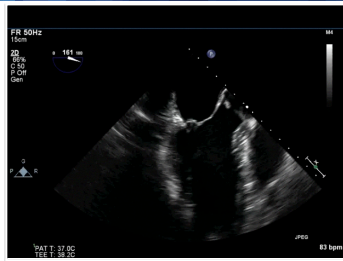




### Case #2

3-D

Speckle tracking



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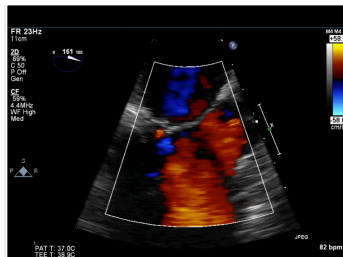
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3-D

Speckle tracking



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Case #2

ARS Question # 1



What would your advice be to the surgeon regarding the mitral valve?

3-D

Speckle tracking

1. Ring annuloplasty
2. Resection of A2/P2 and clefts
3. Option #2 + commissuroplasty
4. Let me show you some cool 3D
5. Replace the mitral valve

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Case #2

ARS Question # 1



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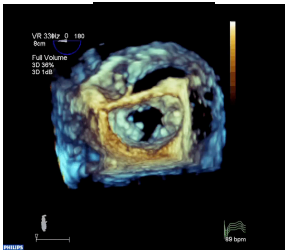
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Case #2



3-D

Speckle tracking



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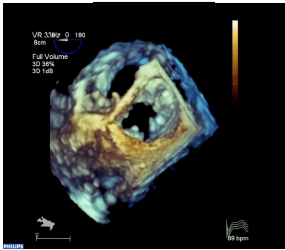
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Case #2



3-D

Speckle tracking



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Case #2

ARS Question # 2



What would your advice be to the surgeon regarding the mitral valve after seeing 3D?

3-D

Speckle tracking

1. Ring annuloplasty
2. Resection of A2/P2 and clefts
3. Option #2 + commissuroplasty
4. Replace the mitral valve

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Case #2

ARS Question # 2



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## Help with predictions

**Quantitative analysis of mitral valve apparatus in mitral valve prolapse before and after annuloplasty: a three-dimensional intraoperative transesophageal study.**  
Maffessanti F, et al. J Am Soc Echocardiogr. 2011 Apr;24(4):405-13

3-D

Speckle tracking

**Quantitative Modeling of the Mitral Valve by Three-Dimensional Transesophageal Echocardiography in Patients Undergoing Mitral Valve Repair: Correlation with Intraoperative Surgical Technique.**  
Calleja A, et al. J Am Soc Echocardiogr. 2015 Sep;28(9):1083-92

**Real-time three-dimensional transthoracic echocardiography for predicting mitral annuloplasty ring size.**  
Labib DO, et al. J Heart Valve Dis. 2014 Sep;23(5):583-90

**Prediction of the annuloplasty ring size in patients undergoing mitral valve repair using real-time three-dimensional transesophageal echocardiography.**  
Ender J, et al. Eur J Echocardiogr. 2011 Jun;12(6):445-53.

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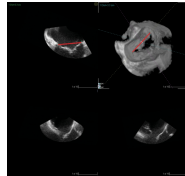
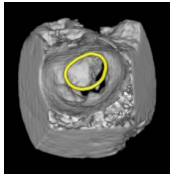
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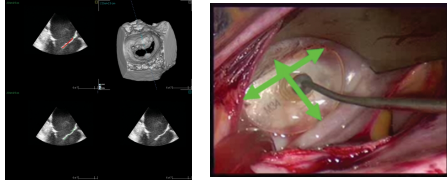
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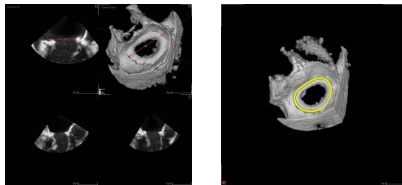
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3-D

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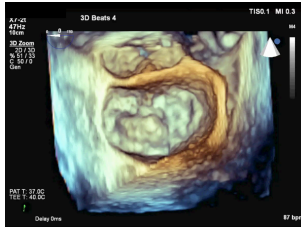
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## Help with predictions



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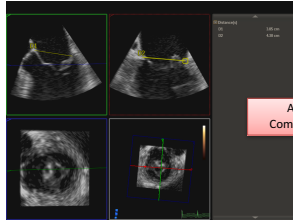
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## Help with predictions



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AP diameter 3.8 cm  
Commissural diameter 4.3

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## Help with predictions

**3-D**

Speckle tracking

A2 = 2.9 cm  
P1 = 1.2 cm  
P2 = 1.9 cm  
P3 = 1.5 cm

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## Help with predictions

**3-D**

Speckle tracking

C-Sept = 2.1 cm  
Septum = 15 mm  
AL/PL = 1.26  
Annulo-mitral angle = 80

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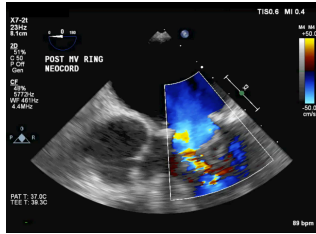
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## Help with predictions



3-D

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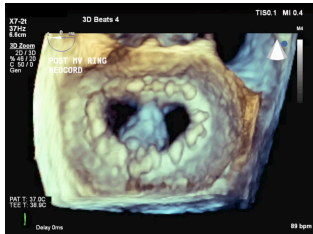


## Help with predictions



3-D

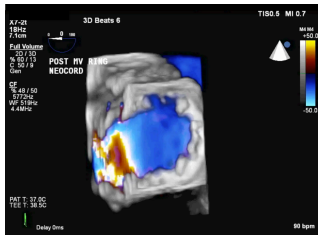
Speckle tracking





# Help with predictions

- 3-D
- Speckle tracking



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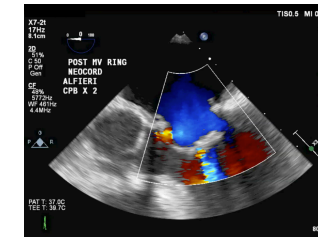
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# Help with predictions

- 3-D
- Speckle tracking



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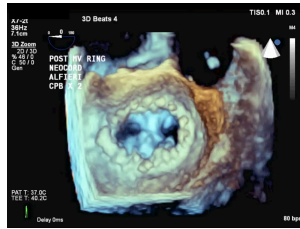
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## Help with predictions



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Speckle tracking



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## Strain, etc

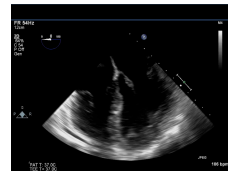
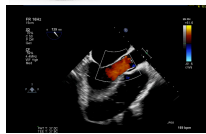


3-D

Speckle tracking



Why do we need strain imaging?



Myocardial strain to detect subtle left ventricular systolic dysfunction.  
Tops, LP et al. Eur J Heart Fail. 2017;19: 307-313

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## Strain, etc



Does chronic volume overload result in myocardial fibrosis?

**Quantification of left ventricular interstitial fibrosis in asymptomatic chronic primary degenerative mitral regurgitation.**  
Edwards NC, et al. Circ Cardiovasc Imaging. 2014;7(6):946-53

3-D

Speckle tracking

- 35 patients with
- ★ Asymptomatic, non-surgical moderate or severe MR
- Age and sex matched controls
- CPET, Echo and MRI

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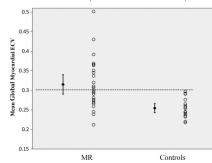
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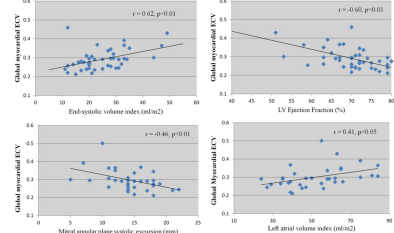
Strain, etc



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Does chronic volume overload result in myocardial fibrosis?



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And in cardiac surgery?



3-D

Speckle tracking



Does GLS by 2DSTE predict early postoperative death after cardiac surgery?

Incremental value of global longitudinal strain for predicting early outcome after cardiac surgery.  
Terraciano J, et al. Eur Heart J Cardiovasc Imaging. 2013;14(1):77-84.

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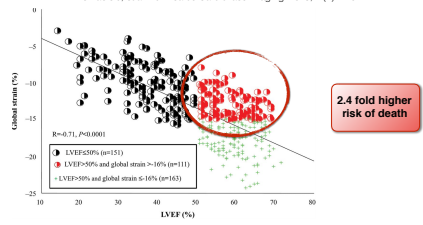
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## And in cardiac surgery?

Incremental value of global longitudinal strain for predicting early outcome after cardiac surgery.  
Ternacle J, et al. Eur Heart J Cardiovasc Imaging. 2013;14(1):77-84.

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## And in cardiac surgery?

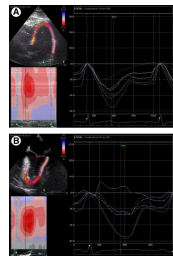
A Comparative Evaluation of Transesophageal and  
Trans thoracic Echocardiography for Measurement of Left  
Ventricular Systolic Strain Using Speckle Tracking.  
Marcucci, CE, et al. J Cardiothorac Vasc Anesth. 2012; 26(1):17-25

3-D

Speckle tracking



Is strain imaging with TEE comparable with  
TTE in patients undergoing cardiac surgery?



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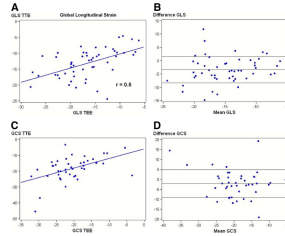
## And in cardiac surgery?

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3-D

Speckle tracking

- Correlation between TTE and TEE was modest
- Inter- and Intra-observer variability was low
- Comparisons with preop TTE may not be valid
- Longitudinal measurements during surgery are



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## And in cardiac surgery?

Preoperative Three-Dimensional Strain Imaging Identifies Reduction in Left Ventricular Function and Predicts Outcomes After Cardiac Surgery

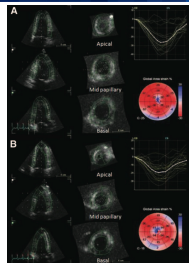
Howard-Quijano K et al. Anesth Analg. 2017;124(2):419-428

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Speckle tracking



- Can 3D strain be used to investigate change in LV function after cardiac surgery?
- Can pre-op 3D strain predict adverse outcome?



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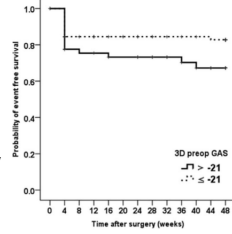
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1. Can 3D strain be used to investigate change in LV function after cardiac surgery?

2. Can pre-op 3D strain predict adverse outcome?



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## Device surgery

3-D

Speckle tracking

1. RV failure occurs in 10-40% of all LVAD surgeries
2. Can we use strain imaging of the RV to identify predictors of RV failure?



Right heart failure and "failure to thrive" after left ventricular assist device: clinical predictors and outcomes  
Baumwol J, et al. *J Heart Lung Transplant*. 30 (2011), pp. 888-895

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## Device surgery

Speckle tracking echocardiography as a new technique to evaluate right ventricular function in patients with left ventricular assist device therapy  
Cameli, M, et al. J Heart Lung Transplant. 2013 Apr;32(4):424-30

3-D

Speckle tracking



Is RVLS assessment feasible as an indicator of RV deformation in LVAD surgery?

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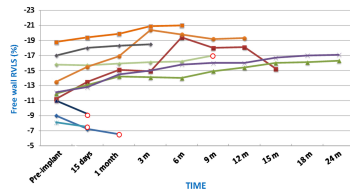
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## Summary of advanced techniques



3-D

Speckle tracking

1. Both 3D and speckle tracking are feasible and useful in the OR
2. 3D seems to be far more user-friendly with robust data supporting its use
3. Strain imaging will take a bit longer...

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## It ain't easy...



1. Time is ticking...
2. Need real time, quick answers
3. Fluctuating hemodynamics/loading conditions
4. No time for offline analysis
5. Simple methods

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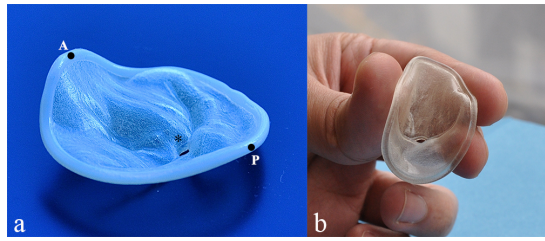
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## What's next?



Courtesy, Dr. Feroze Mahmood, MD, FASE, BIDMC, Boston, MA

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## What's next?



Courtesy, Dr. Feroze Mahmood, MD, FASE, BIDMC, Boston, MA

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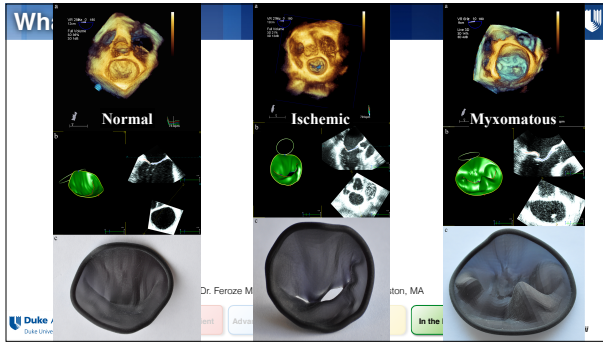
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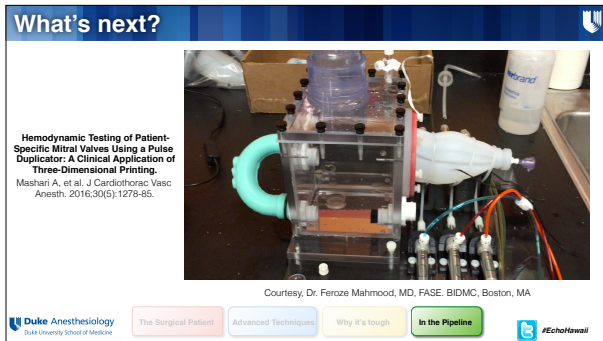
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## Key Points

- Advanced techniques are feasible and useful in the OR
- Potential to improve care and outcomes
- Need to be simple, rapid and intuitive
- More work needs to be done

SUMMARY



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## Thank you!



Questions,  
Comments?

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Thank you



@mswami001

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[madhav.swaminathan@duke.edu](mailto:madhav.swaminathan@duke.edu)



[linkedin.com/in/madhavmd](https://www.linkedin.com/in/madhavmd)



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