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CJMS

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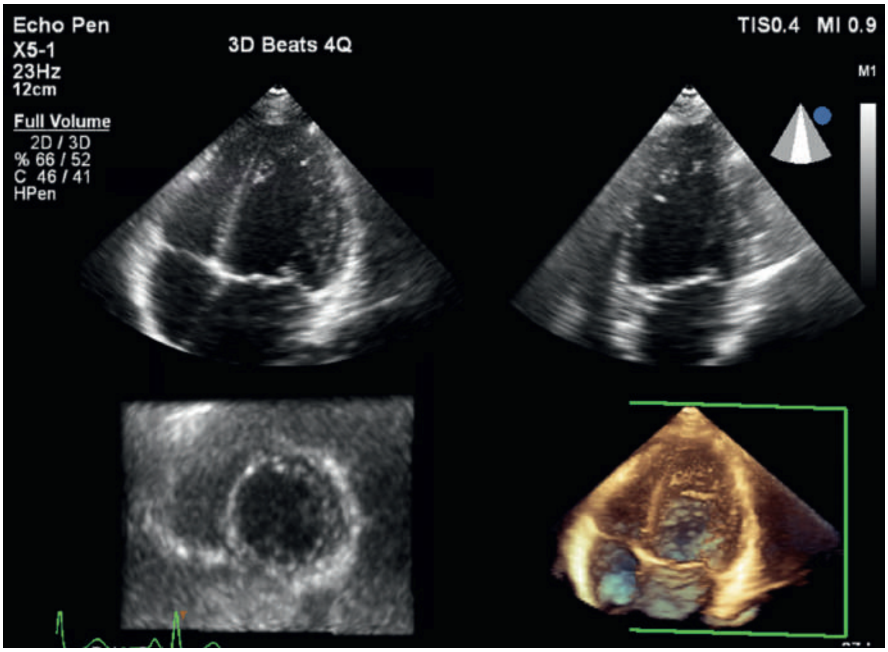

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About the Cover

This image is Figure 9 from Babitha Thampanathan and Jason Michalakos' article "2D and 3D Imaging and Quantification of Mitral Regurgitation: A Pictorial Guide for Cardiac Sonographers."

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Message from the Editor-in-Chief

Welcome to issue three of *CJMS*. We celebrate cautiously as most Canadians (77.49% 12 years & older)[1] have been fully vaccinated against COVID-19. At the same time, the number of cases are increasing in some parts of the country, mostly non-vaccinated individuals. Businesses are re-opening, and the hope is that our health care system will be under less strain once more people are vaccinated. Now comes the time for us to catch up on cases that were put on hold and to remain vigilant by continuing to protect ourselves and those that we care for.

Do you remember the first issue of *CJMS* after the advent of COVID (Volume 11 Issue 2, 2020)? I read that issue again and felt hopeful about where we stand today concerning the implications of COVID for sonographers and the patients we serve. COVID will be with us for some time yet, but it will be more manageable with the lessons we've learned. Organizations that employ sonographers have created policies for staff and patient safety, PPE is readily available, and both patients and health care providers apply social distancing, hand hygiene, and disinfection protocols to minimize the spread of this disease.

In Volume 11 Issue 2 of the *CJMS* in 2020; we published a special report on lung ultrasound, and it's gratifying to note that more sonographers worldwide are looking at this as a valuable diagnostic exam. Point-of-care ultrasound providers are using lung ultrasound extensively. One of the sessions at Sonography Canada's upcoming SonoCon Summit 2021 will focus on this very topic. For additional COVID resources, check out Sonography Canada's website (sonographycanada.ca) for a valuable compilation of information on various COVID-related issues, including coping with stress during this difficult time.

Volume 11 Issue 2 also reminded me that Sonography Canada published results of their Members Survey which indicated that almost 50% of sonographers plan to retire in the next 10 years; now 9 years. This is a gentle reminder to those who employ and educate sonographers to plan your recruitment and succession strategies. The demand for our profession only keeps growing, so promoting, nurturing, and educating our students, and creating a passion for continuing as a professional by creating a positive, collaborative, stress-free environment with the tools required is imperative.

Now … back to the present and this issue of *CJMS*. We have published a very interesting original research study by Drs. Hogan and Hapgood, from Memorial University in Newfoundland, investigated breast ultrasound use in women with breast pain. The research results will aid in the application of your protocols. In addition, our much-published cardiac researcher and author Babitha Thampinathan has collaborated with Jason Michalakos to inform us on 2D and 3D Imaging and Quantification of Mitral Regurgitation using a pictorial format. And finally, Jia Qian Lu describes the importance of multimodality imaging for accurate diagnosis and the importance of actively listening to patients' concerns in her case report on "*Diagnosing Invasive Lobular Carcinoma of The Breast.*"

Canada's youth are back to school with a focus on learning. You can be too by reading the articles in this Fall edition of the CJMS and by planning to participate in the upcoming SonoCon Summit 2021 scheduled to take place from October 1-3. Sonography Canada is hosting its annual conference virtually this year with the theme of ***Adjusting Focus***. This theme was selected as the health care sector and front-line workers have been working around the clock for the last year and a half to ensure the health and safety of all people. Now that we inch closer to our new normal, it's time to look beyond the countless barriers that the global pandemic has placed in our way. The association has a great line-up in store for you and is confirming new sessions every week that touch on the various facets of our profession — generalist, cardiac, vascular, MSK, and more! Check out the event portal at https://bit.ly/SonCan21 where you can register for the event and access the conference program, which includes sessions like:

- Popliteal Artery Entrapment Syndrome (PAES) Diagnosis in a Vascular Laboratory Setting (Simon Greenwood, CRVS)
- Intro to Lung Ultrasound for Sonographers (Heather Cooley, CRGS)
- The Fine Art of the Carotid Ultrasound (Dawn Whyte, CRVS, CRS- AB)
- The Magic Behind the Wand (Mercedes Zajac, CRGS)

Back to "normal." Back to learning. Giving back to the profession with great articles. That is pretty much what this edition is all about.

Sheena Bhimji-Hewitt

Broadening Horizons & Pushing Boundaries

Reference

1. Available at https://health-infobase.canada.ca/covid-19/vaccination-coverage/. Retrieved September 16.2021

*The opinion in this editorial is that of the Editor-in-Chief and not that of Sonography Canada or the Sonography Board of Directors.

Message du rédactrice en chef

Bienvenue au troisième numéro de CJMS. Nous célébrons avec prudence car la plupart des Canadiens (77,49 % des 12 ans et plus)[1] ont été entièrement vaccinés contre le COVID-19. En même temps, le nombre de cas augmente dans certaines parties du pays, la plupart des personnes non vaccinées. Les entreprises rouvrent leurs portes et l'on espère que notre système de santé sera moins sollicité lorsque davantage de personnes seront vaccinées. Le moment est venu pour nous de rattraper les cas qui ont été mis en attente et de rester vigilants en continuant à nous protéger et à protéger ceux dont nous nous occupons.

Vous souvenez-vous du premier numéro de CJMS après l'avènement de COVID (volume 11 numéro 2, 2020) ? J'ai relu ce numéro et je me suis sentie pleine d'espoir quant à la situation actuelle concernant les implications de COVID pour les échographistes et les patients que nous servons. La COVID sera avec nous pendant un certain temps encore, mais elle sera plus facile à gérer grâce aux leçons que nous avons apprises. Les organisations qui emploient des échographistes créent des politiques pour la sécurité du personnel et des patients, l'EPI est facilement disponible, et les patients et les prestataires de soins de santé appliquent des protocoles de distanciation sociale, d'hygiène des mains et de désinfection pour minimiser la propagation de cette maladie.

Dans le volume 11 numéro 2 de la CJMS en 2020, nous avons publié un rapport spécial sur l'échographie pulmonaire, et il est gratifiant de constater que de plus en plus d'échographistes dans le monde considèrent cette technique comme un examen diagnostique précieux. Les prestataires de services d'échographie au point de service utilisent largement l'échographie pulmonaire. L'une des sessions du prochain sommet SonoCon 2021 de Sonographie Canada portera précisément sur ce sujet. Pour obtenir d'autres ressources sur le COVID, consultez le site Web de Sonographie Canada (sonographycanada.ca). Vous y trouverez une compilation précieuse de renseignements sur diverses questions liées au COVID, y compris la gestion du stress pendant cette période difficile.

Le volume 11, numéro 2, m'a également rappelé que Sonographie Canada a publié les résultats de son sondage auprès de ses membres, qui indiquent que près de 50 % des échographistes prévoient prendre leur retraite au cours des 10 prochaines années ; maintenant 9 ans. Il s'agit d'un léger rappel à ceux qui emploient et forment des échographistes de planifier leurs stratégies de recrutement et de relève. La demande pour notre profession ne cesse de croître. Il est donc impératif de promouvoir, d'encourager et d'éduquer nos étudiants, et de susciter une passion pour la poursuite de leur carrière professionnelle en créant un environnement positif, collaboratif, sans stress et doté des outils nécessaires.

Maintenant, revenons au présent et à ce numéro de CJMS. Nous avons publié une étude originale très intéressante menée par les docteurs Hogan et Hapgood, de l'Université Memorial de Terre-Neuve, sur l'utilisation de l'échographie mammaire chez les femmes souffrant de douleurs mammaires. Les résultats de cette recherche aideront à l'application de vos protocoles. De plus, notre chercheuse et auteure en cardiologie Babitha Thampinathan, qui a fait l'objet de nombreuses publications, a collaboré avec Jason Michalakos pour nous informer sur l'imagerie 2D et 3D et la quantification de la régurgitation mitrale à l'aide d'un format illustré. Enfin, Jia Qian Lu décrit l'importance de l'imagerie multimodale pour un diagnostic précis et l'importance d'écouter activement les préoccupations des patients dans son rapport de cas sur le "Diagnostic du carcinome lobulaire invasif du sein".

Les jeunes Canadiens ont repris le chemin de l'école en mettant l'accent sur l'apprentissage. Vous pouvez vous aussi l'être en lisant les articles de ce numéro d'automne de la CJMS et en prévoyant de participer au prochain sommet SonoCon 2021 qui aura lieu du 1er au 3 octobre. Sonographie Canada organise sa conférence annuelle de façon virtuelle cette année, avec pour thème "Adjusting Focus". Ce thème a été choisi parce que le secteur des soins de santé et les travailleurs de première ligne ont travaillé jour et nuit au cours de la dernière année et demie pour assurer la santé et la sécurité de tous. Maintenant que nous nous rapprochons de notre nouvelle normalité, il est temps de regarder au-delà des innombrables obstacles que la pandémie mondiale a placés sur notre chemin. L'association vous réserve un excellent programme et confirme chaque semaine de nouvelles sessions qui abordent les différentes facettes de notre profession - généralistes, cardiaques, vasculaires, MSK, etc. Consultez le portail de l'événement à l'adresse https://bit.ly/SonCan21 où vous pourrez vous inscrire et accéder au programme de la conférence, qui comprend des sessions telles que :

- Diagnostic du syndrome d'entrave de l'artère poplitée (PAES) dans un laboratoire vasculaire (Simon Greenwood, CRVS)
- Introduction à l'échographie pulmonaire pour les échographistes (Heather Cooley, CRGS)
- L'art délicat de l'échographie de la carotide (Dawn Whyte, CRVS, CRS- AB)
- La magie derrière la baguette (Mercedes Zajac, CRGS)

Retour à la "normale". Retour à l'apprentissage. Redonner à la profession avec d'excellents articles. C'est à peu près ce dont il s'agit dans cette édition.

Sheena Bhimji-Hewitt

Élargir les horizons et repousser les frontières

Référence

1. Disponible à l'adresse https://health-infobase.canada.ca/covid-19/vaccination-coverage/. Consulté le 16 septembre 2021.

*L'opinion exprimée dans cet éditorial est celle du rédacteur en chef et non celle de Sonographie Canada ou du Conseil d'administration de Sonographie.

Pictorial Essay

Babitha Thampanathan, HBSc, RDCS, CRCS (AE)
Jason Michalakos, BSc, DCS

2D and 3D Imaging and Quantification of Mitral Regurgitation: A Pictorial Guide for Cardiac Sonographers

About the Authors

Babitha Thampinathan is affiliated with Toronto General Hospital, Ted Rogers Center for Heart Research and Mohawk-McMaster University Institute for Applied Health Sciences.

Jason Michalakos is a cardiac sonographer and ultrasound account manager at Philips Canada. He has presented at multiple Canadian national conferences.

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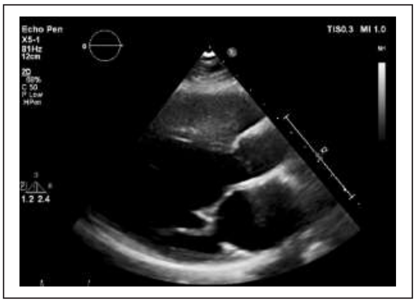
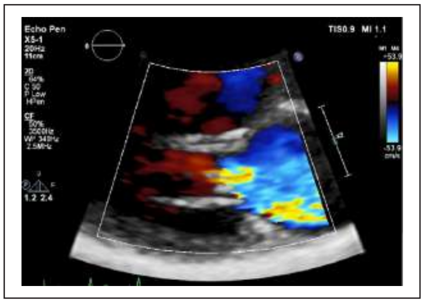
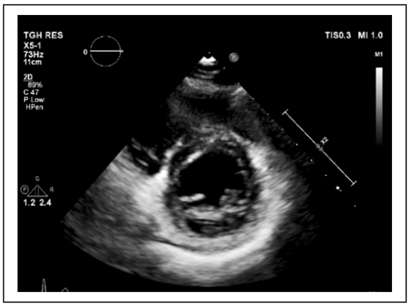
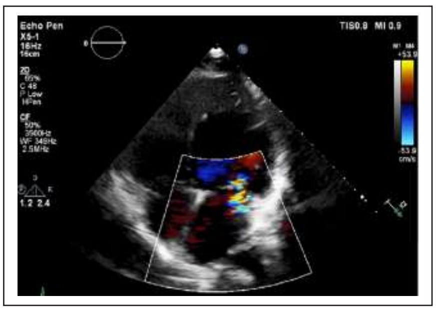
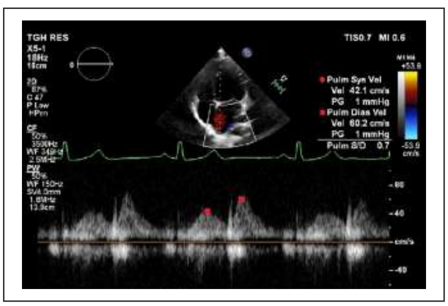
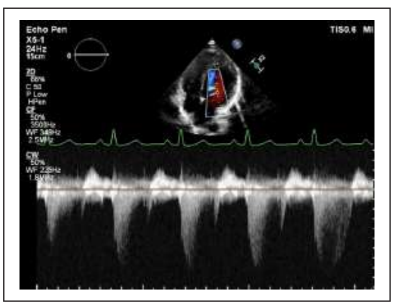
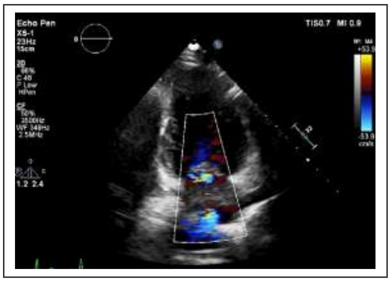
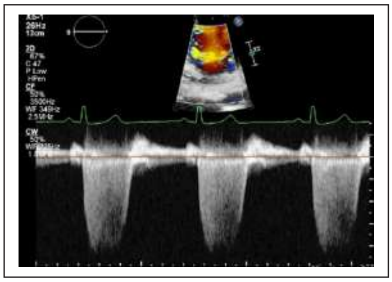
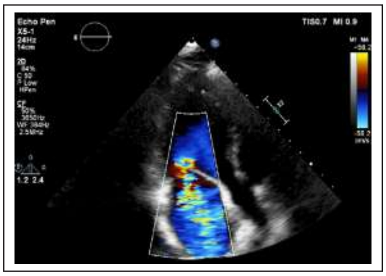
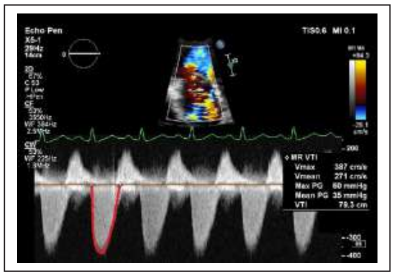
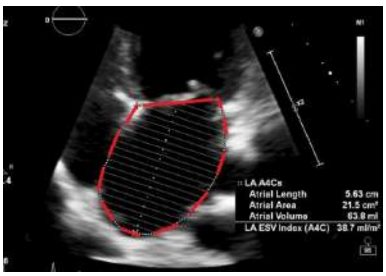
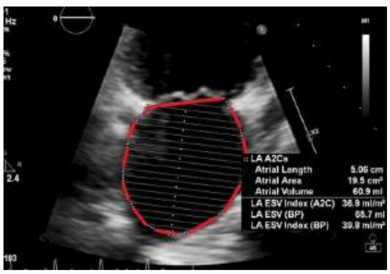
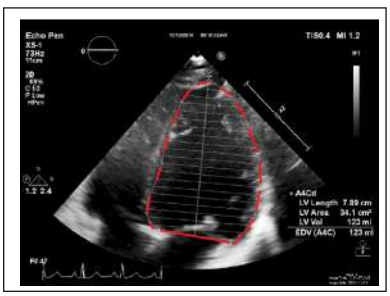
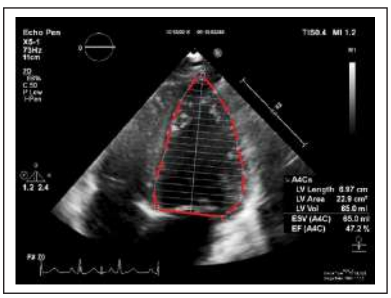
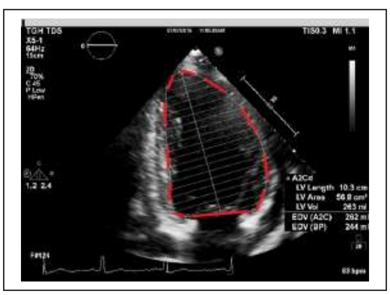
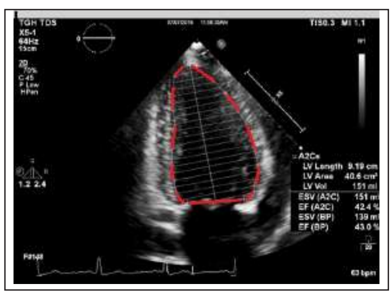
ABSTRACT

Decisions on techniques used to treat structural heart disease has evolved rapidly, especially in the areas of surgery and noninvasive interventional cardiology. The need for accurate and detailed imaging of these structures has made the roles of cardiac sonographers very dynamic. In order to provide valuable information, which is used in surgical or interventional planning, cardiac sonographers perform a comprehensive transthoracic echocardiogram (TTE) and transesophageal echocardiogram (TEE). However, classifying the severity of regurgitation could be challenging as cardiac structures are three-dimensional (3D), yet most imaging is performed with two-dimensional (2D) modalities. Specifically, in cases where there is a reduction in the functioning of left ventricular (LV), relying only on a single-plane 2D image has limitations and could drastically underestimate the severity of regurgitation. With guidance, newer clinical applications, such as 3D imaging, allows capturing of accurate and reproducible quantitation.

Introduction

A 35-year-old female with a history of mild mitral regurgitation and normal LV function, had a sudden onset of exercise intolerance and palpitations. Auscultation revealed a third heart sound. A transthoracic echocardiogram (TTE) was advised. The aim of this case study based pictorial essay is to provide cardiac sonographers with a quick reference manual on optimal image acquisition and post-processing methods when quantifying regurgitation using two-dimensional (2D) and three-dimensional (3D) techniques. The details and concepts mentioned in this case study could be used to quantify all structural regurgitation; however, we would specifically focus on mitral regurgitation

Transthoracic 2D and Doppler images acquired.	2D and Doppler indicators of severity.
  Figure 1A Figure 1B	Figure 1. (A) and (B) TTE demonstrated a slightly posteriorly directed eccentric mitral regurgitation (MR) jet in the parasternal long axis (PSLAX) view.
  Figure 2A Figure 2B	Figure 2. (A) and (B) Parasternal short-axis (PSSAX) views show the mitral regurgitation (MR) jet during systole.
  Figure 3A Figure 3B   Figure 3C Figure 3D	Figure 3. (A) Apical 4-chamber (A4) view. Color Doppler on the mitral valve (MV) showing the mitral regurgitation (MR). (B) Pulsed-wave (PW) Doppler of the MV inflow velocities. (C) Continuous-wave (CW) Doppler of the MV obtained from the A4 chamber view showing MR jet profile. (D) PW Doppler of the pulmonary vein inflow. No evidence of systolic flow reversal.

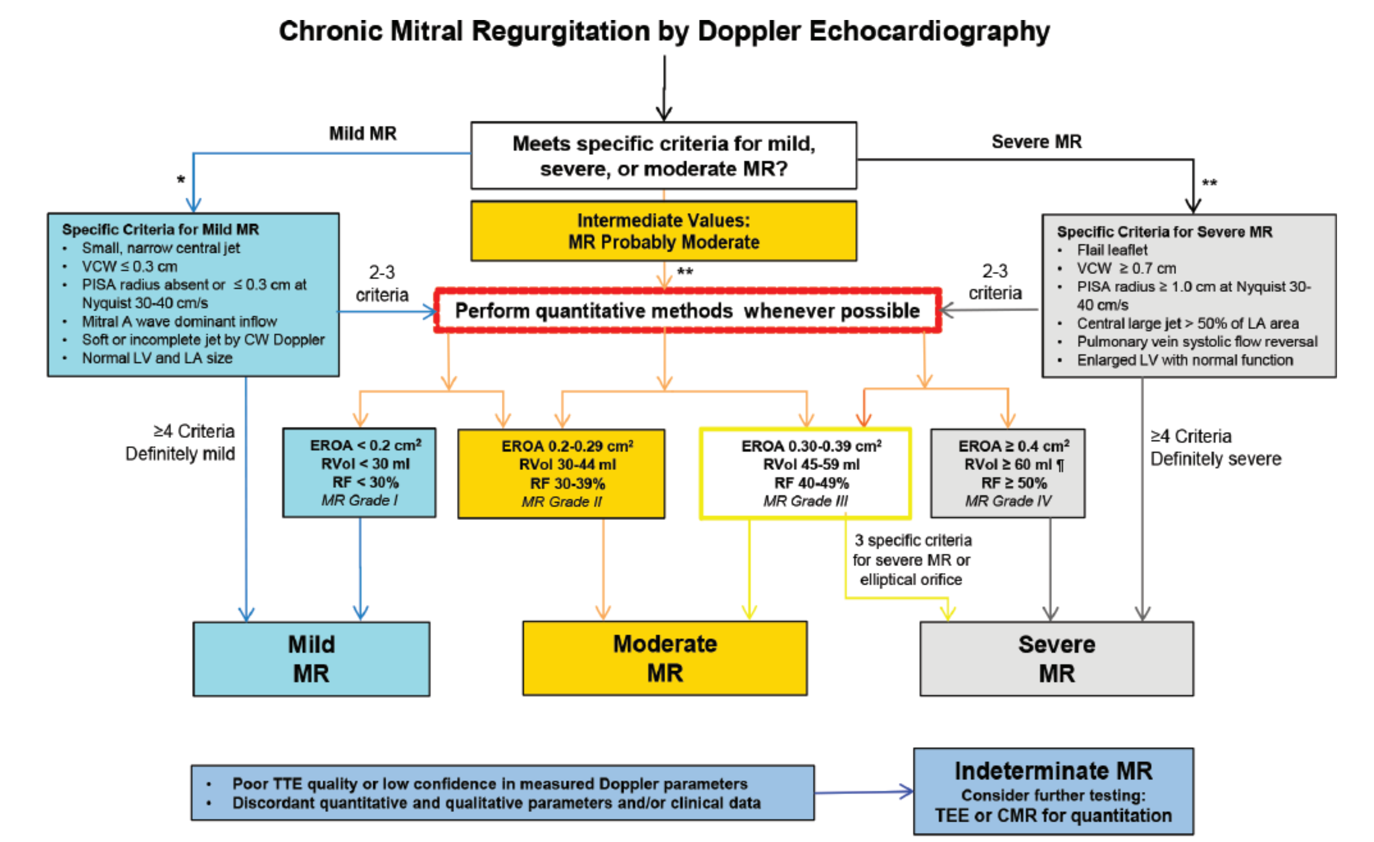
Transthoracic 2D and Doppler images acquired.	2D and Doppler indicators of severity.
 Figure 3E  Figure 3F  Figure 3G  Figure 3H	(E) Apical 2 (A2) chamber view. Color Doppler on the MV showing MR. (F) Continuous-wave (CW) Doppler of the MV obtained from the A2 chamber view showing the MR jet profile. (G) Apical 3 (A3) chamber view. Color Doppler on the MV showing the MR covering >50% of the left atrium (LA). (H) CW Doppler of the MV obtained from the A3 chamber view showing the MR jet profile. Cursor was parallel to MR flow to accurately measure peak velocity and velocity-time integral (VTI) of MR. Note: Importance of obtaining CW samples of the MR jet from multiple views.
 Figure 4A  Figure 4B	Figure 4. (A) and (B) Left atrium (LA) volume measures 39.8 mL/m^2, revealing mild dilation by current guidelines.[1]
 Figure 5A  Figure 5B  Figure 5C  Figure 5D	Figure 5. (A–D) Left atrium (LV) enlargement with mild global systolic dysfunction (LVEF 43%).

(MR). The Philips EPIQ 7 ultrasound system was used to image this case.

How severe is the MR?

According to the algorithm and based on the acquired 2D images, quantitative measures are required to be performed to clarify the severity of MR jet, as there was concern that it may be underestimated. Integration of multiple parameters is important to ensure the accurate assessment of MR severity (Flowchart 1).

Initially based on 2D quantification, the patient's MR severity was classified as moderate; however, there was a lot of inconsistency and discrepancies between different calculations. Owing to the patient's clinical presentation and new onset of LV dysfunction, there was a concern that MR severity was underestimated; hence, 3D quantification was performed. The 2D and 3D quantitative methods and findings are organized in a comparison table. Each method reviews image acquisition, measurement, and calculations using 2D and 3D datasets. Calculations of focus are effective regurgitant orifice area (EROA), regurgitant volumes (RVol), and regurgitant fraction (RF). Most modalities automatically perform these calculations.



*	Beware of underestimation of MR severity in eccentric, wall impinging jets; quantitation is advised
**	All values for EROA by PISA assume holosystolic MR; single frame EROA by PISA and VCW overestimate non-holosystolic MR
¶	Regurgitant volume for severe MR may be lower in low flow conditions.

CMR = cardiovascular magnetic resonance imaging; CW = continuous wave; EROA = effective regurgitant orifice area; LA = left atrium; LV = left ventricular; MR = mitral regurgitation; PISA = proximal isovelocity surface area; RF = regurgitant fraction; RVol = regurgitant volumes; TEE = transesophageal echocardiogram; VCW = vena contracta width.

Reprinted with permission from Zoghbi et al.[1]

Quantitative measure on 2D echo.[2]

2D Vena contracta width (VCW).

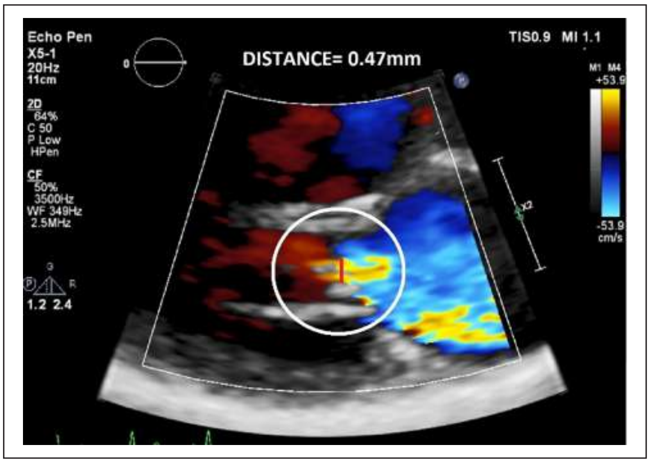


Figure 6. The VCW, measuring 0.47 mm, is the narrowest portion of the neck between the proximal flow convergence region (PFCR) and the flow expansion of MR jet into the atrium.

Image acquisition:

- PSLAX: Complete visualization of MR jet showing the largest MR jet size.
- Limitations of using the 3-chamber (3CH) view: suboptimal lateral spatial resolution.
- Limitations of using the 2-chamber (2CH) view: exaggeration of MR severity if the MR jet is asymmetrical because the parallel axis is occurring through the coaptation line.
- Transducer can be adjusted laterally, or angulated.
- Focus: At the level of valve.
- Zoomed view
- Depth and sector: minimized to focus on the valve.
- Color sector: Narrowing allows for better lateral and temporal resolution.
- Aliasing velocity: 50–70 cm/s.
- Color Doppler gain: Adjusted for noise.

Measurement:

- Assess each systolic frame, find the frame with the largest and cleanest vena contracta (VC).
- Measure end-to-end of color jet, perpendicular to MR jet.

Quantitative measure on 3D echo.[2]

3D Vena contracta area (VCA): direct planimetry.

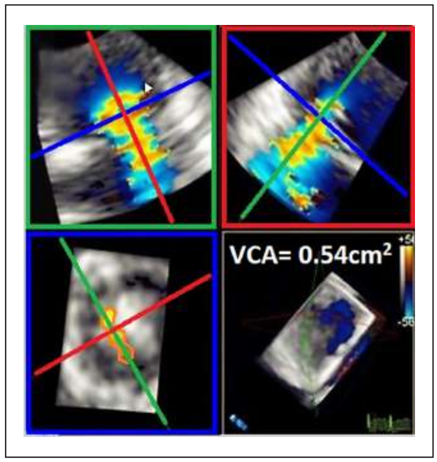


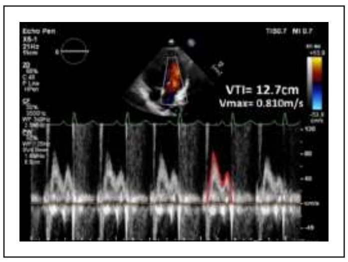
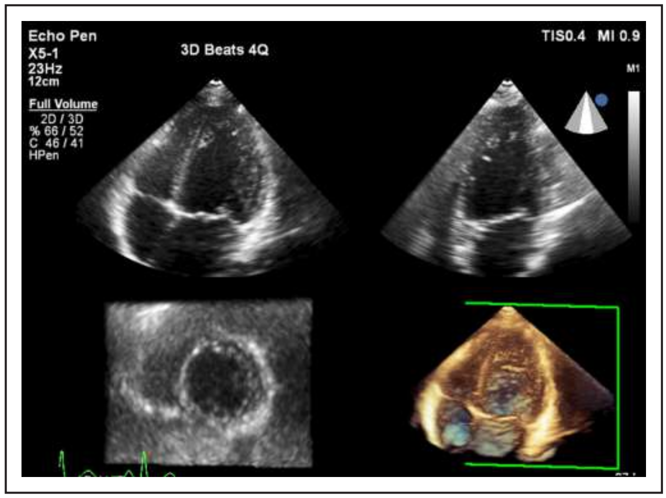
Figure 7. The VCA is the smallest cross-sectional area of the largest regurgitant jet identified during any systolic phase measuring 0.54 cm^2.

Image acquisition:

- Good ECG tracing.
- Optimized 2D views will ensure usable 3D data set acquisition.
- Can use the parasternal or apical transducer position.
- Clearly show proximal flow convergence region (PFCR), vena contracta (VC) and one-third of the downstream jet.
- Gain and compression: Midrange (50–60 units).
- Sector: Smaller lateral width and elevation height.
- Color Doppler sector: Small.
- Increasing the amount of heart beats during acquisition.
- Check for stitching artifact.
- Ensure that the structure being interrogated is completely included in the volume datasets.

Measurement:

- When post-processing 3D, the software will launch the 3D zoomed image from an optimized 2D image during the systolic phase.
- Analyze each frame to identify the largest and best visualized MR jet in longitudinal planes.
- Longitudinal planes (red and green lines) can be rotated through minor and major axes, which allow you to see what portion of the MV you are cutting through.
- The green plane slides between the anterior and posterior MV commissure, while the red plane slides through the scallops.
- The short axis planes (blue line) shows the cross-sectional area of the VC.

Quantitative measure on 2D echo.[2]	Quantitative measure on 3D echo.[2]
	– Move up and down between the coaptation line and the base of the PFCR hemisphere to identify the narrowest portion of the downstream color Doppler jet. – In a zoomed view, use the magnified enface image (blue box) to manually planimeter the VCA along the color/tissue interface.
2D volumetric methods to calculate RVol, RF, and EROA.[2]	**3D volumetric methods to calculate RVol, RF, and EROA.**[2]
Stroke volume method: PW Doppler at the Left Ventricular Outflow Tract and MV can be used to calculate stroke volumes to determine RVol and RF.  Figure 8A  Figure 8B **Image acquisition MV SV:** – Depth: minimized, zoom mode. – Sector width: reduced to focus on MV. – Focus: mitral annulus. – 4-chamber (4CH) view: no LVOT seen, LV is not foreshortened. – Cine-loop: Two cardiac cycles. – Inflow velocity: PW Doppler, 1–3 mm sample placed at the mitral annulus. – Sweep speed: 50–100 mm/s. – Spectral tracing: adequate gain settings, no spectral broadening. **Calculation:** Mitral Annular (MA) Diameter = 3.1 cm VTI mitral inflow = 12.7 cm $CSA_{MA} = \pi\ (MA_{DIAMETER}/2)^2$ $= 3.14\ (3.1/2)^2$ $= 7.54\ cm^2$ $SV_{MA} = (CSA_{MITRAL\ ANNULUS} \times VTI_{MITRAL\ INFLOW})$ $= 7.54\ cm^2 \times 12.7\ cm\ = 95.86\ mL$	3D LV volumes can be used to calculate LV stroke volumes  Figure 9 **Image acquisition 3D LV:** – For the LV: check the long axis images and short axis images displayed in the "4 quadrant view" to ensure that all walls are included from the base to the apex. – Optimize blood-tissue borders of the LV as this has an enormous impact on volumes and ejection fraction. – Suboptimal adjustment of gains: do not measure datasets where there isn't a clear delineation of LV cavity. – This happens when there is movement of the probe, patient respiration, or cardiac motion during acquisition, which causes pyramidal volumes to become unaligned.

Quantitative measure on 2D echo.[2]

Figure 10A

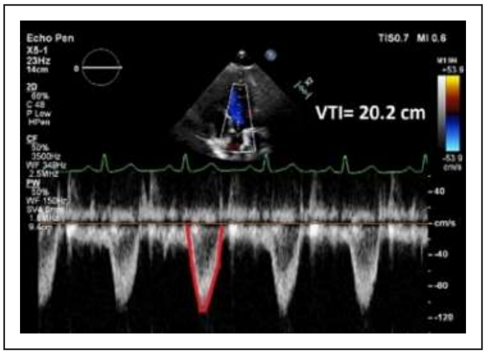


Figure 10B

Image acquisition AV SV:

– Zoomed PSLAX to measure LVOT diameter.
– Depth and focus optimized to see LVOT.
– PW of LVOT: 5 mm proximal to the aortic valve to measure LVOT flow.

Calculation:

LVOT Diameter = 1.5 cm
VTI^{LVOT} = 20.2 cm

$CSA_{LVOT} = \pi\,(LVOT_{DIAMETER}/2)^2$
$= 3.14\,(1.5/2)^2$
$= 1.766\ cm^2$

$SV_{LVOT} = (CSA_{LVOT} \times VTI_{LVOT})$
$= 1.766\ cm^2 \times 20.2\ cm$
$= 35.67\ mL$

$RVol = SV_{MITRAL\ ANNULUS} - SV_{LVOT}$
$= 95.86\ mL - 35.67\ mL$
$= 60.19\ mL$

$RF = RVol/SV_{MITRAL\ ANNULUS}$
$= 60.19\ mL/95.86\ mL$
$= 0.63$ or 63%

$EROA = RVol/VTI_{MR}$
$= 60.19\ mL/79.3\ cm$

Quantitative measure on 3D echo.[2]

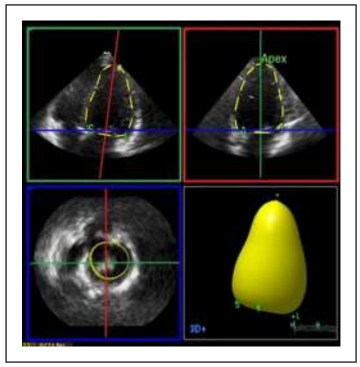


Figure 11A

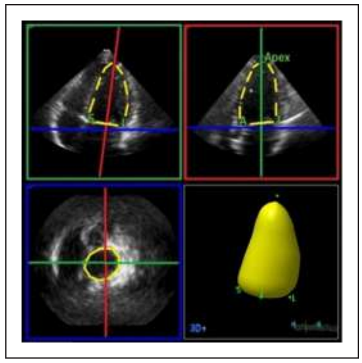


Figure 11B

Measurement:

Review the contours and adjust by using the cursor to select segments that need to either be pulled out or into the compacted myocardium in both end-diastolic and end-systolic volumes.

Calculation:

$3D\ SV = 3D\ LV\ EDV - 3D\ LV\ ESV$
$= 226.69 - 127.23$
$= 99.46\ mL$

$SV_{LVOT} = (CSA_{LVOT} \times VTI_{LVOT})$
$= 1.766\ cm^2 \times 20.2\ cm$
$= 35.67\ mL$

$RVol = 3D\ SV - SV_{LVOT}$
$= 99.46\ mL - 35.67\ mL$
$= 63.79\ mL$

$RF = RVol/3D\ SV$
$= 63.79\ mL/99.46\ mL$
$= 0.64$ or 64%

$EROA = RVol/VTI_{MR}$
$= 63.79\ mL/79.3\ mL$
$= 0.80$

Quantitative measure on 2D echo.[2]

2D Proximal isovelocity surface area (PISA) method to calculate RVol, RF, and EROA.

Figure 12

Image acquisition:

- Optimal images are usually acquired in the 4- or 3-chamber views to ensure that the direction of flow aligns with the insonation beam.
- Adjust the sector width and depth to get the highest possible temporal and spatial resolution.
- Color sector: include the mitral valve and a small part of LV and LA.
- Aliasing velocity: 20–40 cm/s
- Lower the Nyquist limit by shifting the baseline color in the direction of the MR.
- View each frame, identify the largest proximal flow convergence region (PFCR) with a clear isovelocity shell and clear hemispheric shape.

Quantitative measure on 3D echo.[2]

3D PISA method to calculate RVol, RF, and EROA

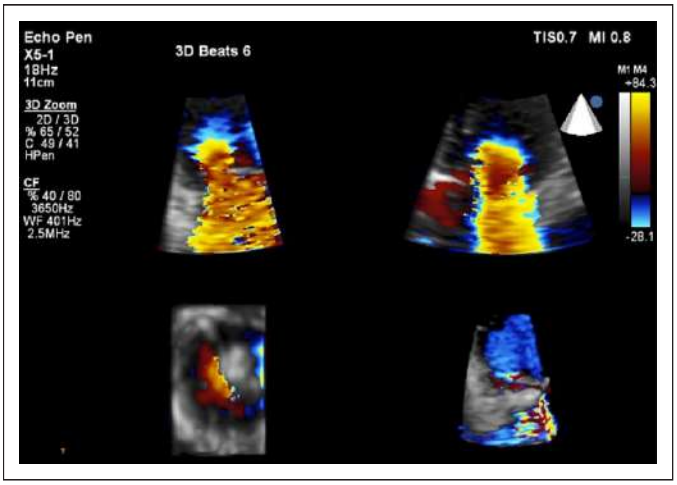


Figure 13

Image acquisition:

- From the apical view, acquire a 3D zoomed image from an optimized 2D image.
- Using the "4 quadrant view," check to ensure that the mitral valve annulus, leaflets, and complete MR jet are captured in the volume sector throughout the entire cardiac cycle with no drop out.
- Ensure color optimization and no alignment artifacts.
- Proximal flow convergence region (PFCR): center of the acquisition volume.
- Single heartbeat: reduces temporal resolution, aim for multiple beats.
- Size of 3D volume sector: affects temporal resolution.
- Depth: decreasing the depth will increase frame rates.
- Volume rate: >10 vol/s.
- Line density: medium or high.

Quantitative measure on 2D echo.[2]

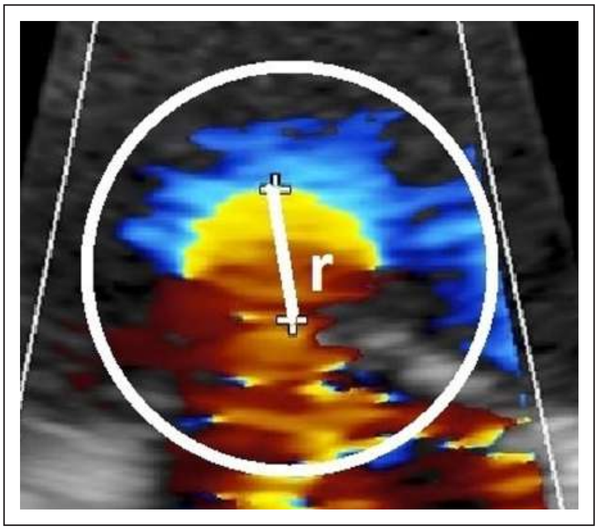


Figure 14

Measurement:

– Measure radius from the outer surface (red–blue aliasing interface) to the center of the MR orifice (VA).

Calculation:

Regurgitant Flow Rate (RFR) = PISA ($2\pi r^2$) × V_{Alias}
= 2 × 3.14 × $(0.7\text{ cm})^2$ × 28.1 cm/s
= 86.51 mL/s

EROA = RFR/$Vmax_{MR}$
= 86.51 mL/s/3.87 m/s
= 22.34 mm^2

RVol = EROA × VTI_{MR}
= 22.34 mm^2 × 0.79 m
= 17.65 mL

RF = RVol/SV_{LVOT}
= 17.66 mL/35.67 mL
= 0.49 or 49%

Quantitative measure on 3D echo.[2]

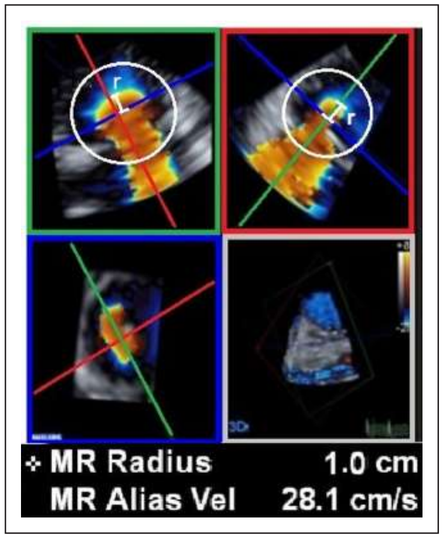


Figure 15

Measurement:

– In the four quadrants displayed, find an optimal view of the MR jet.
– Identify the systolic frame with the largest and best visualized PFCR.
– Color Doppler aliasing velocity for Proximal isovelocity surface area (PISA): shift in the direction of the MR jet between 20 and 40 cm/s.
– Red and green quadrants: display a long-axis view of PFCR, move parallel to MR orifice.
– View each frame, identify the largest PFCR with a clear isovelocity shell and hemispheric shape. Find the largest vertical radius for PISA and measure (follow 2D guidelines).

Calculation:

Regurgitant Flow Rate (RFR) = PISA ($2\pi r^2$) × V_{Alias}
= 2 × 3.14 × $(1.0\text{ cm})^2$ × 28.1 cm/s
= 176.56 mL/s

EROA = Regurgitant flow rate/$Vmax_{MR}$
= 176.56 mL/s/3.87 m/s
= 45.6 mm^2

RVol = EROA × VTI_{MR}
= 45.6 mm^2 × 0.79 m
= 36.04 mL

RF = RVol/SV_{LVOT}
= 36.04 mL/**35.67** mL
= 1.01 or **101%**

Discussion

The 2D VCW measured 4.7 mm (Figure 6), suggestive of moderate MR. The 2D PISA radius (Figures 12 and 14) measured 0.7 cm at an aliasing velocity of 28.1 cm/s, which resulted in a calculated EROA of 0.22 cm^2 and regurgitant volume of 18 mL/beat. This was indicative of mild to moderate MR according to the current guidelines; however, it was felt to be underestimated.[1] There are limitations with 2D Doppler alignment during acquisition, which are reflective of the inconsistencies seen in calculations.

Using the 3D dataset, additional length and width measurements of the base of the PISA could be visualized, which is used to generate a more accurate EROA. The multiple orthogonal planes could help obtain the largest PISA radius possible. The 3D PISA radius measured 1.0 cm (Figure 15), which was used to calculate an EROA of 0.46 cm^2 and a regurgitant volume of 36.04 mL/beat. The 3D VCA at an aliasing velocity set between 50 and 60 cm/s was measured at 0.54 cm^2 (Figure 7). The advantage of unlimited plane orientation allows the exact shape and size of the true regurgitant orifice to be measured along with consistency in quantification.

According to the current guidelines of the American Society of Echocardiography (ASE), generally a 3D EROA ≥ 0.4 cm^2 is consistent with severe MR, 0.20–0.39 cm^2 with moderate, and <0.20 cm^2 with mild MR.[1] A 3D VCA > 0.4 cm^2 denotes severe MR.[1]

Conclusion

With the information gained from post-processing of 3D datasets and decompensation of LV function, the MR was determined to be severe and the patient underwent surgical intervention.

This case study highlights that severity classification is not based on the assessment of a single 2D color Doppler frame as there are limitations with image quality during acquisition and interobserver variability. This limitation causes variabilities and inconsistencies during quantification. Cardiac valves are anatomically a 3D structure and an integrative approach using 3D imaging is the most beneficial technique for patients as it proves to be more accurate and reproducible.

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Article title: 2D and 3D Imaging and Quantification of Mitral Regurgitation

Author's Names: Babitha Thampanathan and Jason Michalakos

1. To ensure the mitral regurgitation profile jet is best demonstrated use:

a) Pulsed wave Doppler
b) Continuous wave Doppler
c) Pulsed wave & colour Doppler
d) Continuous wave & colour Doppler

2. When evaluating the PISA radius, ensure the Nyquist limit is set at which of the following:

a) 10-20 cm/s
b) 20-30 cm/s
c) 30-40 cm/s
d) 40-50 cm/s

3. According to ASE guidelines, severe mitral regurgitation includes all the following parameters except:

a) Effective Regurgitant Orifice Area <0.2cm^2
b) Pulmonary vein systolic flow reversal
c) Vena Contracta width >0.7 cm
d) Regurgitant volume >60ml

4. All of the following can result in dataset misalignment, except:

a) Cardiac Motion
b) Good ECG capture
c) Movement of the probe
d) Patient respiration or movement

5. The authors argue that assessment of mitral regurgitation severity can be further verified by which of the following:

a) TEE
b) Cardiac MR
c) 2D Angio Doppler
d) 3D Colour Doppler

Case Report

Jia Qian Lu BMRSc, RDMS, CRGS, DMS

Diagnosing Invasive Lobular Carcinoma of the Breast: A Case Report

About the Authors

Jia Qian Lu is a Generalist Sonographer and works at the Breast Cancer Centre at Sunnybrook Health Sciences Centre in Toronto, Ontario. She has a bachelor's degree in Medical Radiation Sciences from McMaster University and an Advanced Diploma in Ultrasonography from Mohawk College. She also has certificates in Clinical Education and Leadership in Health Care from the Michener Institute of Education at UHN.

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ABSTRACT
Invasive lobular carcinoma (ILC) represents only 10–15% of all invasive breast cancers. Owing to challenges in screening and detection, diagnosis of ILC is often delayed and susceptible to high false-negative rates. This is a case report of ILC illustrated by mammography, ultrasound, magnetic resonance imaging and ultrasound-guided core-needle biopsy in a postmenopausal female.

Keywords: invasive lobular carcinoma; magnetic resonance imaging; mammography; multimodality; ultrasound

Introduction
Invasive lobular carcinoma (ILC) represents 10–15% of invasive breast cancers.[1] Histologically, it is comprises noncohesive cells organized individually in a single-file linear pattern in a fibrous stroma.[2] There are challenges in the detection of ILC because of the lack of signs and symptoms (S&S). With mammography, lack of architectural distortion and microcalcifications,[1] and the lack of mass formation, makes it challenging to definitively diagnose ILC. Diagnosis of ILC is often delayed[1] due to lack of signs and symptoms and the challenges with imaging detection along with high false-negative rates.[3] Use of multimodality breast imaging is encouraged in diagnosing ILC. In this report, a clinical case using mammography, ultrasonography (US), and magnetic resonance imaging (MRI) for diagnosing ILC of the breast is presented.

Case Report
A 76-year-old postmenopausal female presented in the breast imaging department with fullness and tethering above and around her previous surgical scar on the left breast. She was referred by her family medicine physician. In 2001, she had a lumpectomy for ductal carcinoma *in situ* and fibroadenoma. The initial diagnostic imaging examination was a mammogram with standard craniocaudal (CC) and mediolateral oblique (MLO) views of the left breast.

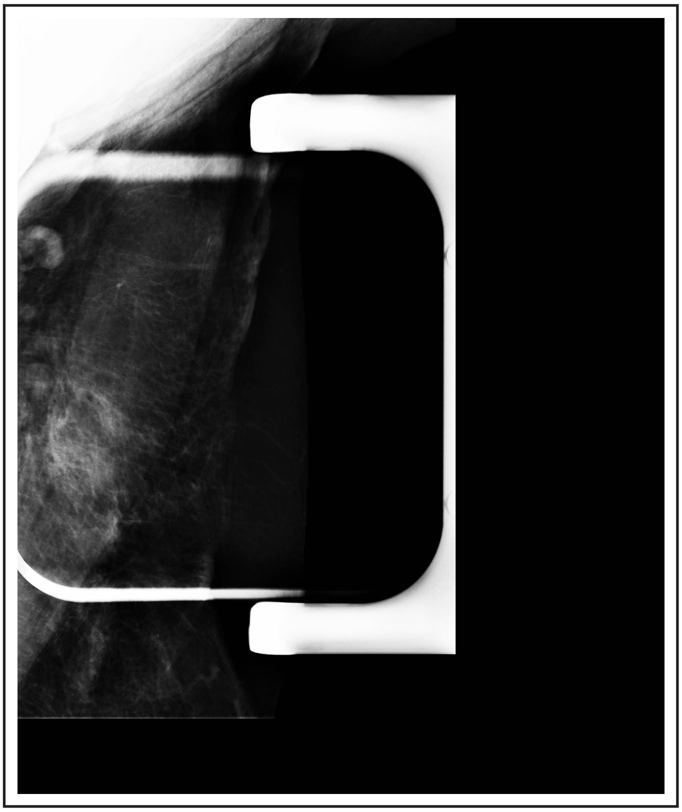

Figure 1. Mammogram. MLO view, close to previous lumpectomy scar.

An additional spot, MLO view of the patient's area of concern (AOC) in the axillary region, close to her previous lumpectomy scar was performed (Figure 1). The radiologist reported an ill-defined asymmetry, superior and lateral to the scar and remarked on the difficulty in definitively characterizing the asymmetry because of the presence of scar.

Following the mammogram, an ultrasound examination was also performed due to a specific AOC stated by the patient. After identifying the patient and obtaining verbal informed consent, sonographer completed ultrasound examination of the breast. The sonographer noted a prominent post-surgical scar in the upper outer quadrant of the left breast (LUOQ), creating indentation of the skin with fullness superior and lateral to the scar. Instead of a targeted scan, the entire left breast and axilla were scanned to ensure optimal scanning. The patient was positioned supine right posterior oblique with a supporting sponge under the left shoulder and the left arm raised above the head. The left breast and axilla were exposed, ultrasound gel was applied to this area. The patient's left arm was raised up while resting on a rolled towel for patient's comfort. A Philips IU22 ultrasound system with the linear array L17-5 transducer and a breast preset were utilized. The ultrasound study was performed by the sonographer, followed by the attending breast radiologist. The sonographer's technical impression indicated no axillary lymphadenopathy and an ill-defined area with posterior acoustic shadowing at the tail of the axilla. The radiologist's report confirmed an ill-defined area located at 1 o'clock (OC) position, 9 cm from the nipple (CFN), measuring 2.1 × 2.1 × 1.6 cm (Figures 2–4), superior and lateral to scar,

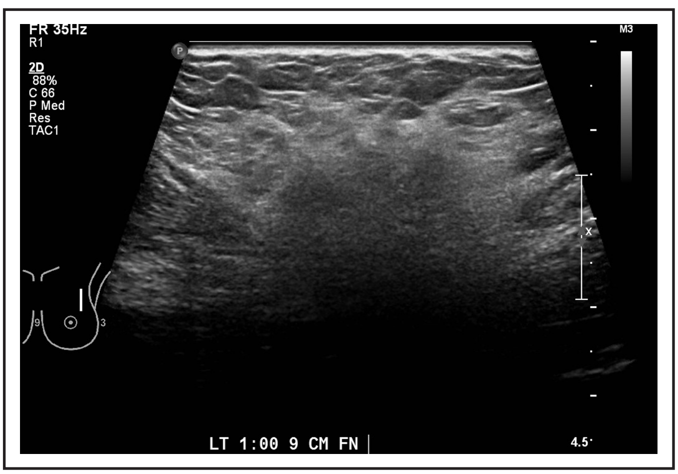

Figure 2. Ultrasound. L Breast- Ill-defined area located at 1 OC, 9 (CFN), measuring 2. 2 x 2.1 cm

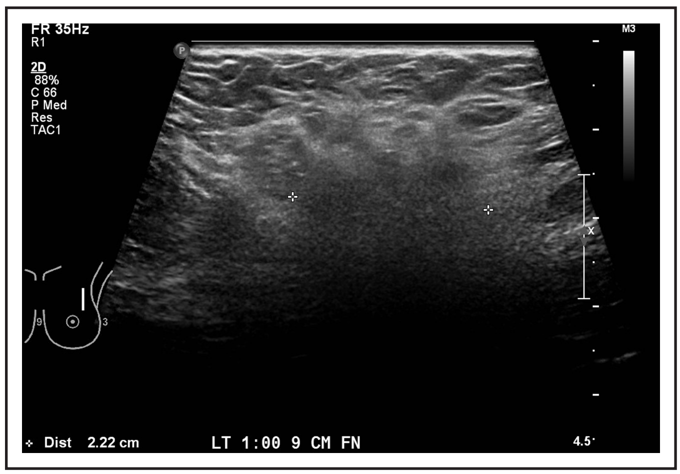

Figure 3. Ultrasound. L Breast- Ill-defined area located at 1 OC, 9 (CFN), measuring 2. 2 x 2.1 cm

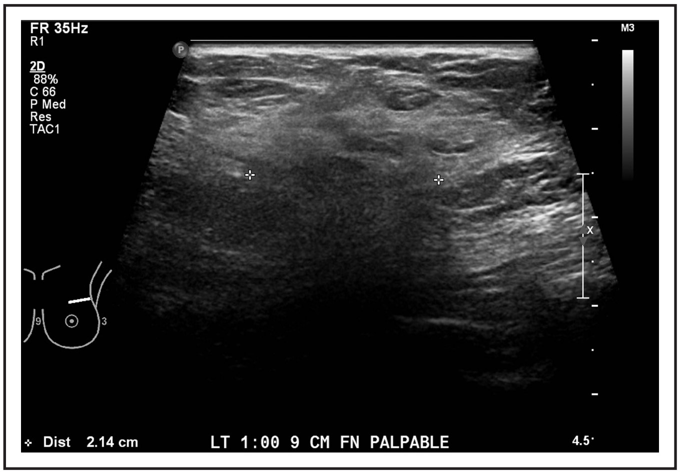

Figure 4. Ultrasound. L Breast- Ill-defined area located at 1 OC, 9 (CFN), measuring 2. 2 x 2.1 cm

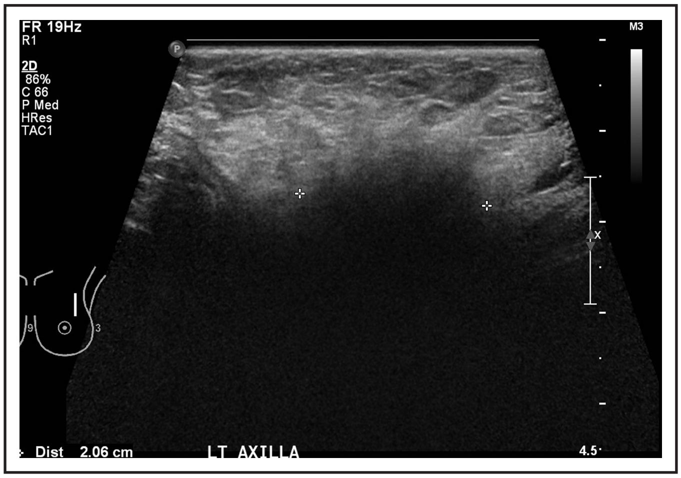

Figure 5. Ultrasound: L Breast. Using tissue harmonics to emphasize areas of shadowing.

located in the L axillary tail of the left breast. Owing to difficulty in characterizing this suspicious area on both mammogram and ultrasonography, an MRI was recommended by the radiologist.

Most malignancies enhance rapidly and wash out quickly on MRI. In this case, on the delayed phase (Figure 8), the surgical scar and nearby lesion still enhanced and the contrast did not wash out. Surgical scars normally do not enhance on MRI, especially when the scar is due to a surgery dating back in 2001. In this case, the scar enhanced right away, as shown in Figure 7. Figures 6–8 demonstrate the presence of surgical scar before giving the injection of contrast on T2-weighted image, and the scar and surrounding area post-injection in T1-weighted and delayed phases. In Figure 6, the image demonstrates the pre-gadolinium (gadovist) T1-weighted surgical scar on the left breast. Figure 7 demonstrates the T1-weighted post-gadolinium dynamic image of the left

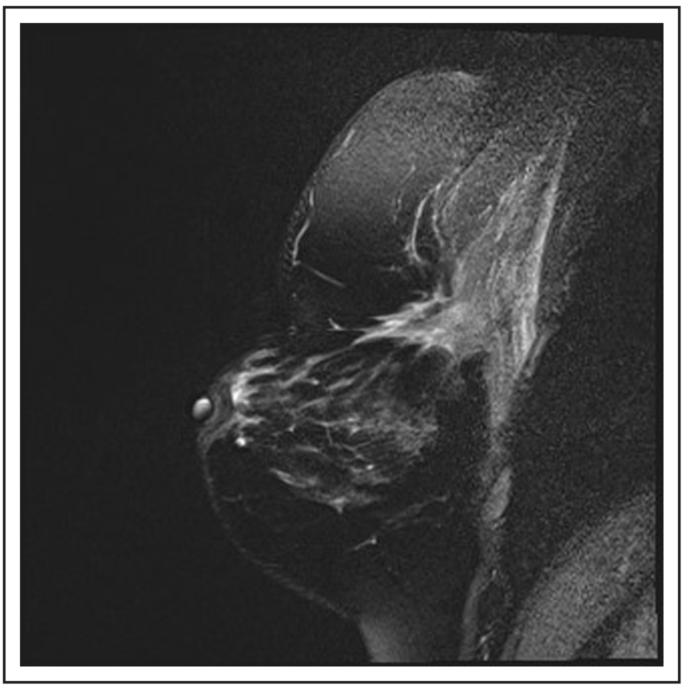

Figure 6. Pre-gadolinium (gadovist) T1-weighted surgical scar on the left breast.

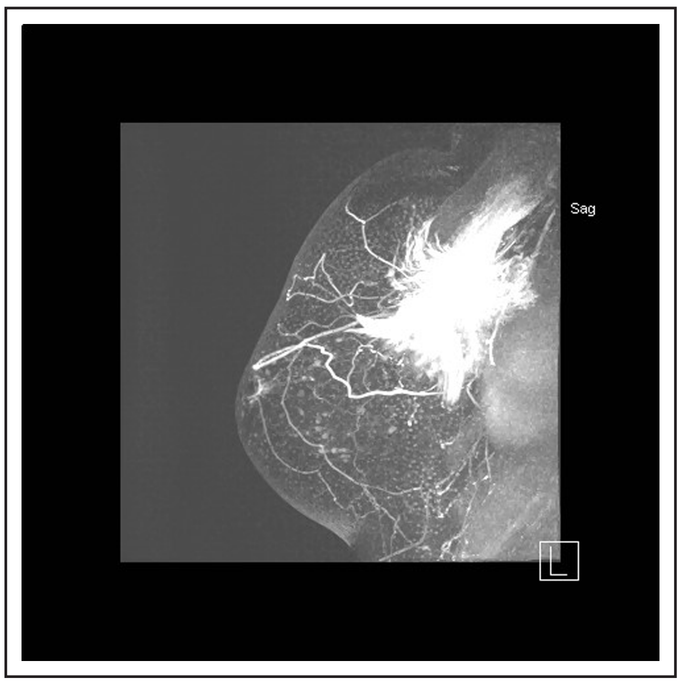

Figure 7. T1-weighted post-gadolinium dynamic image. Enhancement beyond the scar.

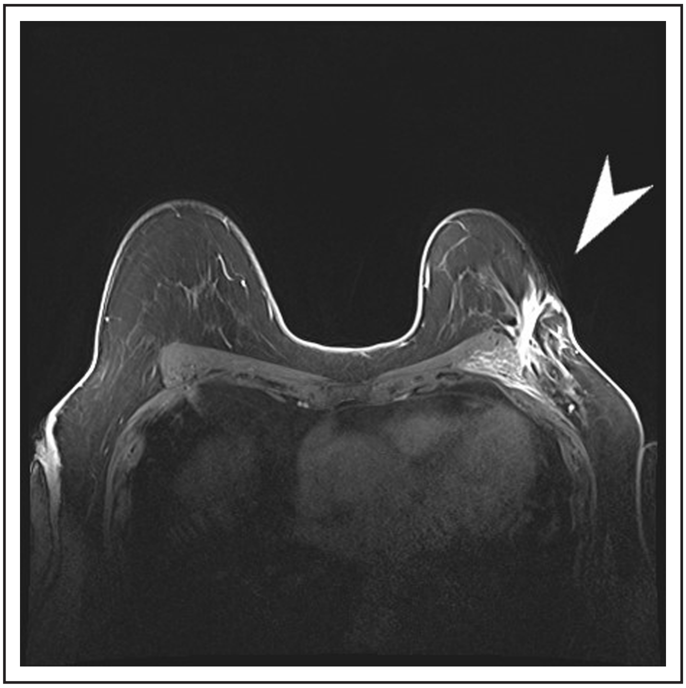

Figure 8. Delayed phase of post-gadolinium T1-weighted axial view; enhanced surgical scar and the abnormal area.

breast. Figure 7 is a maximum intensity projection (MIP) of the first phase, 60 s after injection of gadolinium, showing enhancement beyond the scar. Figure 8 demonstrates the delayed phase of post-gadolinium T1-weighted axial view; the enhanced surgical scar and the abnormal area are also observed. The MRI report concluded that the patient's AOC is most likely the area of malignancy, and that the enhancement during initial phase and delayed phase support this finding. The MRI report also noted post-operative distortion with skin retraction of the AOC and described an enhanced 6.4 × 4.5 × 5.1cm irregular area with speculated borders extending into the axilla with extension from subcutaneous tissues to the chest wall with enhancement of the pectoralis major muscle and the tissues between the pectoralis major and minor muscles. The extent of enhancement in the pectoralis muscle measured approximately 8.8 × 7.7 × 3 cm. It was observed that the MRI indicated much larger affected area with possible mass extension into the anterior chest wall. The radiologist recommended an ultrasound-guided core-needle biopsy of the mass. After patient's identification by the sonographer and informed consent of the breast radiologist, an ultrasound-guided core-needle biopsy, using

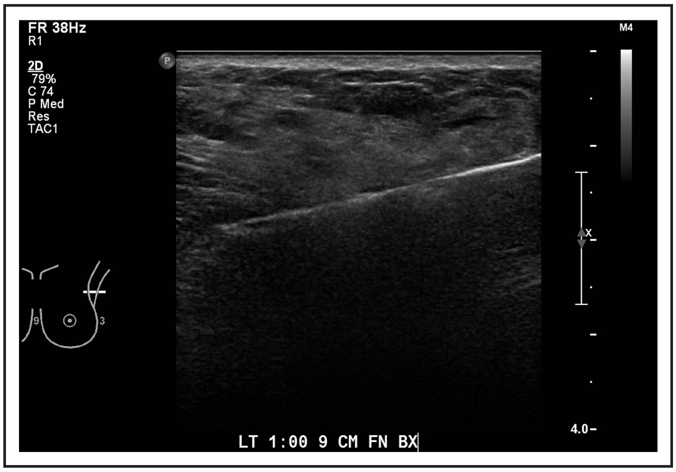

Figure 9. Ultrasound. Ultrasound-guided core-needle biopsy of the mass.

14G-10CM trucut core biopsy needle, was performed in the breast imaging department (Figure 9). The patient orientation/set-up on stretcher and opening of sterile biopsy tray were made by the sonographer. While the ultrasound-guided biopsy was performed by the breast radiologist, the sonographer assisted in taking and documenting ultrasound images and depositing the samples into a formalin jar. Five core samples were sent for analysis to pathology department. The pathology noted the following: "Invasive breast carcinoma, lobular type, intermediate grade with lymphovascular invasion present. It is 100% positive for estrogen receptors and 80% positive for progesterone receptors. The human epidermal growth factor receptor 2 (HER-2) is negative."

The surgical oncologist and breast surgeon recommended staging for the patient's clinical T4 tumor and requested a computed tomography (CT) scan of the chest, abdomen, pelvis, and bones. Owing to the involvement of muscles in the chest wall, the patient having surgical resection at that time was not recommended. The patient was referred to a medical oncologist for consideration of systemic therapy, possibly neoadjuvant chemotherapy.

Discussion

This patient had a history of ductal carcinoma *in situ*. The majority of both ILC and invasive ductal carcinoma (IDC) are positive for estrogen and progesterone receptors.[2] Initially, mammogram and ultrasound were requested, since the patient had a tethering sensation around her previous surgical scar. The mammography result was inconclusive due to the lack of obvious mass formation and asymmetry from previous surgery. The ultrasound examination was also inconclusive and it was difficult to characterize the observed ill-defined area. With respect to diagnostic imaging, lack of mass details and characteristics on mammography and ultrasonography is a feature of ILC, unlike the imaging characteristics of other types of breast carcinomas. In terms of differential diagnoses, IDC is an option because of the frequency of occurrence, as it makes up the other 80% of invasive breast cancers.[1] Regarding the learning and teaching points in ultrasound, it is important to interrogate AOC slowly and steadily with transducer, ensuring full contact and sufficient use of ultrasound gel. Ensure that the focal zone is at or just posterior to AOC, and adjust to the highest possible frequency while maintaining penetration and optimal resolution. Fullness felt by patient can sometimes be erroneously assumed to be caused by the presence of a surgical scar. Although scarring can cause an altered look to normal breast tissue, it is important to think of potential malignancy processes. Careful correlation should be exercised with ultrasound image and scar on the skin. It is important to pay close attention to areas of fullness and roping around AOC. While assessing the ultrasound study, look closely at any ill-defined areas or areas of shadowing that just do not seem to "look right." Applying tissue harmonics can help to emphasize areas of shadowing for easier detection (Figure 5). Despite new ultrasound technology, such as 3D and elastography, diagnoses of ILC is not made solely on the basis of imaging. In this case, diagnosis was confirmed with a core-needle biopsy result. Overall, the ultrasound-guided core-needle biopsies have 97–99% sensitivity.[4]

Conclusion

This case report emphasizes that diagnosis of ILC of the breast is challenging due to lack of its signs and symptoms as well as the challenges to visualize it on different diagnosing imaging modalities, thus necessitating the use of more than one modality. This case followed the patient's diagnostic journey through an inclusive mammogram, a suspicious ultrasound because of posterior acoustic shadowing associated with an ill-defined area, and followed to have a conclusive MRI that showed vast extension of this mass into the anterior chest wall. MRI is the gold standard for ILC and is excellent for mapping the extent of this disease, especially with contrast. Ultrasound-guided core-needle biopsy, along with a staging CT scan, is recommended to confirm the diagnosis of ILC in this patient. All imaging modalities play a diagnostic role in ILC, and there are many imagers that are required to provide compassionate and competent care to the patient.

Acknowledgment

Special thanks to Dr. Belinda Curpen (breast imaging radiologist) and Joanne Feng (MRI and mammography technologist) for their guidance and expertise. Images were used with permission obtained from chief privacy officer and director of medical imaging at Sunnybrook Health Sciences Centre.

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Article title: Diagnosing Invasive Lobular Carcinoma of the Breast: A Case Report

Author's Names: Jia Qian Lu BMRSc, RDMS, CRGS, DMS

1. What makes detecting Invasive Lobular Carcinoma of the Breast so challenging?

a) Lack of clinical signs
b) Lack of mass formation in pathophysiology
c) Lack of microcalclfication in mammography
d) All of the above

2. Which of the following imaging modality plays an important role in diagnosing ILC?

1) Mammography
2) Ultrasonography
3) Nuclear Medicine
4) Magnetic Resonance Imaging

a) 1,2,3
b) 1,2,4
c) 1,3,4
d) 2,3,4
e) All of the above

3. What is the most appropriate transducer frequency to evaluate the breast?

a) C1
b) L9
c) L17
d) EV10

4. What is the immediate next step when findings are inconclusive on mammography and sonography when suspecting ILC?

a) MRI
b) Fine needle aspiration
c) 2 months follow up with ultrasound
d) 6 months follow up with mammogram

5. What is the sensitivity of ultrasound guided core breast biopsies?

a) 5 to 10%
b) 10 to 15%
c) 70 to 80%
d) 97 to 99%

Original Research

Sarah Hogan, BSc
Connie Hapgood, MD, FRCPC

Use of Ultrasound for Breast Pain in a Newfoundland Cohort

ABSTRACT

Background and objective: Breast pain is a common complaint for which ultrasound is often used for evaluation. The purpose of this study was to determine the number and outcome of breast ultrasounds conducted in patients having breast pain with no other associated clinical features.

Method: All patients who underwent breast ultrasound for breast pain at a local hospital from January 1, 2016 through December 31, 2018 were identified. The result of each ultrasound was recorded along with variables such as clinical features (palpable lump, nipple discharge, and skin dimpling), age, sex, pain characteristics, menopausal status, and family/personal history of breast cancer.

Results: A total of 1660 ultrasounds (12.8%) for breast pain were performed at a local hospital center, accounting for 12.8% of the total breast ultrasounds done during the stated period. The age range of the patients was 17–91 years, with a mean age of 45.4 years and standard deviation (SD) being 15 years. Most of the patients had no clinical findings associated with their pain (64%). More abnormal ultrasound findings in patients with clinical features (29%) were determined compared to patients with no clinical features (16%). The majority of abnormal ultrasounds in patients with no clinical features were done in patients aged 41–50 years (13.9%), and patients aged >50 years (10.9%). No abnormal findings in patients aged <20 years were detected, and only 15 patients (6.5%) aged 21–30 years with no clinical findings had abnormal ultrasounds.

Conclusion: Patients aged 17–30 years had the lowest abnormal finding rate, with no cancerous outcomes. These results support the prudent use of breast ultrasound in case of young patients.

Keywords: breast; radiology; ultrasound

Introduction

Breast pain is a common problem found in women and is reported to affect almost 70–80% at some point during their lives.[1,2] In the vast majority of patients, the etiology of breast pain is benign.[3] Recent studies have shown that breast pain alone is rarely associated with malignancy (0.2–1.2%).[1,4–6] Breast pain and malignancy are found in patients aged on average 52 years.[5]

Breast ultrasound is a common investigation done for breast pain.[7] According to the Canadian Association of Radiologists (CAR), breast ultrasound is indicated in patients having focal, persistent, and noncyclical breast pain with clinical findings such as skin dimpling, nipple discharge, and palpable lumps.[8] However, even in these cases, cancer as an etiology is rare.[2] These guidelines are echoed by the American College of Radiology (ACR), which states that breast ultrasound is appropriate for breast pain if it is noncyclical and focal.[2] This is also reiterated by the European Society of Breast Imaging, which recommends that breast ultrasound is definitely recommended in patients with clinical findings such as a palpable lump, nipple discharge, and skin changes.[9]

Breast ultrasound has become quite common and overused in the settings of breast pain.[10] Studies recommend a mammogram in patients aged >40 years presenting solely with breast pain, and reassurance alone should be provided for women aged <40 years stating breast pain.[10] The American College of Radiology Appropriateness Criteria expert panel recommends that ultrasound should be used in patients aged <30 years presenting with significant breast pain. The criteria state that ultrasound or mammogram can be used in case of women aged 30–39 years having breast pain. Both ultrasound and mammogram could be used in patients aged >40 years.[11]

At our center, many referrals for breast ultrasound are not indicated based on current criteria. Inappropriate imaging of breast pain puts patients at risk of unnecessary procedures in the future and inefficient utilization of ultrasound. Although mammogram is recommended as the first line of investigation for women aged >40 years with breast pain, we often use ultrasound at our center, which leads to long waiting period for these services. For this reason, we chose to focus this study on the use of ultrasound alone.

Therefore, the objective of this study was to characterize the use of breast ultrasound for patients presenting with breast pain at our center.

Method

The design of this study was a retrospective audit. Appropriate approval for this project was obtained from the regional Health Ethics Research Board (HREB). A consecutive sample of male or female patients who underwent ultrasound for breast pain from January 1, 2016 to December 31, 2018 was collected at St. Clare's Mercy Hospital in St. John's, Newfoundland and Labrador, Canada. The patients were selected through Picture Archiving and Communication System (PACS) and by using the search engine "Mpower." Following keywords were used to identify the ultrasounds completed for breast pain during the stated time frame: breast pain, breast tenderness, and mastalgia. The scans were identified by accession numbers. The variables recorded included age, sex, menopausal status, pain characteristics, presence of a palpable lump/dimpling, breast feeding, pregnancy/postpartum status, family or personal history of breast cancer, history of hormone replacement, nipple discharge, infectious signs, and recent trauma or surgery (within 1 year).

We recorded the mammogram performed within a year along with the results of all performed ultrasounds. The data were stratified into the following age groups: <20 years, 21–30, 31–40, 41–50, and >50 years. Patients with a known diagnosis of current breast cancer, and those aged <17 years were excluded from the study.

The outcomes were ultrasound findings (no findings, benign findings, and malignant findings) and subsequent diagnosis of cancer on follow-up radiological imaging performed within a year following the original breast ultrasound.

Data analysis was conducted using IBM SPSS Software (Armonk, NY), with $\alpha = 0.05$. We entered the following variables to run a multivariate logistic regression:

postmenopausal status, age, palpable lump, nipples discharge, signs of infection, unilateral pain, hormone replacement therapy (HRT), recent trauma or surgery, pregnancy status, breast feeding or postpartum status, and family or personal history of breast cancer. The outcome was cancer.

Results

A total of 12,986 breast ultrasounds were performed at our hospital between January 1, 2016 and December 31, 2018. Of these, 1660 (12.8%) were done for breast pain, which included 1559 (93.92%) female and 101 (6.08%) male patients. The age of female patients ranged from 17 to 90 years, with an average age of 44.6 years (SD = 14.8). The age of male patients ranged from 17 to 91 years, with an average age of 57.2 years (SD = 17.9).

Table 1 describes the findings of female patients. Of the 1559 breast ultrasounds performed for breast pain in females, 993 had no associated clinical findings, accounting for 63.7% of performed ultrasounds. In this group of no clinical findings, 851 (85.7%) patients went on to have a normal breast ultrasound. However, two (0.24%) cancer patients, both aged >50 years, were found in this group. In this group of no clinical findings, 142 (14.3%) females had an abnormal breast ultrasound. Four (2.81%) of these patients had a subsequent cancer diagnosis, with one cancer patient aged >50 years, two patients with cancer aged between 41 and 50 years, and the fourth cancer patient aged between 31 and 40 years. No cancer was determined in patients with an abnormal ultrasound aged <31 years. Cancer diagnosis was established based on ultrasound results or subsequent imaging.

Comparatively, 566 female patients with breast pain, in addition to clinical findings, presented for ultrasound. This accounted for 36.3% of the ultrasounds

Table 1: Number of normal and abnormal ultrasounds based on clinical findings in females

Age	No clinical finding + abnormal US	No clinical finding + normal US	Clinical finding + abnormal US	Clinical finding + normal US	Sum
≤20	0 (0%) 0 cancers	18 (1.15%) 0 cancers	2 (0.13%) 0 cancer	15 (0.96%) 0 cancers	35
21-30	14 (0.89%) 0 cancers	129 (8.27%) 0 cancers	13 (0.83%) 0 cancers	68 (4.36%) 0 cancers	224
31-40	45 (2.89%) 1 cancer	249 (15.97%) 0 cancers	46 (2.95%) 1 cancer	127 (8.17%) 0 cancers	467
41-50	45 (2.89%) 2 cancers	150 (9.62%) 0 cancers	40 (2.56%) 0 cancer	97 (6.22%) 1 cancers	332
>50	38 (2.44%) 1 cancers	305 (19.56%) 2 cancers	54 (3.46%) 12 cancers	104 (6.67%) 0 cancers	501
SUM	142	851	155	411	1559

performed in females having breast pain. In this group of clinical findings, 411 (73.6%) females went on to have a normal breast ultrasound. One (0.24%) cancer patient, aged 41–50 years, was determined in this group.

In the group of patients with clinical findings, 155 (27.4%) patients had an abnormal ultrasound. A total of 13 (8.39%) cancer patients were identified in this group, with one (0.65%) cancer patient aged 31–40 years, and 12 (7.74%) cancers patients aged >50 years.

Table 2 describes the findings of male patients. In all, 53 (52.5%) male patients had no clinical findings. In this group of male patients with no clinical findings, 26 (49.1%) had abnormal ultrasounds, and 27 (50.9%) had normal ultrasounds. There were 48 (47.5%) male patients with clinical findings. In this group of male patients with clinical findings, 26 (54.2%) had abnormal ultrasound and 22 (45.8%) had normal ultrasound. The majority of male patients who had ultrasound for breast pain were aged >50 years. No cancer was detected in male patients, and the primary finding was gynecomastia.

Table 3 illustrates the distribution of other variables in our patient population. Most of the patients had unilateral pain (1359; 87.2%). Few patients had a history of recent trauma or surgery (58; 3.72%), and very few patients were either pregnant, postpartum, or breastfeeding (37; 2.37%); 346 (22.2%) patients had a family or personal history of breast cancer. The majority of patients were pre-menopausal females (1005; 65.5%).

The nonmalignant ultrasound findings in female patients included simple cysts, benign fibroadenomas, benign lymph nodes, lipomas, mild ductal ectasia, small abscess, and post-operative hematoma. The most common benign ultrasound finding was simple cysts. No malignant ultrasound finding was determined in male patients who underwent ultrasound for breast pain.

We performed a multivariate logistic regression to determine the effects of age, pregnant/postpartum/breast feeding status, recent trauma or surgery, HRT, cyclic pain, menopausal status, palpable lump, nipple discharge, and signs of infection in case of breast cancer diagnosis. Palpable lump ($P = 0.002$, $B = -1.373$, standard error (SE) = 0.472, Wald test = 8.466) and age were significant predictors of breast cancer ($P < 0.001$, $B = 0.074$, $SE = 0.016$, Wald test =

Table 2: Number of normal and abnormal ultrasounds based on clinical findings in males

Age	No clinical finding + abnormal US	No clinical finding + normal US	Clinical finding + abnormal US	Clinical finding + normal US	Sum
≤20	0 (0%) 0 cancers	0 (0%) 0 cancers	2 (0.98%) 0 cancers	0 (0%) 0 cancers	2
21-30	1 (0.99%) 0 cancers	1 (0.99%) 0 cancers	3 (2.97%) 0 cancers	2 (0.98%) 0 cancers	7
31-40	3 (2.97%) 0 cancers	3 (2.97%) 0 cancers	2 (0.98%) 0 cancers	4 (3.96%) 0 cancers	12
41-50	2 (0.98%) 0 cancers	5 (4.95%) 0 cancers	5 (4.95%) 0 cancers	2 (0.98%) 0 cancers	14
>50	20 (19.80%) 0 cancers	18 (17.82%) 0 cancers	14 (13.86%) 0 cancers	14 (13.86%) 0 cancers	66
SUM	26	27	26	22	101

Table 3: Variables in Female Patients

Variable	# Patients
Pregnant, postpartum, or breastfeeding	37 (2.37%)
Recent trauma or surgery	58 (3.72%)
Family/personal history of breast cancer	346 (22.2%)
Unilateral pain	1359 (87.2%)
Bilateral pain	200 (12.8%)
Cyclic pain	18 (1.15%)
Post menopausal	554 (35.5%)
Pre menopausal	1005 (65.5%)
HRT	72 (4.62%)
Palpable lump	506 (32.5%)
Nipple discharge	58 (3.72%)
Signs of infection	32 (2.05%)

22.113). No other variable significantly predicted cancer as a diagnosis.

Discussion

Breast ultrasounds accounted for a significant use of healthcare resources during 2016–2018. On the basis of provincial MCP billing codes, ultrasounds done for breast pain were estimated to have accounted for at least $116,200 healthcare budget during the stated period. Probably, this was an underestimate, because use of departmental resources were not considered here. According to radiological guidelines, use of breast ultrasound is indicated for investigating breast pain in patients with clinical findings, and not for patients presenting solely with breast pain and no other associated findings.

This audit was aimed to determine whether breast ultrasound was utilized appropriately at our center, with the end goal of reducing unnecessary breast ultrasounds in order to save time and resources. Previous studies have recommended that reassurance is appropriate for patients presenting with breast pain and no other clinical findings.[7] A study conducted in 2016 determined that women presenting with breast pain only had a low malignancy rate, and recommended that reassurance alone is appropriate in this subset of patients.[4] Our results support this recommendation, and provide an age cut-off to be considered when determining the appropriateness of breast ultrasound in patients presenting solely with breast pain.

The malignancy rate in female patients was 1.28%, which reflects findings of the current literature.[1,4–6] Our results indicated that more breast ultrasounds were done in case of female patients with no clinical findings than those with clinical findings. This practice does not adhere to the recommended guidelines. There were fewer instances of cancers were encountered in patients with no clinical findings than in patients with clinical findings, and all these occurred in patients aged >30 years. No cancer was identified in patients aged ≤30 years and in those who presented solely with breast pain.

According to multivariate logistic regression breast cancer is more likely to be the outcome of ultrasounds performed for pain in patients having a palpable lump associated with their pain. Therefore, breast ultrasound is an appropriate investigation for patients with breast pain and associated palpable lump. These results support the stringent use of breast ultrasound in young patients with no clinical findings except breast pain, as clinical findings are considered a separate variable.

The retrospective design of this study resulted in some limitations. The authors had limitations of the information included on imaging requisitions and radiology reports. The focal or diffused quality of patients' breast pain was not always commented upon, and the authors were therefore unable to collect this on their dataset. The only pain qualifier that could be consistently recorded was unilateral versus bilateral pain. A prospective study design in the future must ensure that such data would be collected. The authors attempted to identify all patients who underwent ultrasound for breast pain in a time frame using few keywords such as "breast pain," "breast tenderness," and "mastalgia." It could be possible that some ultrasounds for breast pain were completed without including these keywords in their reports, in which case reports of such patients would have been missed by authors in the dataset.

Conclusion

This study supports the stringent use of breast ultrasound in young patients having breast pain but no associated clinical findings. The low malignancy rate in patients aged <30 years indicates that reassurance could be used safely for these patients, which would not only decrease the rate of unnecessary follow-up procedures but also save healthcare budget.

Conflicts of interest

There are no conflicts of interest or financial disclosures to declare for this project.

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Article title: Use of Ultrasound for Breast Pain in a Newfoundland Cohort

Author's Names: Sarah Hogan, BSc and Connie Hapgood, MD, FRCPC

1. Breast pain is a(n)_______ symptom for many women and the etiology for the pain is mostly ____________

a) Common, Benign
b) Uncommon, Benign
c) Common, Malignant
d) Uncommon, Malignant

2. American and European guidelines recommend breast Ultrasound be conducted in any woman that has breast pain associated with

1) Palpable Lump
2) Nipple Discharge
3) Focal Breast Pain
4) Cyclical Breast Pain
5) Non-Cyclical Breast Pain
6) Breast Skin changes

a) 1,2,4
b) 1,2,4,6
c) 1,2,3,4,6
d) 1,2,3,5,6

3. The following breast diagnostic imaging examinations should be used in women over the age of 40 that have non-cyclical pain as their symptom.

a) Ultrasound
b) Mammogram
c) Magnetic Resonance Imaging
d) Ultrasound & Mammogram
e) Ultrasound, Mammogram & Magnetic Resonance Imaging

4. This research study supports findings from other literature on women with the singular symptom of breast pain

a) True
b) False

5. This research study supports the recommendation to reassure and not do any diagnostic imaging tests on women under 30 with the singular symptom of breast pain and no other clinical findings

a) True
b) False

The healthcare sector and front-line workers have been working around the clock for the last year and a half to ensure the health and safety of all people. Now that we inch closer to our new normal, it's time to look beyond the countless barriers that the global pandemic has placed in our way.

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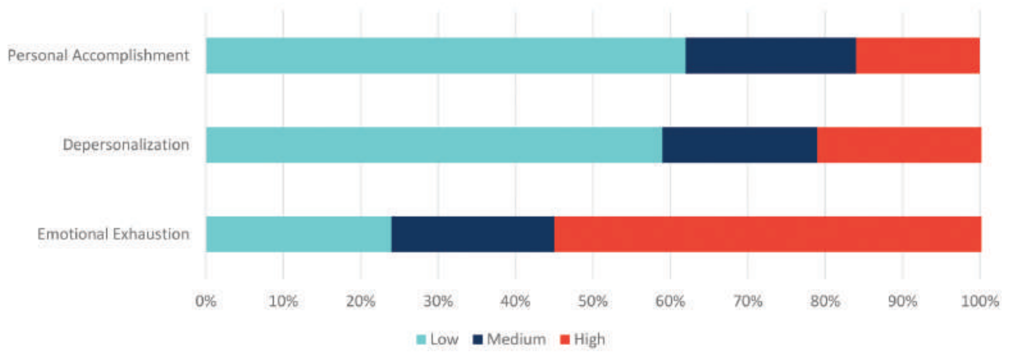
Mental Health of Canadian Sonographers

In May 2021, **78%** of sonographers indicated that they were somewhat or very satisfied with their job. However, this was 5 percentage points lower than in 2018.

7 out of 10 sonographers often or always find their work to be stressful. This is an increase of 9% over 2018.

63% of respondents did not have access to, or were unsure about, stress management or stress reduction programs in their workplace.

Mental Health Status 2021



Anxiety	Behaviour Control	Depression	Positive Affect
71%	87%	80%	61%
-3%	+9%	-5%	+12%

Only 1 in 10 sonographers believe working conditions in sonography will get better over the next 5-10 years.

55% of respondents indicated that they have too much work to do everything well.

Top 3 factors expected to affect sonographers in the future

- **Higher demands for productivity within the workplace**
- **Increasing risk of musculoskeletal injury (e.g. repetitive strain injury)**
- **General stress and burnout**

Look for a full article about the results of the 2021 Mental Health Survey in CJMS Volume 12, Issue 4.