The power and promise of myocardial work

Examining diagnostic accuracy and the potential to predict patient outcomes

Myocardial work (MW) to assess cardiac performance is rapidly gaining awareness, acceptance, and application. Supported by a growing body of evidence, myocardial work is emerging as a promising tool for detection, diagnosis, treatment, and prognostication of cardiovascular diseases.[1] This non-invasive method has been validated in a variety of clinical conditions, including coronary artery disease and heart failure patients undergoing cardiac resynchronization therapy.[1]

We recently asked Dr. Qamruddin to share her insights on the utility of myocardial work in the echo lab, and how she's using the tool to drive awareness and prevention of cardiovascular disease in women.

Myocardial work integrates strain measurement with LV systolic pressure and is less load dependent. It augments AFI by taking pressure into account, assessing total stroke work of the heart, and adding another dimension to the assessment of LV function. The introduction of innovative software for non-invasive MW calculations, including speckle tracking imaging with global longitudinal strain (GLS), has made it possible to utilize this method in many different clinical settings.

Ochsner Medical Center's Heart and Vascular Institute in New Orleans was an early adopter of MW, and the tool has played a valuable role as a support tool in patient assessments and critical clinical decisions done by physicians. Embracing innovation is part of Ochsner's DNA. It has been a pioneer in heart and vascular care for decades, inventing percutaneous atrial septal defect closure, implanting a pacemaker in the youngest patient on record, and leading the way in using a smartwatch to help manage high blood pressure.

Technical Director of Echo Quality and Research, Dr. Salima Qamruddin is exploring the value of MW in everyday practice. Her work includes examining the utility of MW in reducing the rate of false positives in stress testing. She is also studying MW parameters in predicting outcomes in patients with low flow aortic stenosis undergoing TAVR.

Dr. Qamruddin has another important role at Ochsner Heart and Vascular Institute. The cardiologist serves as Director of the Women's Cardiovascular Wellness Clinic. Myocardial work is also having an impact on patients there. Dr. Qamruddin is investigating MW as a predictor of women at high risk for myocardial infarction and heart failure.

Can you describe the cardiac program at Ochsner Medical Center and your role in the echo lab?

Dr. Qamruddin: *Ochsner Heart and Vascular Institute is the only heart transplant and high acuity cardiac surgical center in the Gulf South, making for a high-volume echo lab with complex cases, including structural TEEs for percutaneous interventions. We are also a center of excellence for complex diseases such as hypertrophic cardiomyopathy and cardiac amyloid.*

Our echo lab has a volume of about 100 echocardiographic studies per day. I oversee all quality aspects of our lab, including sonographer training and physician reading. In my position, I am passionate about using strain and 3D echocardiography to improve diagnostic accuracy of diseases.

You have been a champion of AFI strain imaging within the echo community. What is the value of incorporating strain into your workflow?

Dr. Qamruddin: *Myocardial strain gives true deformation of the myocardium and ejection fraction calculations can be volume and geometry dependent. A myriad of studies has shown the prognostic utility of global longitudinal strain in heart failure and valvular heart disease. I believe we are not using this technique to the fullest. GE HealthCare's automation of strain and artificial intelligence techniques will significantly enhance patient care—as it can help the physician detect subclinical dysfunction, evaluate total stroke work of the heart, and prognosticate disease.*

For example, say you have a patient with a normal ejection fraction with concentric remodeling, advanced diastolic dysfunction and poor GLS. The composite of the above parameters suggests high risk for heart failure (HF) admission. Hence, aggressive up-titration of medications in this patient can prevent HF hospitalization. This improves patient care and decreases the burgeoning cost of health care.

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The latest version of Vivid introduced Easy AFI LV, which leverages artificial intelligence and View Recognition to perform strain and biplane EF automatically. How has artificial intelligence impacted workflow?

Dr. Qamruddin: *This has significantly improved the efficiency of the workflow. The best example is a breast cancer survivor that needs a follow-up echo after getting chemotherapy treatment that may be toxic to the heart. Easy AFI LV will give both GLS and EF within seconds.*

At times we have to adjust the contours manually. Despite that, in a busy echo lab these time efficient tools are helping physicians report GLS more often, which is prognostically important. Auto EF has reduced time for biplane EF and gives an added tool, but physicians can still choose to do manual EF.

Uncovering invisible illness in women's health: Sarah's story

Imagine being 29 and suffering a heart attack. Watch one woman's powerful story and discover the role of ultrasound in a special BBC Storyworks production.

The utility of GLS has also been cited in the literature for cancer patients, especially those who have received cardiotoxic chemotherapeutic agents. Subclinical left ventricular dysfunction may be detected with GLS and in cases of low GLS, cardioprotective agents may be initiated.[2]

Utilizing AFI, it's now possible to estimate myocardial work non-invasively. How would you describe myocardial work?

Dr. Qamruddin: *Myocardial work is an advanced assessment of GLS analysis that can reduce the afterload-dependent limitation of GLS by incorporating left ventricular afterload into the analysis of GLS.*

> *Adding MW parameters at peak stress to standard dobutamine stress echocardiography (DSE) images improved diagnostic accuracy of the DSE from 45 to 81%. Patients with significant coronary artery disease had a significant drop in GLS, MW and Myocardial efficiency (ME) at peak stress.*

For example, we know that GLS drops with increased afterloads in patients with hypertension and aortic stenosis, when in fact the overall stroke work of the heart increases. MW assesses total stroke work of the heart in each cardiac cycle that includes systolic ejection, isovolumetric contraction, and isovolumetric relaxation. That provides a more robust analysis of the total work done by the heart in health and various diseases.

MW has been validated with invasive measures and it correlates well with oxygen consumption and regional myocardial glucose metabolism.[3] *Myocardial work has been shown to be reduced in several diseases with reduced global myocardial work efficiency (GWE), which is the ratio of the constructive compared to wasted work, and hence greater wasted work.*[3]

There's a growing body of research on MW. What are some of the applications?

Dr. Qamruddin: *One of the areas where MW has been studied is its use in chronic resynchronization therapy. Patients with elevated constructive work responded better to therapy.*[3] *MW is currently being studied in amyloid, hypertrophic cardiomyopathy, and aortic stenosis. This may help us prognosticate patient outcomes better than GLS and improve stratification for certain therapies.*

Myocardial work (MW) and global work efficiency (GWE) that are derived as a product of systolic blood pressure with peak GLS of each segment, have been shown to be superior in diagnosing significant obstructive coronary artery disease. The research shows similar results in those having acute coronary syndrome presenting to the emergency department.[4]

How has MW improved diagnostic accuracy in assessments?

Dr. Qamruddin: *Adding myocardial work and global work efficiency (GWE) during stress echocardiography can help reduce false positive studies*[5] *and reduce downstream cost of additional testing. We presented this data at the 33rd American Society of Echocardiography scientific sessions in Seattle, WA. Adding MW parameters at peak stress to standard dobutamine stress echocardiography (DSE) images improved diagnostic accuracy of the DSE from 45 to 81%. Patients with significant coronary artery disease had a significant drop in GLS, MW and Myocardial efficiency (ME) at peak stress.*[5]

How have you utilized myocardial work in low flow aortic stenosis patients?

Dr. Qamruddin: *Even with TAVR, low flow aortic stenosis is a challenging condition and mortality is up to 30% at two years. One of the questions is who best benefits from TAVR? Newer data suggests that contractile reserve does predict outcomes in this group.*

Women's heart health

Your other role at Ochsner Heart and Vascular Institute is Director of the Women's Cardiovascular Wellness Clinic. How are myocardial work and strain imaging impacting work with cardiac disease in women?

Dr. Qamruddin: *Women who have hypertensive disorder in pregnancy and lower GLS have been associated with preterm delivery and small for gestational age neonate. These women are also at an increased risk of myocardial infarction and heart failure later in life.*[6-8]

Since GLS is load dependent incorporating MW may identify women with lower stroke work and greater subclinical LV dysfunction, and these women may be at significantly higher risk of heart failure called peripartum cardiomyopathy immediately or at higher risk of developing heart failure later in life. We are working on incorporating GLS into the workflow for these patients.

We are also seeing use of GLS in women with identifying non-obstructive artery disease, which is a cause of heart attack in 10-15% of women. Incorporating MW and ME may give a better assessment of the total stroke and efficiency of the heart, and flag patients that have chest pain in setting of ischemic of non-obstructive coronary artery disease.[4]

You are a huge advocate for women's heart health and combating heart disease. What are some of the statistics people need to know?

Dr. Qamruddin: *One in five women die of heart disease. It kills six times more than breast cancer—yet screening for heart disease is minimal. Cardiovascular disease is the leading cause of death among breast cancer survivors. Women's risk factors include high blood pressure and diabetes in pregnancy, premature ovarian failure, and polycystic ovarian syndrome. Another risk factor is inflammatory disease, such as lupus and rheumatoid arthritis, which are 10 times more common in women.*[9]

What are some of the issues surrounding awareness?

Dr. Qamruddin: *Unfortunately, only 56% of women are aware that they are at risk of heart disease, and this statistic has decreased over the past decade. There are not enough awareness campaigns in the community—schools, colleges, and workplaces. Until we get young women to engage in this conversation, we will continue to see these staggering numbers because heart disease starts at least two decades before it manifests. I thank companies like GE HealthCare that are collaborating with physicians to raise these concerns and spread awareness.*

How do you partner with the Women's Health team at your hospital?

Dr. Qamruddin: *I partner with obstetrics and gynecologists and focus on prevention, especially in young women. I see women with high blood pressure in pregnancy soon after they have delivered to discuss long term complications that include heart attacks, strokes, and heart failure. I also see menopausal women and breast cancer survivors and assess their risk for downstream heart disease.*

What are the different types of heart attacks seen in younger women?

Dr. Qamruddin: *There are two types of heart attacks that are seen specifically in young women. MINOCA is myocardial infarction of non-obstructive coronary artery disease and accounts for 15-20% of heart attacks in women under age 50. It occurs when there is a blockage in smaller arteries of the heart that may not be seen with an angiogram and may require greater testing (PET, CMR). The other heart attack is called SCAD or spontaneous coronary artery dissection. It affects 40% of women before the age of 50 and tends to occur right after giving birth or within the first six weeks following delivery. High blood pressure, infertility treatments, and autoimmune disease can increase the risk of SCAD.*[9]

What do you want women and clinicians to know about heart disease?

Dr. Qamruddin: *Women with gender specific (premature menopause, hypertension and diabetes in pregnancy, preterm delivery, inflammatory and autoimmune disorder) along with traditional risk factors (smoking, hypertension, Diabetes, high cholesterol, family history of premature heart disease) must see a preventive cardiologist to assess their risk. Calcium scores and other tests may flag high risk individuals early and prevent future heart disease. Prevention is the best cure.*

Dr. Salima Qamruddin, M.D., serves as the Director of Echocardiography Quality and Research and Director of Women's Cardiovascular Wellness Clinic at Ochsner Heart and Vascular Institute in New Orleans. She is also a senior lecturer at the Ochsner Clinical School, University of Queensland, Australia. Dr. Qamruddin has numerous publications in the field of cardiac ultrasound. Her research interests include heart valve disease predominately in women and new technologies that improve diagnostic ultrasound. Dr. Qamruddin's work in women's cardiovascular wellness revolves around raising awareness through media and lectures and utilizing novel technologies for heart disease prevention in women of all ages. She has a special focus on heart attacks in women, preeclampsia, breast cancer survivors and menopause.

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