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Echocardiography in a Heartbeat

HIGH-SPEED VOLUMETRIC ECHOCARDIOGRAPHY.

What makes you to be able to tell from the detailed analysis of just one heartbeat? We are about to find out. You are listening to ReachMD XM 157, The Channel For Medical Professionals. Welcome to Advances in Medical Imaging. I am Dr. Jason Birnholz, diagnostic ultrasound consultant in Oak Brook Illinois, your host and with me today is Dr. Mani Vannan. Dr. Vannan is a professor of Clinical Internal Medicine at the Ohio State University College of Medicine, Joseph M. Ryan Chair in Cardiovascular Medicine and Director of Cardiovascular Imaging at the Ross Heart Hospital at the Ohio State University. Today we are discussing something brand new, High-Speed Volumetric Echocardiography.

DR. BIRNHOLZ:

Dr. Vannan, thank you very much for joining our program.

DR. VANNAN:

It's my pleasure.

DR. BIRNHOLZ:

I wonder if we might put the new advances and echocardiography in context by a little review of the history of echocardiography.

DR. VANNAN:

Sure. In the last 30 to 35 years, echocardiography has seen a revolution in the real sense of the word at the very beginning when we did echocardiography, we relied on spikes. Literally spikes of ultrasound waves coming back to the transducer after impinging on the target and those were called A Mode echos amplitude mode echos. Since those early years when we were looking at the spikes to diagnose cardiac disease, we have come a long way over the last decade two-dimensional echocardiography has become the bread and butter of clinical echocardiography. It has become very sophisticated. It is the bedrock of almost every clinical decision we make in cardiovascular medicine. It looks at anatomy. It looks at physiology in a manner that no other technology can do, especially a portable technology, such as echocardiography. In the last ten years, there has been a big task to try and bring 3-dimensional echocardiography into the clinical setting and what we have seen are a very systematic advance in technology so that today we are in the brink, I think of actually implementing in the Clinical Arena 3D echocardiography in a meaningful way. So I think echocardiography is truly seen in evolution and

a revolution imaging technology, almost like no other imaging modality in cardiovascular medicine.

DR. BIRNHOLZ:

Well 3D, approaches of 3D has been around for some years. What's new now?

DR. VANNAN:

You are right, 3D has been around for about 10 years now. The fundamental problem with 3D or fundamental problems I should say with 3D have been two things over the last ten years and that is at the acquisition and meaning the image acquisition and so that when you put a transducer on the chest of a patient and you are trying to get 3 dimensional picture of the heart. The technology has not been sophisticated enough for us to allow that to do it almost instantaneously. We have relied on putting the transducer on the chest and then waiting for about 4 or 5 or 6 heartbeat before you can get the entire volume of the heart and then we build the 3D volume, which is somewhat tedious. It's certainly a vast advance over 2D echo, but it is still tedious because one of the attractions of echocardiography as being that it is real time. Every heartbeat is recorded in real time and it happens. When you do this 4 beat or 6 beat capture for 3D, you are essentially negating the technique of its fundamental advantage, which is realtime because you are now building the volume overflow to 6 heartbeats instead of every heartbeat. Very similar to MRI and CT scan to this day because both those techniques are all based on multiple heartbeat cycles and then put together as a single heartbeat. The second problem with 3D echo has been that having acquired the volume albeit over 4 or 6 heartbeats, you then don't have a very intuitive way of getting meaningful numbers, data, and information out of the 3D volume. There is a whole host of information in the 3D volume of the heart. The heart is a beating organ. It not only has anatomical features, but it is a profoundly sophisticated physiological structure. To get all of that in 3D and not have an intuitive way of looking at the data in an efficient manner has been the second impediment in implementing 3D echo successfully in clinical practice.

DR. BIRNHOLZ:

Well, I have heard that new technique referred to as echo in a heartbeat perhaps somewhat sensible is a single heartbeat that you are analyzing very thoroughly and adequate sampling or do you in practice tend to look at a lot of different beats?

DR. VANNAN:

The new techniques are, you know, so called echo in a heartbeat is more than a cliché. It sounds very attractive, but in performance, it has to match up to that cliché and it does. For the first time, I think we have the ability when you put a transducer on the chest, in a heart cycle if there were 800 millisecond in our heart cycle; every millisecond is accounted for in a true 3D image. It is not a 2D image, but it is a true 3D image, so we are able to get volume image throughout the cardiac cycle so that now whatever happens between the consecutive millisecond if captured in 3D volume, you don't lose information and is realtime. So it is truly an advance. So all you need is a single heartbeat virtually to get the entire volume of the heart. So the practical implication of that would be in an ideal world, you put a transducer on the chest in a single heartbeat, you get the entire heart information and you take the transducer off the chest. That may be somewhat of an exaggeration because in a clinical setting, the patients are sometime not that cooperative to get everything in one heartbeat. So you can acquire 2 or 3 heartbeats, but every heartbeat has entire information. So you can then choice which of those heartbeats that you would like to use, if one of them has got a little bit of artifact then you could use the other one etc. So it's a distinct advantage over the previous technology.

DR. BIRNHOLZ:

Well I guess that means if you are in some sort of full screening mode you can do an awful lot of patients per day with one instrument.

DR. VANNAN:

That's right. I in this age in our preliminary experience now, what we have done, is to put the transducer on 2 separate locations on the chest and that's all it takes and that is compared to the 2D echocardiograms that we do now as a standard practice where we get multiple standard views of the heart because it is 2 dimensional echo and you need to cover the entire heart in multiple views, where as with this new technology one should be able to put the transducer in 2 separate locations and if you have 2 very good heartbeat information you have done virtually in a matter of a couple of minutes or 3 minutes at the most.

If you are just joining us, you are listening to Advances in Medical Imaging on ReachMD XM 157, the channel for medical professionals. I am Dr. Jason Birnholz and I am speaking with Dr. Mani Vannan. We are discussing a high-speed volumetric echocardiography.

DR. BIRNHOLZ:

Now Dr. Vannan, have you taken the machine off to a Coronary Care Unit and looked at some acutely ill patients?

DR. VANNAN:

We haven't taken the machine physically to a Coronary Care Unit only because the machine has been in a preliminary state of development, so we housed it in a room, but we did have a very sick patients come down to the echo lab, who are extraordinarily short of breath and in these patients, it is usually we spent 15-20 minutes patients on oxygen etc., where we try and get us much information as we can. We have done a few patients now with this new technology and I recall at least one patient whose example I show now who was extremely short of breath and has severe heart failure and we got entire heart information, not only the structure i.e. the anatomy we also got flow information, valve leak information with color Doppler, all in a matter of literally a minute and a half. That's all it took us to get the entire heart information and that was a big relief for the patient who just could not lie down flat, just could not stay still etc. So that to me is the telling example of how far we have come in terms of doing 3D even in very sick patients.

DR. BIRNHOLZ:

Lets move to the people who are not quite so compromised. Have you tried doing any stress echos with this new technique?

DR. VANNAN:

We have not tried the stress echos yet, but it is a very intuitive application of this technology. When we do a stress echo generally if we were to do a treadmill stress test for example, the challenge we have is at the peak exercise when the patient is ready to come off the treadmill because he or she is exhausted or has chest pain or short of breath or has got leg pain, the patient comes off the treadmill and we literally have the patient jump on to a couch and lie in the correct position for echocardiogram and then we have to acquire the entire heartbeat or heart information as quickly as possible , preferably within the first minute because the heart rate is coming down all the time . That's being a challenge in stress echocardiography. I think we have done very well with 2D echo, but with this technology, I would see that we put the transducer on the chest on two different locations and you should be done in literally two heartbeats and you have the entire heart information and then you can clearly not spend a whole lot of time trying to chase the heartbeat because it is

coming down all the time after a stress test. We could it a really very close to the peak heart rate, which would be a true stress test.

DR. BIRNHOLZ:

Well, I take it down that you are going way beyond global measures like ejection fraction and looking at much more specifically at how heart is contracting.

DR. VANNAN:

That's right and I think the advantage of doing imaging in one heartbeat in a truly volumetric fashion is that when you are measuring anything in the left ventricle, which is the main pumping chamber of the heart and you what to measure the ejection fracture or you want to measure left ventricular volume or you want to measure mechanical function such as the muscle function, such as strain or strain rate of the muscle, all of this are based on the predication that what you are measuring is at every heartbeat because all these indices change every heartbeat, especially in patients who are sick. So if you are looking a normal it may be acceptable not desirable, but may be acceptable to look at the data or number that is derived from multiple heart cycles in a 3D echo, but when you are looking at abnormal hearts or patients with heart disease, it is not acceptable and not desirable to get these numbers from multiple heartbeats. So doing it in one heartbeat means now we have a real reliable method of looking and believing those numbers that we get out of 3D echo because these are numbers for every heartbeat and even if they change every heartbeat, the numbers will reflect that change truly.

DR. BIRNHOLZ:

Now, instead of situation of trying to diagnose a problem or even grade it, what about using this technique for monitoring therapy?

DR. VANNAN:

Absolutely. I mean a simple example of that would be ejection fraction. One of the big issues with echocardiography and measuring ejection fraction as an index of efficacy or lack of efficacy of a therapy has been that 2 dimensional ejection fraction is variable between 2 days in the same patient for no other reason then the fact that we cannot reproduce the exact plane of imaging of the heart, with the currently the technology where you have to get multiple heart cycles to build the volume. The same problem exists because you now holding for 4 or 6 heartbeat cycles to do it, with the single heartbeat, it is far more reliable and reproducible in terms of looking at ejection fraction as an index of accessing a specific therapy, efficacy, or lack thereof. So I think we are on to using echocardiography in a meaningful way to direct therapy or change therapy in patients.

DR. BIRNHOLZ:

My thanks to Dr. Mani Vannan, who has been our guest and we have been discussing high-speed volumetric echocardiography.

DR. BIRNHOLZ:

Dr. Vannan, this has been really fascinating. Thank you so much for joining us.

DR. VANNAN:

Thank you.

I am Dr. Jason Birnholz. You have been listening to Advances in Medical Imaging on ReachMD XM 157, The Channel for Medical Professionals. Be sure to visit our website at www.reachmd.com now featuring podcast of this and other features of series. Thank you for listening.