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Sci-Fi in the OR: Utilizing Holograms in Cardiac Ablation Procedures

Dr. Sorrentino:
Each year, more than 75 thousand cardiac ablation procedures are performed in the United States alone, but as the number of procedures being conducted continues to climb, so do the potential complications that arise from it, but could something straight out of a science fiction movie like holograms help improve physician accuracy and reduce these complications? That's the question we'll be exploring with one of the innovators behind a recent technological advance and clinical study. For ReachMD, this is Heart Matters, and I'm Dr. Matthew Sorrentino. Joining me today is Dr. Jennifer Silva, Associate Professor of Pediatrics at the Washington University School of Medicine and Director of Pediatric Electrophysiology who co-led a team that tested a unique headset using mixed reality technology during cardiac ablation procedures at St. Louis Children's Hospital. Dr. Silva, welcome to the program.

Dr. Silva:
Thanks for having me.

Dr. Sorrentino:
Dr. Silva, we're talking about the first in-human use of a mixed reality, holographic display during cardiac ablation procedures, which is a pretty remarkable advance, but before we dive into the specifics of your study, can you share with us how this idea of bringing a bit of science fiction into the operating room even materialized and let our listeners know what do you mean by mixed reality?

Dr. Silva:
Sure, I'd love to. The story of this technology is actually the story of my family, interestingly enough. So, my husband is a cardiac biomedical engineer here at Washington University in St. Louis, and just as all families share their day and the things that worked for them in their day and the things that didn't work for them in their day, my husband found himself on the listening end of the things that were working for me when I would do procedures on patients. So, I have the pleasure of being a pediatric electrophysiologist, which means that I get to do these complex procedures called ablations in children who have heart rhythm abnormalities, but there were serious limitations with some of the things that we were doing, and as I mentioned, I would talk about these issues, these problems, the things that I wished could be when we were at home at night. Fast forward to 2015, and he was at a meeting at Microsoft where they were talking through emerging technologies that were going to be breaking on the scene in the next year, two, three-year timespan, and that's when they were talking about what we would call the extended realities, and this ties into the other question you were asking about virtual versus augmented versus mixed reality, and what Microsoft was demonstrating was a mixed reality headset. So, in contrast to what had previously existed, these boxy virtual reality headsets that were fully immersive and great for things like gaming, mixed reality is a see-through headset, so when you put it on, you can still see what's in your natural environment, and you can import or augment your environment with these digital images or holograms. So, he was at this meeting, and he was looking at it, and he said, "You know, I bet we can use this to make my wife's life easier," and he called me, and we immediately had a conversation about what the technology was, what we thought it could do to impact and improve the way we take care of patients, and that was the inception of this project.

Dr. Sorrentino:
So, I assume up to this point when you were doing your ablation procedures, you were using fluoroscopy or some sort of one or two-plane way of looking at the atrium or whatever part of the heart you were ablating. How would aholographic image change that? How would it improve how you can see where you're putting your catheters?

Dr. Silva:
So, you're exactly right. The technology that's existed in electrophysiology for visualization or seeing what you're doing initially started

with fluoroscopy and advanced to include what we call electroanatomic mapping. Now, electroanatomic mapping are commercially available systems that generate shell of the cardiac geometry and then overlay the electrical system on top of that shell. Those data are then compressed onto a flat two-dimensional screen and then displayed at 90 degree angles to each other, similar to the way we do fluoroscopy. That was the last real big advance in visualization in electrophysiology. Every anatomy's unique, and we know that when people are doing these procedures, whether they be electrophysiologists or even, quite frankly, interventionalists, there's significant mental gymnastics that goes along with taking those flat two-dimensional images and reconstructing the unique patient-specific three-dimensional anatomy. Can we take that out of the equation? Can we just display the 3D data in 3D? And as it turned out, this was a great technology to do that with. That's where we started. What we then quickly realized was, in addition to being able to just see your data in 3D, to then be able to manipulate the data, to have control over it, to turn it leftward or rightward, to change the size of it or the transparency of it, really allows for a much more intuitive understanding of your patient's specific geometry and those electroanatomic relationships, and that's what ended up getting borne out in the clinical study.

Dr. Sorrentino:
So, before we jump into the clinical study, it sounds like you can have a beautiful 3D holographic image that's suspended out in space over your patient, but how would that lead to manipulating catheters? Do you still have to move the catheters by hand?

Dr. Silva:
So, we haven't taken the physician out of the loop in any way, shape, or form. The physician is integral to the procedure, and so while the physician has their hands on the catheter and manipulating the catheter, we can see those catheter movements in real time in that three-dimensional hologram. Now, I also want to add that this was an important part of the usability of our system. So, the way that you control the data and control how you move it is all done through a gaze dwell mode of control, so instead of using your hands or pointing and clicking or talking to it, which technologically will probably be ready with an actual language processing in the next couple of years – or at least our fingers are crossed and we're hoping that's the case – this is actually done purely by gaze dwell, which means that with slight movements of the head, you're able to control and select menu items and manipulate your data.

Dr. Sorrentino:
For those just tuning in, this is Heart Matters on ReachMD. I'm Dr. Matthew Sorrentino, and today I'm speaking with Dr. Jennifer Silva who co-led a study that was published in JACC: Clinical Electrophysiology that tested the use of a holographic display during cardiac ablation procedures. Dr. Silva let us know a little about your study, then. What did you try to show in the study? And what were the results?

Dr. Silva:
So, when we first conceived of this study, we wanted to be very focused on how this was going to impact the patient. To do that, we devised the study where we asked the question –could a three-dimensional display improve your accuracy? And the way we devised the experiment were that patients who were coming for an EP study would routinely undergo a series of tests after their ablation procedure was done while they're in their, quote, "waiting phase" of the procedure while we're doing other testing to see if we can restart or restimulate any abnormal heart rhythms. What we found was that when physicians used the 3D system, they were more accurate than by using conventional visualization systems. We asked a couple of other questions as well – for instance, is the system usable? Did it make you feel sick or nauseous? Did it give you headaches? And what we found was that it was an incredibly usable system, and there were no ill or adverse effects to the physicians that were wearing the headsets. One particularly interesting question, I thought, that we had asked was – Do you feel like you learned something new about your patient's anatomy? And respondents overwhelmingly answered yes. Ninety percent plus felt like they had learned something new about the patient's anatomy. That was incredibly gratifying for our team.

Dr. Sorrentino:
How hard is it for your physicians to learn this new technology? Especially if they've been used to the old planar views, how difficult is it to think in 3D and to use your gaze to move your catheters to the right spot?

Dr. Silva:
That's a great question. So, the physicians who participated in this study all had a 20-minute tutorial prior to using the system, and then that was it. They were off to the races. So, we were very intentional about creating a system that's incredibly intuitive and easy to use, and we found that that actually was the case. The interesting thing isthat in electrophysiology, we're constantly thinking in 3D, and so what this was doing was allowing us to not focus on that piece but to focus on other aspects of the case as well. So, we really found that it was an enhancing technology to what we were already doing.

Dr. Sorrentino:
So, of course finding the area that you want to ablate is so important and making sure that you're ablating the rhythm you're going after.

When you mentioned accuracy, do you mean that you're better able to ablate the lesion and therefore have better results?

Dr. Silva:
So, the way we designed the study was point accuracy. So, what do I mean by that? I mean if you're trying to get to a certain spot in the heart, how close can you get to that point if we place that point in the geometry? It's sort of like target practice, so it's not necessarily a mapping enhancement because mapping is done generally with large and frequent movements through the chamber, but this is actually the finer aspect of electrophysiology. So, if I'm trying to get to a certain place because I'm trying to map a very small region or because I'm trying to ablate a small region, we found that with three dimensions and the control that the system provides, users were able to navigate more accurately to that spot.

Dr. Sorrentino:
So, at this point, what are your next steps? How do you see advancing this technology further? And do you see it taking over ablation techniques down the road and replacing our existing techniques?

Dr. Silva:
That's a great question. So, this technology is currently under review at the FDA, and we're enthusiastic and excited to see what they have to say about that. I think that the FDA has now realized they're entering an era of digital health in medicine where virtual and augmented reality is going to play an increasing role in the way we take care of patients, and so it's really exciting to be on the forefront of that. I do think that what we are demonstrating here is over time going to become an integral part of systems because in the EP lab, we have many systems in the lab. We have our mapping system, we have our pacing system, we have our ablation generators, we have our fluoroscopy. I do believe that this particular system that we're developing is essentially going to become a data aggregation system by allowing for control of multiple different tools in the laboratory and allowing the physician, who is ultimately the person responsible for the procedure, to actually have more control over their procedure. I'm excited to see where the field is in three years.

Dr. Sorrentino:
These are all really exciting potential opportunities, and we look forward to hearing from you and from others about advances in the future, really bringing science fiction into the laboratory, but right now I want to thank my guest, Dr. Jennifer Silva, for joining me to share this interesting new technology and, more importantly, for providing new insights in the cardiology field. Dr. Silva, it was great talking with you today.

Dr. Silva:
Thank you. You as well.

Dr. Sorrentino:
For ReachMD, I'm Dr. Matthew Sorrentino. To access this episode and others from Heart Matters, visit ReachMD.com/HeartMatters, where you can be part of the knowledge. Thanks for listening.