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ReachMD
www.reachmd.com
info@reachmd.com
(866) 423-7849

Stanford Surgeons Perform First Beating-Heart Procedure

Dr. Butler:
With many barriers standing in the way of people in the United States in need of a heart transplant, fewer than 10 percent of patients actually receive this surgery according to Stanford Medicine. However, surgeons are working on a new way to increase the pool of healthy donated hearts.

You're listening to *Heart Matters* on ReachMD. I'm Dr. Javed Butler, and joining me today to discuss his team's first beating-heart transplant is Dr. John MacArthur. He's an Assistant Professor of Cardiothoracic Surgery at Stanford School of Medicine.

Dr. MacArthur, welcome to the program.

Dr. MacArthur:
Well, Dr. Butler, thank you for having me.

Dr. Butler:
Great. So to get us started on this topic a little bit, can you just give us a little bit of an overview of patients with advanced heart failure? What is the demand or the need for heart transplantation? How many donor organs are available today? What is the mismatch? Can you just give us a little bit of a landscape in this area?

Dr. MacArthur:
Yes. There are many patients that are waiting for heart transplantation for various reasons. Some may be due to ischemic cardiomyopathies, some may be due to nonischemic dilated cardiomyopathies, and some are inheritable disorders. And when these patients progress to heart failure, it starts to affect their quality of life, and that's when they present to us and are considered candidates for heart transplantation. Now we are limited by the number of heart transplants that we're able to do based on the donor pool that's available, and so we're always looking for different techniques to expand that donor pool to help the patients that are in need.

Dr. Butler:
And is the donor pool over the last number of years—is that increasing, decreasing, or remaining stable? And is the heart failure epidemiology changing—increasing, decreasing, or staying put?

Dr. MacArthur:
I think over the years, the number of patients that need to be treated for heart failure is stable. The patients may have a different mix of etiologies that result in heart failure, but the overall number seems to be relatively stable. The donor pool has also remained relatively stable. And we have always been looking for different ways to increase our abilities to expand the donor pool, and one of the major breakthroughs in the last several years has been the ability to use donors after cardiac death to expand the donor pool.

Dr. Butler:
But we need to find out ways where we can increase the availability of this potentially life-saving therapy to our patients. So with that said, let's dive into your procedure of the beating-heart transplant. Can you tell us what it is and how it works?

Dr. MacArthur:
Sure. I think before we get into that, we may need to just briefly talk about the technology that I mentioned that makes it possible to perform heart transplantation from a donor that as we commonly refer to as DCD, or a donor after a circulatory death, and this is opposed to brain-dead donors who are declared dead based on brain death exam. In patients that are unable to be declared dead because they don't meet the criteria for brain death, in those patients we have to allow time to progress to allow them to expire, and if they do so in a given time frame, then we now have the ability to quickly remove the heart and place it in an ex vivo environment where it continues to get blood flow, and it's in a sense reanimated. We are able to restart the heart, and based on blood tests and visual assessment, we are able to make our own assessment on the suitability for that heart for transplantation.

Now the way that we have traditionally done that, and the way that's been studied is, after the donor expires, the heart is stopped–that's naturally the heart stops—the team of procurement surgeons that is there will remove the heart and put it in an ex vivo environment where blood is then instilled into the heart through the aorta. This then restarts the heart, and the heart is then taken to the implanting facility.

Now the traditional mechanism for then making that heart ready for implantation is to stop the heart once again using a solution that will stop the heart and is put into a cold solution to bring the temperature down. And we have, and others have noted, that when you do this technique, that the heart takes quite a long period of time to restart and have the strength to come off the heart-lung machine in the recipient that's receiving the heart transplant. The reason for this is likely due to a so-called two-hit hypothesis. That's where the first time that the donor expires, there's a period of ischemia to the heart muscle, and then when you bring that heart back to the facility for implantation, that's the second time of ischemia when you stop the heart. And so those two episodes where the heart muscle is not getting enough oxygen, we think is the reason for why the heart may take a prolonged period of time to reach its full potential. And so we thought why not cut out that second hit to the heart and maybe we should just not stop it, and so that's what we did.

And the mechanism for that is when the heart is back in the operating room with the recipient, we place a catheter into the ascending aorta, and we hook that catheter up to the cardiopulmonary bypass machine, and we're able to instill blood into the aorta while removing it from the ex vivo machine from which it had received blood previously. We then prepare that heart and implant it all the while it's getting blood flow and oxygen delivered to the muscle, and it continues to beat the whole time. And this technique we've done several times now at Stanford and we've seen that the amount of time spent on the cardiopulmonary bypass machine is significantly less than compared to before the traditional technique, and so we think this is going to really be a great mechanism to allow us to use going forward in DCD patients. And we're working, also, on techniques to use this in brain-dead donors as well so maybe we don't have to stop the heart at all.

Dr. Butler:
For those just joining us, you're listening to *Heart Matters* on ReachMD. I am Dr. Javed Butler, and I'm speaking with Dr. John MacArthur about his first beating-heart transplant.

This is absolutely fascinating. So you, I think, answered the first question that I was going to ask you is that can this technology be also then applied to the donor harvesting so that you don't have to stop at all? And if I heard you correctly, you said that that's a potential?

Dr. MacArthur:
That's a potential. It's still being worked out in our research labs here. The group that has really been a major part of performing these first beating-heart transplants is working also on ways to expand this to brain-dead donors so that the heart never has to be stopped. Of course, in the DCD population, the heart has to stop in order for us to proceed with procurement, but in brain-dead donors the heart shouldn't have to stop. It's only necessary to do so at the current time based on the given means for which we have to procure hearts it's necessary to stop the heart, but we're developing ways to get around that and to have the heart have continuous blood supply, and also, that will allow it to beat continuously without any ischemic time.

Dr. Butler:

So do you think that this will improve the outcomes of the existing donors? Or do you think that this will also increase the donor pool that now you can take older donors, donors that maybe some comorbidity mix that would make you uncomfortable or donors from a farther geographic area, and even if the transfer time to the implanting center is long doesn't really matter? So will it substantially increase the donor pool or simply the outcomes of the donated hearts?

Dr. MacArthur:
Well, I think that's a great question. I think that these new techniques that we're developing will certainly allow us to give better outcomes to our current patients. I'm not sure how this will affect the donor pool. It will allow us to travel further. Right now, we are limited geographically by the time it takes to get to any location because the longer the heart is ischemic, the worse the outcomes will be, or at least if we get to a certain ischemic time, around six, seven, eight hours, we know that the incidence of primary graft dysfunction increases. That's using old techniques, but with this, we may be able to significantly increase the distance traveled and increase the time between procurement and implantation without sacrificing any outcomes for the recipients.

You bring up a good point about accepting maybe older donors or donors that were once thought to be not ideal for one reason or another. This new way to think about the procurement process and the transportation process and implantation process may allow us to assess hearts that were once thought to be unsuitable for transplantation. The platform we are working with may allow us to get a better sense for the donor contractility and ability to be successfully implanted without making a decision until we have this information. Currently, we have to make a decision based on echocardiographic data and visual information at the time of procurement that may or may not translate into how the heart functions in the recipient.

Dr. Butler:
Super. I mean, this is so exciting. Now I know that this is new, so you are just collecting the data, but do you have any information in your early experience in terms of the patient outcomes and how are the patients doing?

Dr. MacArthur:
Well, we've only done this in a handful of patients so far, but every single one of these patients has done very well with no complications from the implantation technique. Obviously, we are continuing to study this and monitor these patients into the longer term because that will be absolutely necessary to understand how this affects patients in more than just the perioperative setting but into the long-term setting as well over years and years. So we will continue to study this and continue to develop these techniques to try to really get the best outcomes for our patients.

Dr. Butler:
I mean, this is such phenomenal information that I can't hold my excitement as to which direction all this will evolve in. I certainly look forward to reading a lot of publications and papers from you. But this is about the time that we have, so can you just give us any final additional thoughts that you might have for our audiences today about donation of organs in general or about the future of beating-heart transplants in the future?

Dr. MacArthur:
I would just say that at Stanford, there's a long, rich tradition of pioneering heart transplantation surgery, and we aim to continue that tradition. We're always looking for different ways and techniques to bring the best outcomes for our patients, and we are committed to that moving forward.

Dr. Butler:
Well, with those words, thank you very much from my side, and as I said, I look forward to further discoveries by you and your team. This has been a fascinating discussion about the future of heart transplantation, and I would like to thank my guest, Dr. John MacArthur, for sharing his experience and his insights.

Dr. MacArthur, it was absolutely a pleasure and great speaking with you today.

Dr. MacArthur:
Well, thanks so much for having me on, Dr. Butler. I really appreciate it.

Dr. Butler:
For ReachMD, I am Dr. Javed Butler. To access this and other episodes in our series, visit ReachMD.com/HeartMatters where you can Be Part of the Knowledge. Thanks for listening.