Stents: Sabeeda Kadavath, MD

Intro

My name is Sabeeda Kadavath. I am a structural interventional cardiology fellow. I am involved with cardiac interventions, which is mainly coronary interventions and structural interventions, as a trainee in this year of my training.

Why are stents used?

Stents are nothing but tubular structures that are used to keep a vessel open. These patients- the scenarios in which we use stents in our patients are when patients come in having clinical symptoms, either chest pain, worsening shortness of breath, or anything that is suggestive of which is an angina equivalent, suggesting that there is some underlying coronary artery disease. Patients undergo a diagnostic angiogram. After that is done, if there is clear evidence that this lesion, the blockage of the vessel is the cause of the patient's symptoms, and if that has been confirmed, either by using some stress modality or see some physiologic testing on the cath lab table, and/or imaging, then we put in something called a stent. And the purpose of putting in the stent is to keep the vessel open long-term. That's the bottom line. We want the lesion to be treated in such a way that the patency of the vessel is maintained.

Describe your first experience deploying a stent.

It was overwhelming because everything was new. That day, it was my first day of training. But what I do remember is the people I was working with walking me through the steps. And so basically what- the way a stent is delivered into a vessel, you have a stent that is mounted on a balloon. And the balloon is- there is a delivery system, and it has got an inflation port which is connected to an indeflator, which is what is used to inflate the balloon. And that is how the stent is delivered at the site desired. It is- So it is not a one man process. Usually, more often than not, the interventional cardiologist is the one who is advancing the stent and positioning it at the site where you desire to deploy it. And you have either a tech or a trainee or somebody else who's scrubbing in with you, help you deliver the stent by inflating the balloon to nominal pressure.

How long is the process of deploying a stent?

It is not a very long process. The steps that go into stent deployment: one is first you obtain an angiogram that shows you the site of the lesion, the culprit lesion, which needs to be addressed. So once you see that, you would calculate, sometimes you can use some measurements that are available with your control device. Or visually you can see what is the stent that you would choose for this patient. And then you mount the stent on a wire, and then you deploy it. So I would say a few minutes is at most is what it takes to deploy a stent.

How do you define the success of a stent?

What is more common in practice is patients receive a stent and angiography using contrast- is what is used to determine that the stent is deployed correctly where it needs to be, the fact that it- the dimensions of the stent are appropriate for the vessel that is being treated. In recent times, there is more evidence to suggest that use of imaging in the form of intravascular imaging using either an IVIS, or optical coherence tomography, which is OCT, can add more valuable information when it comes to finding appropriate stent size, length, finding out the characteristics of the region that we're treating. And this sort of helps predict the patency of the stent and its long-term clinical outcome in ensuring that the stent doesn't thrombose quickly, there is no quick restenosis of the stent, and the stent is placed appropriately-- that is, from a healthy vessel to a healthy vessel-- and that it is not placed at an unhealthy segment, which increases the chance of the stent clotting off in the near future.

How do you choose which stent to use?

So there are various platforms that are available. There is the Medtronic, there is Boston Scientific, there's Abbott. And so these are some major manufacturers of stents. One of the important things that we look for when we are choosing a stent is, more often than not, patients require a drug eluting stent. In the past, there was the bare metal stent, which is just scaffolding of the stent without any drug coating. But in present times, a drug eluting stent is the first choice that is made. Second, it depends on the lesion. The size of the vessel, the lumen of the vessel, so if it is say a 2.5 millimeter vessel, you would want a 2.5 millimeter stent. And you also choose the stent based on the length of the lesion that you're treating. More common and most cath labs in the country they stock on certain manufacturers compared to others. So that also perhaps has a role to play in which stent gets chosen for a particular procedure.

Why are drug-eluting stents used?

Going back into the history of stents in the past- it was 1986, I believe, and Dr. Gruentzig was the first one who spoke about angioplasties. In the 1980s, early 90s, they would open up a vessel with balloon angioplasty. But what was noted with more than half the time there would be acute vessel closure or early restenosis of the vessel. So late 90s, 2000s, what was seen was that having a drug coating in the stent would keep the vessel open for a long time. And the way that works is when you have a drug coating, it acts as an anti-cytotoxic agent. It prevents inflammation and that is what ensures that the stent stays open for long.

What changes have you seen in the development of stents?

So my experience perhaps is limited compared to more senior folks in the specialty, but I have seen a use of bare metal stents very early in my training- So maybe like five or six years back there were some instances the patients would get a bare metal stent. That is a stent without a drug coating. And those would be patients who were supposed to be a high bleeding risk or say if they had a surgery or a procedure that was coming up which would demand that their plaque could not be held. And with the feel of that these patients may close off their stent quickly, these patients were given a bare metal stent because those- the practice was they required a shorter duration of anti-platelet therapy. However, now, with the newer trials that are coming out in anti-platelet therapy, there is some evidence to suggest that even one month to three months of anti-platelet therapy, may be ok in patients who get drug-eluting stents. So now I've- almost every case that I've done has a patient receiving a drug-eluting stent.

How and when do you know there is a problem with a stent?

When it comes to patency of the stent and making sure the stent is open and there is no problem, the worst-case scenario would be a patient presenting pretty soon after a stent is placed with a complication like a myocardial infarction, which would more often than not suggest that the stent is closed off or something that we call a stent thrombosis. If it is over a period of time, maybe few weeks, months later down the line, then more frequently it is because of the in-stent restenosis, wherein the lumen of the stent that has been placed becomes narrower over time. So these are, and then they would have the occurrence of the symptoms for which the patient originally got the stent.

I have seen both instances occur. The stent thrombosis- which is like, would be very soon after placement of the stent- that is something actually that's being observed nowadays, but this is seen more in COVID patients in my experience. I have been doing cardiac catheterization cases for the last few years as a trainee, but in the last six months is when I've seen the most number of stent thrombosis in patients who've had COVID. When it comes to in-stent restenosis, yes- it is something that is seen quite often, more frequently than we'd like to. Things that we do as interventional cardiologists to prevent that from happening is: One- again, use imaging and use angiography wisely to appropriately place the stent. Second, put patients on anti-platelet agents so that-- it usually takes a stent approximately three months

for it to endothelialize which is, which means forming a layer of endothelium around it to prevent the stent lumen from narrowing. So if patients do not adhere to their anti-platelet regimen, then that is something that can mean more instances of in-stent restenosis in those patients.

What are some challenges when working with stents?

Challenging parts is choosing the appropriate length of the stent to make sure you're covering the entire disease segment. The problem- what is tricky also is the fact that- now with the new generation stents, it is a little bit easier- but again, if you have a lesion in a distant vessel, which means like if a vessel is low and at the narrow or tapered bit you want to deliver to stent. Or if you have a bifurcation, which means a branched vessel and you're trying to advance your stent. Or in a patient with difficult, challenging anatomy, that it be a little bent- tortuous- deploying stents in those patients. If there is calcium that needs to be treated before you deploy the stent. So such clinical scenarios can make our delivery of the stent a little more difficult than normally would have been present. So these are some issues that you face and then you need to treat the lesion appropriately before you deploy a stent by using lesion modification devices. For example, if there's a lot of calcium, you do something called atherectomy, where you try to modify the calcium. If the guide, which is the catheter that is used to support your wire over which all your balloons, stents go in- If that is not sitting correctly, then sometimes you need guide extension devices and other such support devices to make sure that the entire system is stable for you to deliver the stent.

What improvements do you recommend to stent technology?

Any change in engineering and design of these stents would really help the interventional cardiologists with putting in these stents. Like I mentioned earlier, if- what we require when we are deploying a stent- you want to stent that is easily trackable. You want to be able to see it with angiography. It has to be opaque, but you don't want it too opaque so that you don't see the vascular structures. You want it to be trackable. You want it to be deliverable, so you can- it can go to any vessel where you desire to deploy the stent. You want it to have- not have complications like stent thrombosis and in-stent restenosis. So you want a stent- There has been evidence to suggest that thin strut size has a lower rate of in-stent restenosis. So if we can improve technology and improve stent strut thickness, that may be helpful. There is some literature to suggest that open struts are better than closed ones. Because then it helps you with access to side branches. But you also want to make sure that you're covering the plaque- the disease segment appropriately. So that's something that we could work on more. There is some literature- There are some studies that are trying to see if we can have bioresorbable polymers and stents, wherein after a period of time, the stent just dissolves completely. So that is something that is open for future development. You want stents that have good radius strength. Because after you put a stent in, there is some recoil. So the way you know how much the stent is going to recoil is you inflate the stent and you compare that with a stent at its nominal pressure, like without any inflation. So the difference between the two is how much you expect the stent to recoil. And if the stent recoils, then there's a chance that they can restenose. So you want stents that have good radial strength that open and they oppose against the vessel segment. So they maintain patency of flow and they stay open for long. So there are different ways we can work on these stents and help with improving them.

What message do you have for future biomedical engineers?

I am hopeful that you and your students and future biomedical engineers are working to make these stents more long-term. Right now, when it comes to patients who present with multi-vessel disease, then you compare bypass surgery versus coronary interventions. In those patients, we do not have any good data to suggest that coronary interventions are as effective as compared to bypass surgeries. So if we improve, stent design, stent patency, and long-term outcomes, I'm quite optimistic that the results that we see will be as good and as beneficial to the patient.