ECG in Acute Cardial Ischemia

Announcer: Welcome to Mayo Clinic's ECG Segment: Making Waves, Continuing Medical Education podcast. Join us every other week for a lively discussion on the latest and greatest in the field of Electrocardiography. We'll discuss some of the exciting and innovative work happening at Mayo Clinic and beyond with the most brilliant minds in the space, and provide valuable insights that can be directly applied to your practice.

Dr. Kashou - Welcome to Mayo Clinic's ECG segment "Making Waves." In this episode, we'll explore the role of CineECG in acute coronary syndrome. We're excited to have Dr. Ton Gorgels as our expert guest today. Our focus will be on the role of the ECG in acute coronary syndrome, determining the site of occlusion, so localization, and then the potential value of CineECG, which is really neat, and I want you to hear about, in ACS. But first, let's introduce our guest today. So Dr. Ton Gorgels is a highly accomplished cardiologist with a distinguished career. He received his medical degree from Radboud University in 1973, completed his internal medicine residency training at St. Kanesha's Hospital and cardiology training at the university of a hospital of mastery. From 1980 to 2013, he served as a cardiologist and staff member focusing on electrocardiography of cardiac ischemia and out-of-hospital cardiac arrest. Dr. Gorgels completed his PhD thesis in 1985 on ventricular impulse formation and the influence of digitalis intoxication. He was appointed as a professor of cardiology at Maastricht University in 2005 and currently holds the position of emeritus professor while practicing still as a cardiologist at HartKliniek Maastricht in the Netherlands. Dr. Gorgels, thank you so much for joining us today.

Dr. Gorgels - Thank you very much for inviting me. It's a pleasure to be here.

Dr. Kashou - So we had this meeting at Eski not too long ago, and I was so excited by what the work that you were sharing with Peter, and I thought it would just be a great highlight for audience to know what this unique work you're doing, but maybe even starting at the basic. And so maybe we could start as, what is the role of the ECG in acute coronary syndrome, or as ACS, as we call it?

Dr. Gorgels - Yes, I think the ECG remains a very important tool in diagnosing acute coronary syndromes. A diagnosis, the presence of STEMI, ST elevation myocardial infarction, or non-ST elevation myocardial infarction, it stages the ongoing ischemic process. There's already changes in the QRS and the T wave or only in the ST segment. It's very important to determine the coronary occlusion side, which is the culprit vessel and is it proximal or distal in the vessel. That determines the size of the cardiac area at risk. It's also very important to identify the presence of conduction disturbances and the presence of cardiac arrhythmias. And it helps very much in deciding on the management. Should we go for PCI, thrombolysis, or shall we wait and see? Furthermore, it's the ECG is important in evaluating the effect of reperfusion therapy. Are the signs of reperfusion already in this ECG and what is the value of reperfusion arrhythmias? We did quite some studies in that regard. And finally, ECG is, of course, important to assess the residual cardiac damage and the prognostic significance after myocardial ischemia. So that's actually, I think therefore in spite of other upcoming techniques, I think the ECG remains a very important and indispensable tool in the emergency room.

Dr. Kashou - It's really amazing, and you've seen this over your career, as the ECG still remaining prevalent, and maybe perhaps we're getting a better understanding of what these signatures, these electrical signatures coming from the heart are telling us. And perhaps we're, like you said, now even getting prognostic information how we manage our patients. Now focusing on the ACS topic, and you mentioned localization, how exactly can we use the ECG to determine the site of occlusion and also areas that may be at risk based on an occluded vessel?

Dr. Gorgels - Yes, it is, of course, very important to assess the the culprit vessel. Are we dealing with an LAD occlusion or is it the circumflex or the RCA? So this is the first question, and I think the ECG is very optimum in this. And we have also found that the ECG is very informative regarding the site of occlusion. Is it proximal in the culprit vessel, proximal in the LAD, is in the mid LAD or distally? And as far as right coronary artery is concerned, is it before or after the right ventricular branch? The right ventricular involvement is, as you very well know, is very important to assess because that may influence the clinical picture and also the prognosis of the patient. And a very specific situation comes in circumflex occlusions. Are we dealing with a circumflex? And the problem is in circumflex occlusions is that it's not always that evident that we are dealing with a complete occlusion of the vessel because it's frequently presents as an non-STEMI. And we are going to discuss CineECG, and I think the CineECG could be very helpful in this regard.

Dr. Kashou - And so that's the localization because the management happens, and you mentioned that the left circumflex that we sometimes call the, it's silent on the ECG.

Dr. Gorgels - Yeah.

Dr. Kashou - But per... Go ahead. I'm sorry.

Dr. Gorgels - No, that's right. It's called the, it's acting in silent. It may present as a no ST segment changes at all, and that's very difficult then to diagnose ischemia in that situation.

Dr. Kashou - And perhaps, you mentioned the CineECG. I guess for those unaware in, this is a newer technique but certainly has tremendous potential. Maybe you could share, what is the CineECG? And then we'll look at how is it value and how can it add value in ACS?

Dr. Gorgels - Yes, we studied the 12-lead ECG, and as far as the side of the ischemic area was concerned, by looking to the area with most ST segment elevation, we did that with the so-called ischemia vector, or using, combining all the leads actually and derived the ST vector, which pointed actually to the severest area, ischemic area. That correlated very well with the culprit side of the occlusion in either the LAD, RCA, or circumflex. And we restudied this by using the CineECG, and we found actually very good correlations between the what was find in the 12-lead electrocardiogram and in the CineECG. So we found that the CineECG was very accurate actually in determining the side of the ischemic area.

Dr. Kashou - And so it's the CineECG, so I guess tell me, how does this CineECG work? What exactly is it telling you? I heard that the ST segment injury vector seems to have a prominent role on it, but what exactly, what is it capturing that's so unique?

Dr. Gorgels - Yeah, the CineECG actually shows the electrical pathway as derived from the 12-lead ECG, and it's projected on the cardiac anatomy. So it shows the start of the QRS till the end. So it shows the QRS, the ST segment, and the T wave, and it reacts on the cardiac anatomy. So you very well see the electrical pathway through the ventricles. And by combining at all 12 leads from the electrocardiogram.

Dr. Kashou - That's quite fascinating. Yeah.

Dr. Gorgels - It's very fascinating because you very clearly can show, for instance, right or left bundle branch block and fascicular blocks, and so it helps non-experienced clinicians which are not very experienced in electrocardiography to understand actually the pathway in that situations, to understand actually what's going on. And we studied that in the ST elevation acute coronary syndromes, and we looked to the change in the ST direction in different situations, in different forms of LAD occlusions and RCA occlusions, and also in circumflex occlusions. We found very good correlations actually between what was expected from the 12-lead ECG and what we saw in the CineECG. And the most intriguing finding actually was what we found in circumflex occlusions because we had examples where actually no or not much changes in the ST segments were seen in the surface electrocardiogram but where the CineECG, to our surprise, shows very clearly the direction, the change in the ST direction into the posterior basal area pointing to indeed an occlusion in the circumflex. That was a surprising finding, and it suggests that the CineECG could have more information than just a 12-lead electrocardiogram.

Dr. Kashou - It's really fascinating. And I guess for a simple learner, and I appreciate you saying for the novice learner, this could be tremendously helpful because what I'm hearing is the, we have the 12-lead ECG, and then you can envision an illustration of the heart. And as the ECG goes through its timeframe it conducts through the heart, you're seeing the conduction pathway, and so any alteration of that pathway, as you mentioned, right or left bundle branch block, would be represented graphically or illustrated in an image based on that. And you kind of went on with the team to look at, how does this affect the CineECG in ACS? And the silent one. And I wonder, is there something? Because you're still using the 12-lead to capture and create the CineECG. Are there other findings maybe you've noticed from your own personal or the research side of things of what is being picked up in this left circumflex that's normally silent?

Dr. Gorgels - Yes, we found that in different circumflex disease can also show just as prominent positive U waves in the precordial leads. And also in that situation where actually not much of ST segment changes were seen, we saw that there was a clear change of the ST segment in the posterolateral direction. So and also in this form of circumflex expression on the 12-lead ECG, we saw that the CineECG was very helpful actually in helping finding the side of the most ischemic area and the related occlusion in the circumflex. And what we actually envisage now is we are going to study a database of patients which came in with chest pain and inconclusive electrocardiograms, where they were studied with acute MRI and an acute CT scan in the acute situation. And it was also actually found that these imaging techniques were helpful in

diagnosing ischemia in those cases. But what we hypothesized now is that the CineECG might also be helpful to analyze those electrocardiograms. Half of those were indeed ischemic. Half were finally found not to be ischemic. So we can sort out whether the CineECG will help us in differentiating patients coming in with chest pain and non-inclusive or inconclusive electrocardiograms. So that could be a further step where the CineECG could be helpful.

Dr. Kashou - You do see tremendous value with this from the basic teaching and then to the application of patient care. That retrospective, that could be the initial study of assessing, are there changes in management or different outcomes that could have happened based on using this in ECG? I see this really making a lot of waves. A lot of it's just learning this new technology because you're now looking at the ECG in a different manner. Now, before we close, I'd like to ask you, do you have any final takeaways for the audience here and/or where they can learn more about CineECG?

Dr. Gorgels - Well, there is a website on the CineECG, where they can go through, and there is much more information as we can discuss in these few minutes. And I think that why is the CineECG could be of additional value next to the 12-lead ECG is because the pathway is actually computed differently than what is in the regular surface electrocardiogram. The pathway is actually computed by all leads, all unipolar leads available in the 12-lead ECG, and, therefore, that's one thing. And the other thing that this regards amplitude, so very small changes are going to have influence in the direction, and so that could be the reason that the CineECG gives additional and maybe different information than standard 12-lead electrocardiogram.

Dr. Kashou - And perhaps more sensitive, especially in some of these cases where someone has LVH or high voltages, and from what I'm hearing is it disregards that and it just focuses on the conduction pathway. I think this is tremendously fascinating.

Dr. Gorgels - Exactly. Yeah. It's the next step-

Dr. Kashou - Have you-

Dr. Gorgels - Yeah.

Dr. Kashou - Go ahead, please.

Dr. Gorgels - Well, it's the next step into the development of electrocardiography, I would say, yeah.

Dr. Kashou - For sure, for sure. I mean, again, this continues to evolve, and like you said, from the beginning of your career to even now, we're still studying it, we're still seeing new things.

Dr. Gorgels - Exactly, yeah.

Dr. Kashou - As we wrap up here, we've explored the crucial role of the ECG and ACS, including the ability to localize coronary occlusion. We looked at the potential value of CineECG, and I certainly see this coming around the corner. I know Peter and you and the whole

team are making a lot of efforts in this. The ever-evolving capabilities of this electrical signature from the heart and the significance of ECG in patient care continue to be evident. We hope that this discussion has broadened your understanding and shed light on this emerging diagnostic tool for ACS. On behalf of our team, we extend our gratitude to Dr. Gorgels for joining us today. We hope he'll join us again with Peter in the future. Thank you. Thank you for joining us today. We invite you to share your thoughts and suggestions about the podcast at cveducation.mayo.edu. Be sure to subscribe to a Mayo Clinic Cardiovascular CME podcast on your favorite platform, and tune in every other week to explore today's most pressing electrocardiography topics with your colleagues at Mayo Clinic.