Hi. I’m Jeff Klein, editor of RadioGraphics and today I’m pleased to have with us Dr. Scooter Plowman from the Stanford University Medical Center Clinical Excellence Research Center, and Dr. Constantine Raptis of the Mallinckrodt Institute of Radiology who are co-authors of one of our featured papers in the current July 2017 issue of RadioGraphics entitled “Imaging of Pregnancy-related Vascular Complications.”

Doctors welcome.

R. Scooter Plowman Thank you very much. Nice to be here.

J.S.K. Scooter. Let’s begin with you. Your paper in the current issue is really a very interesting one and while we’ve published a number of papers related to a variety of pregnancy related imaging issues over the last number of years, we haven’t published much on the topic of vascular complications that are related to pregnancy. How did you come up with the idea for this particular exhibit and for the paper?

R. Scooter Plowman, MD, MBA, MHSA Yeah, thank you Jeff. That's nice to hear. And the credit really for the idea is not mine to take. This was actually the brainchild of our senior author Cookie Menias and she has had a long interest in dye imaging and which I think crossed paths then with the interests in cardiothoracic and cardiovascular pregnancy complications. Among some of her former chest colleagues at Washington University, Cylen Javidan and Costa Raptis who is here with us and Sanjeev Bhalla and you know after pulling I think some similar cases the idea for the collaborative effort and imaging vascular complications really ensued and it was really neat to see all the pieces come together.

J.S.K. Well great, thanks for that. After the introduction of your paper in which you review some of the demographic issues that relate to smoking and diabetes and their effect on pregnancy which obviously impact many of the conditions that you illustrate in the paper; you discuss the physiologic changes of pregnancy and briefly review the selection of imaging examinations in pregnant patients. Can you touch on the use of magnetic resonance imaging in the pregnant patient?

R.S.P. Yeah, yeah happy to. The role of MR imaging in pregnancy has really evolved now to much higher numbers where I think it’s becoming commonplace even for example in the evaluation of appendicitis where ultrasound is sometimes difficult to localize the normal appendix in pregnant patients, MRI does so quite seamlessly and the ACR now endorses MR imaging in pregnancy in all three trimesters even on 3T. And in fact Costa I don’t know if you want to comment on this on, but I think that's probably been your experience as well at Mallinckrodt?

C.A.R. Yeah that’s actually absolutely correct. You know we deal with, so this is a pretty rare complication, a rare thing to happen in any patient, but it does have a slightly increased incidence with some spontaneous case reports in pregnant patients. And you know when you’re dealing with a coronary artery dissection whether you’ve got a patient who is pregnant or not pregnant if that is really a strong clinical suspicion, our first line recommendation would be do either an intravascular ultrasound and/or a cath. And the reason for that is because that’s, in often times would
help you, you’d be there with the cath and then you could also treat the patient you’re going to consider stenting at the same time. There’s really not a huge radiation savings between a cath and doing a coronary CTA. So you know you’re not really saving the patient anything in that regard. What you are saving the patient if you do elect to do a CTA is you’re avoiding having to do a catheterization and do a groin stick on arterial access. So you’ve got a patient where the concern is high, we would recommend going straight to a cath and evaluating in that means and we do have that discussion with our cardiologists on occasion. Now if you’ve got a patient who suspicion is low but it’s still a consideration and you’d just like to “rule something like that out” given that it’s so rare, I think a gated CTA is a decent test. Now there’s not a lot of literature to back up using it at an (inaudible) false negatives and false positives, that kind of stuff, for a gated CTA, but really what you’re looking for is the same think you’d be looking for in a dissection in any vessel. Intimal-medial flap you know that would appear as a hypoattenuating line that goes through the vessel. Now when you’re dealing with – the coronaries are not large of vessels so identifying the intimal-medial flap can be difficult. In some patients you may not actually see the flap you may just see the vessel abruptly occlude and we can assume that there may be a coronary artery dissection there. The real kicker when you’re dealing with small vessels like the coronaries in the setting of coronary artery dissection is distinguishing intimal-medial flap from a flow artifact. Occasionally you can get slow flow within the vessels and that can produce these linear hypoattenuating defects within the lumen of the vessel that can simulate dissection flaps. So how do we distinguish those two things? Well really the key features are that an intimal-medial flap really should be a fairly sharp and well defined linear hypoattenuating structure, whereas flow artifacts are often indistinct and look a little bit more like boat smoke. So if you see these flow artifacts in one plane, often times they can simulate the intimal-medial flap, but when you reconstruct them I think it’s often easier to identify their indistinct borders. So when we’re dealing a coronary CTA, question on a coronary artery dissection, it’s very, very important that you do multiplanar reconstructions and really lay out that vessel to make sure that what you’re looking at really does have those sharp margins, extends towards both walls of the vessel, and is not just an indistinct flow artifact. You can see in Figure 4 here in the paper and I know that it’s a relatively subtle finding, but there is a linear hypoattenuating defect that kind of extends diagonally through the left coronary artery there and you can see that that is the intimal-medial flap in the setting of dissection in this patient. So we can make the diagnosis here on the imaging study and then the question is how do you treat this patient? Well we’ve got a couple options. They could do (inaudible) they do bypasses in rare situations in which the coronary artery is severely thrombosed the patient may even require a heart transplant.

J.S.K. Great, well thank you for that. Costa rounding out this paper reviews of Budd-Chiari syndrome and placental abruption. Now in placental abruption you indicate in the paper that ultrasound is somewhat limited in evaluation of placental abruption and that MR may have a role in specific situations. Can you talk to us about the use of ultrasound in placental abruption and show us Figure 9 which I think is a nice example of the use of MR in this particular setting?

C.A.R. Yeah I mean the issue with ultrasound in abruptions that has a very high false negative rate, it’s a difficult diagnosis to make. You’re basically looking for retro placental hematoma with is this intermediate echogenicity mass that occurs behind the placenta. It’s tough to identify, very operator dependent, so it’s an exam that’s done frequently because it’s available, it’s not that hard to do it, but it is recognized to have a high false negative rate. Now really the diagnosis of placental abruption is a clinical one. So typically you know if you’re going to make that diagnosis it’s done on the clinical grounds and ultrasound can be supported. Now if you’ve got a patient who has a negative ultrasound and there’s still a high suspicion for abruption and it perhaps for a specific reason that knowing whether or not the patient has abruption could have an impact on their care or how they would manage the patient, you could consider doing an MRI examination just specifically for abruption. Just like with ultrasound, essentially what you’re looking for is a blood clot or hematoma in the retroplacental area and that could be marginal abruption right in the center of the placenta. There’s different types of abruptions. But as you can see in Figure 9 here we have a T1-weighted, non-contrast image and you can see that there these hyperintense blood products that are within the amniotic sac and that if it’s blood in the amniotic sac so concerning, it goes along with the history of vaginal bleeding. And then in number B here, or Figure B, you can see that you’ve got a star that’s positioned on a myometrial contracture and that’s really the big fooler in the setting of an abruption. You’ve got – the blood is there, the myometrium can contract and that can itself look like a hematoma. Really the finding here is the arrow that’s placed on the hypointense subchorionic retro placental hematoma. So what you’re looking for is that hematoma between the along the placenta, retroplacenta, on the margin of the placenta and it can have different appearances. It can be T1 hyperintense early if it’s an acute finding. If it’s a more chronic abruption it can be – then evolve to more hypointense. So in this case is a hypointense on the T2-weighted images. So MR can help confirm the presence of that hematoma. We think it’s a great test that we should be doing a ton of for abruption. I actually don’t, but I think in specific situations where you’ve got a negative sonogram and there’s still a pretty high clinical suspicion with some clinical import, I think it’s a reasonable choice.

J.S.K. Great, well thank you for that. Dr. Plowman let’s move on to discuss some vascular entities that are encountered during the delivery and then the postnatal period. You cover amniotic fluid embolism, venous sinus thrombosis and some other conditions and of course
acute pulmonary embolism. Table 3 shows the imaging algorithm that is currently endorsed by the thoracic radiology community, (inaudible) medicine organizations and the obstetrical societies which I think is really important to review, but as you probably know unfortunately is not always followed clinically. So can we just take a look at Table 3 here and perhaps you could just talk through some of the recommendations as far as imaging of patients with suspected pulmonary embolism in pregnancy.

R.S.P. Yeah, yeah, of course, absolutely indeed the Society of Thoracic Radiology and as you mentioned the American Thoracic Society as well as the ACOG all recommend initial compressive lower extremity ultrasound for pregnant patients with positive leg symptoms, DVT, and then you know chest radiography is recommended for those without leg symptoms. And then you know following that ventilation perfusion scintigraphy and CT pulmonary angiography would generally follow and you know a negative or a positive chest radiography result or respectively so. You know going through kind of the table a little bit more specifically, then we see that in Item #3 there the table, it specifically says if no signs or symptoms of DVT exist, pulmonary vasculature imaging and instead of lower extremity compressive ultrasound is suggested. And then skipping to #5 it says if chest radiography findings are normal, then lung scintigraphy or as we know VQ scan is suggested and should be the next imaging tests rather than CT pulmonary angiography. Finally, I think what’s interesting is for scintigraphy, PIOPED II study criteria reserves high probability diagnoses which is greater than 80% likely to pulmonary embolism, or those patients who have two or more large segmental unmatched perfusion defects, so without correlative findings on chest radiography hence the negative indication following a chest radiography. So CTPA of course is highly specific and allows for visualization of the embolus within the pulmonary arterial circulation, but for patients then who have those positive findings even initially at compressive ultrasound, anticoagulation therapy is recommended.

C.A.R. I would just add one thing about this table. It’s important I think as a radiologist, and I’m a cardiothoracic radiologist, we deal with this situation. It’s not common obviously but it does happen probably several times a month. The rationale for this is really based on limiting the breast dose to the mother. You know if you really came down to fetal dose, VQ has a higher fetal dose than a CT for pulmonary embolism. CT for pulmonary embolism is really only at like less than a milligray dose to fetus so it’s extremely low dose. What we’re trying to do in this protocol is limit the breast dose to the mother and the breasts are more radiosensitive during pregnancy and there’s a much higher breast dose with a CT pulmonary embolism protocol than there is a VQ scan. So we’d like to get the VQ scan and get an answer and do just one test. So that’s why we use that chest radiograph and if the chest radiograph is normal, you’ve got a pretty good chance that you might get like a normal or very abnormal VQ. The problem is if you’ve got an abnormal chest x-ray that greatly increases your chance of an indeterminer not clinically useful report on your VQ. So then we just go to ped protocol just so that we do only one study. But the rationale for this table and I think it’s important to understand and you can convey that to your clinical colleagues, is to limit the breast dose. And I think if you have a like an agreed upon plan with your obstetric and ED colleagues that is based around a table like this, I think it’s very easy to employ it in real clinical practice as long as everybody’s on board ahead of time. I think it’s harder in real time to direct these things without agreements up front.

J.S.K. Yeah I would agree with that. I think you know again as another cardiothoracic radiologist one of our biggest struggles is the imaging not so much of pregnant young women, but of young women who present with chest pain or symptoms in whom you’re trying to convince your clinical colleagues that ventilation perfusion scan is a very sensitive way to exclude PE and with the issue with the CT study as you say is really more of a matter of breast radiation than it is to be concerning to the fetus in the pregnant patient. So I think that’s probably an ongoing struggle for which at least at present there seems to be no real solution, but thank you for that explanation. Dr. Raptis the final portion of the paper discusses a couple of the underlying conditions that can be exacerbated by pregnancy. Can we look at one of these cases, which is Figure 20, which I think is a nice example of a patient with underlying aortopathy that you illustrate here where a pregnancy is likely associated with or exacerbates the presence of acute aortic pathology?

C.A.R. Right so you know there’s a bunch of different aortic vascular conditions that result in an increased risk over your lifetime of aneurisms and dissections, those include more common things like Marfan, Loeys-Dietz is a rare one, there are other heritable aortopathies and during pregnancy these patients have an increased risk of complications, so in many situations in patients particularly with Loeys-Dietz we have a large population of Loeys-Dietz in our institution. In patients who have known aneurisms we actually get them screening MR during their pregnancy just to make sure we sort of have a baseline of where their aneurism is at and can evaluate if any are changing rapidly. Now these patients can also present acutely with complications related symptoms. One of the big ones is aortic dissection. We show that in Figures 20 and 21. These are two different patients. You can see in Figure 20 there’s an aortic dissection involving that descending aorta. That patient went on for an emergent ascending aortic repair. It was a type A dissection done for an emergent type ascending aortic repair. In Figure 21a it was another patient who already had had a stented descending aorta who developed a proximal extension of their aortic dissection or a superimposed aortic dissection involving their ascending aor-
ta. You can see that as a large out pouching false lumen and it’s number 21a. The white arrow is pointing to that. So you know really the issue with pregnant patients is twofold. One is you know recognizing that if a patient has an underlying risk factor or genetic syndrome that places them at risk for acute aortic syndromes in this fashion, imaging is definitely indicated in the acute setting. You might also want to consider using it in the more chronic setting when the patient, before the patient has symptoms just to get a baseline for they’re at; and in those situations we usually use a noncontrast MR to get a lay of the land for where they’re at. You know these are serious issues and obviously can lead to very bad outcomes so imaging promptly is necessary.

**J.S.K.** Great, well thank you for that and really nice examples of that condition. I’d like to thank Dr. Scooter Plowman and Dr. Costa Raptis for taking the time today to discuss their paper which deals with pregnancy related vascular complications which can be found in the current July 2017 issue of *RadioGraphics*. Doctors thank you very much for your discussion today.

Thanks for having us.

Yeah thank you it was a pleasure.