Oklahoma Heart Institute

VOLUME 13 | NUMBER 2 | WINTER 2018

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REDUCE-IT: Topline Results Demonstrate Role for EPA in Cardiovascular Risk Reduction

Chronic Total Occlusions Can Be Opened

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Published by Oklahoma Heart Institute
Edited by Newsgroup Communications, Tulsa, OK
Designed by Amanda Watkins
For advertising information contact:
Elaine Burkhardt at 918.749.2506
newsgroupcom@gmail.com
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The Oklahoma Heart Institute Magazine is mailed directly to referring physicians and other referring health care professionals in the Tulsa area and is also available in our patient waiting rooms.

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ON THE COVER
To celebrate its first holiday season, the Tulsa Gathering Place's Wonderland of Lights welcomes and delights visitors to our new park. Here, the Boathouses' green lights cast their festive reflection on Peggy's Pond. Photo by Tyler Layne

to our readers

This issue of Oklahoma Heart Institute magazine focuses on newer therapies for treating heart disease.

Dr. Eric Auerbach, from our Prevention division, reports the findings from the recently released REDUCE-IT Trial, which is a large randomized, double blinded, study showing the value of Omega-3 fish oils in reducing major adverse cardiac events. Oklahoma Heart Institute was one of the study centers in this trial.

Dr. Raj Chandwaney, from the Interventional division, uses a case report to highlight the use of newer techniques to allow doctors to open chronically, totally, occluded blood vessels to the heart in symptomatic patients with chronic total occlusions (CTOs).

Dr. Siva Soma, from the EP division, reports on newer treatment strategies for patients with rapid heart rhythms due to SVT (supraventricular tachycardia).

We hope that you enjoy the articles and welcome any comments or suggestions regarding the magazine content.

Sincerely,

Wayne N. Leimbach, Jr., MD
Publisher/Editor,
Oklahoma Heart Institute Magazine

REDUCE-IT

Topline Results Demonstrate Role for EPA in Cardiovascular Risk Reduction

By Eric G. Auerbach, MD, FACC

Lowering LDL-cholesterol has become a foundational strategy in cardiac risk reduction, and has undoubtedly prevented countless heart attacks and strokes. Nonetheless, many people remain at risk and will suffer a cardiovascular event despite receiving aggressive therapy to lower cholesterol. Learning to find and mitigate this residual risk is therefore a central goal of the preventive cardiology community.

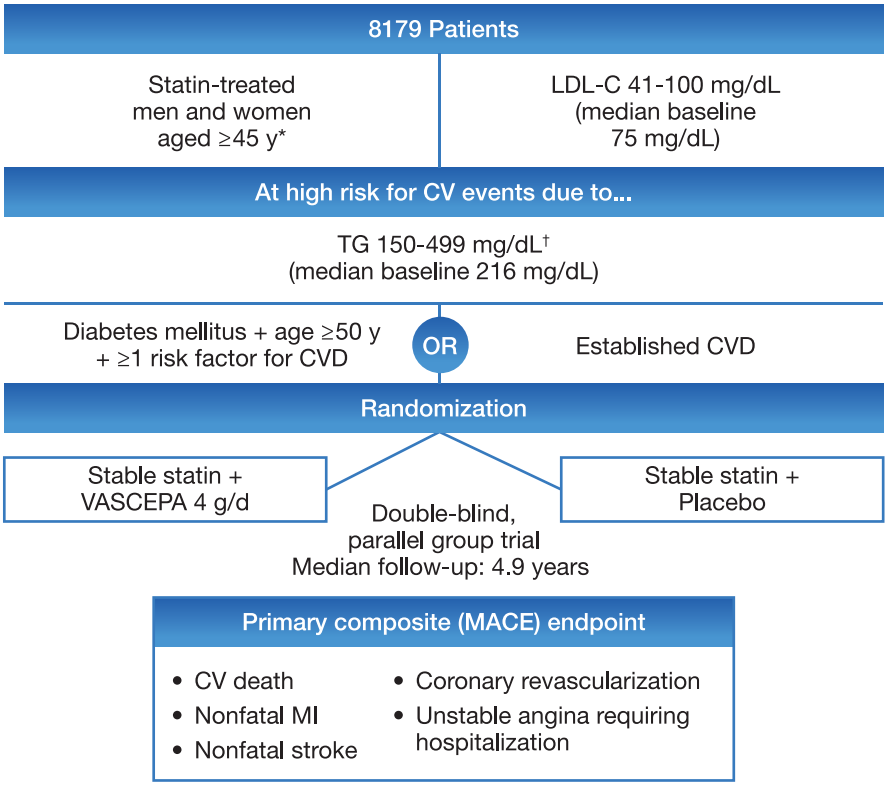
The REDUCE-IT trial was a cardiovascular outcomes study that enrolled patients with established cardiovascular disease, or were at high risk for cardiovascular disease, with moderately elevated triglycerides. Study subjects, who already had well-controlled LDL cholesterol on statin therapy, were randomized to Vascepa (icosapent ethyl) 4g daily or placebo. The study was sponsored by Amarin Pharma (the manufacturer of Vascepa). Oklahoma Heart Institute was a site in the trial.

There were two main rationales for conducting the REDUCE-IT trial. First, a large body of clinical trial data suggests that lowering triglycerides might be a fruitful strategy in managing cardiovascular risk. Secondly, there is good reason to believe that the omega-3 fatty acid EPA might have properties that make it a good tool for risk mitigation.

High triglycerides are clearly a marker of risk. In the PROVE-IT (TIMI-22) trial, for example, patients receiving statin therapy who had triglycerides over 200 mg per deciliter had about a one-third greater chance of having a cardiovascular event than those with triglycerides below 200 mg per deciliter. And, subgroup analysis of many large trials has suggested that triglyceride-lowering therapies might provide some of the most potent preventive benefits ever observed in subjects who are at high risk. In analysis of the Helsinki Heart Study, for example, the subgroup of

Figure 1

REDUCE-IT Study Design



*Participants enrolled should not be advised to use VASCEPA in place of participation. VASCEPA should not be taken in place of a healthy diet and lifestyle or statin therapy.

†Original protocol criteria specified a TG level of 150 to <500 mg/dL. A 2013 protocol amendment modified qualifying TG levels to ≥200 to <500 mg/dL.

There were two main rationales for conducting the REDUCE-IT trial. First, a large body of clinical trial data suggests that lowering triglycerides might be a fruitful strategy in managing cardiovascular risk. Secondly, there is good reason to believe that the omega-3 fatty acid EPA might have properties that make it a good tool for risk mitigation.

study subjects with triglycerides over 200 mg per deciliter and HDL-cholesterol below 42 mg per deciliter enjoyed a whopping 70% risk reduction if randomized to gemfibrozil rather than placebo. Several subsequent fibrate trials have been received by the medical community as "negative" studies, but have shown potential for strong benefit in subgroups with high triglycerides and low HDL cholesterol. Despite this consistent finding in subgroup analysis of major clinical trials conducted over decades, REDUCE-IT is the first major trial to focus on this high-risk subgroup.

In addition to lowering triglycerides by about 50% in people with hypertriglyceridemia, the omega-3 fatty acid EPA has other properties that might make it a good agent for risk reduction. EPA has both anti-inflammatory and anti-oxidant properties. In vivo, EPA has been found to decrease volume of atherosclerotic plaque, increase fibrous cap thickness, and decrease serum hsCRP (a nonspecific marker of inflammation). In vitro, EPA prevents oxidation of LDL-cholesterol, which is a primary condition for the development of plaque in the first place. It may be due to these properties that EPA has been found to reduce risk, independent of its ability to lower triglycerides.

In the JELIS trial, over 18,000 Japanese men and women with total cholesterol over 250 mg per deciliter, with or without heart disease, were randomized to 1.8 g EPA versus placebo. High triglycerides were not part of the entry criteria. In JELIS, EPA was associated with a 19% reduction in major adverse cardiovascular events compared to placebo. Because of differences between the Japanese and American populations, applicability of JELIS in the U.S. has been questioned. However, the need to test this hypothesis was a motivation for REDUCE-IT.

Results from REDUCE-IT were released at a late breaking clinical trials session at the American Heart Association Scientific Sessions on November 10th, 2018 in Chicago, and were simultaneously published in The New England Journal of Medicine. Subjects in REDUCE-IT were randomized to Vascepa, a highly purified formulation of EPA, at a dose of 2g twice daily, versus placebo. Entry criteria included established cardiovascular disease, or at high risk based on diabetes plus at least one additional risk factor, with well controlled LDL-cholesterol (at or below 100 mg/dL), but elevated triglycerides in a range of 150 to 500 mg/dL. At time of randomization, median LDL cholesterol was 75 mg per deciliter, and median triglycerides were 216 mg per deciliter. In this population, REDUCE-IT demonstrated a 25% risk reduction in Vascepa treated subjects compared to those receiving placebo. This result was highly statistically significant (based on a p-value less than 0.001) and further supported by positive findings amongst multiple secondary endpoints. In addition to the 25% reduction in the primary composite endpoint (which included cardiovascular death, nonfatal myocardial infarction, nonfatal stroke, coronary revascularization, and unstable angina), subjects randomized to Vascepa enjoyed a 20% reduction in cardiovascular death and 30% fewer sudden cardiac deaths compared to those in the placebo group. A trend towards reduced all-cause mortality was noted but did not reach statistical significance.

Figure 2

Each capsule contains 1g of pure EPA, differentiating Vascepa from other products that are typically a mixture of EPA, DHA, and other unspecified oils.

In the REDUCE-IT trial, Vascepa was well tolerated, with a discontinuation rate comparable to placebo. There were higher rates of new atrial fibrillation and peripheral edema in the Vascepa arm, as well as a higher rate of major bleeding. No fatal bleeds occurred in either group, however, and there were no significant differences in rates of hemorrhagic stroke, serious central nervous system bleeding, or gastrointestinal bleeding.

REDUCE-IT findings are particularly interesting when viewed in context of other recent publications regarding omega-3 fatty acids. For example, a meta-analysis of ten randomized trials including 78,000 patients, published earlier this year in the Journal of the American Medical Association, indicated no benefit to omega-3 fatty acids in reduction of cardiovascular risk. In that regard, it is notable that REDUCE-IT tested a highly purified and stable EPA ethyl ester, which is clearly a different product than the mixed fish oils utilized in other trials. Additionally, REDUCE-IT tested a daily dose of 4g, which is sufficient to achieve plasma EPA levels that have been associated with cardiovascular benefit.

Also thought provoking is the relationship between triglycerides and benefit that was observed in REDUCE-IT. In subgroup analysis, observed cardiovascular benefits were similar regardless of baseline level of triglycerides, and regardless of achieved triglycerides on therapy. Overall, clinical benefit from Vascepa appeared to exceed what would be expected based on triglyceride reduction, suggesting the potential for pleiotropic effects of EPA.

REDUCE-IT is an important trial that both raises and answers some key questions. REDUCE-IT proves that EPA, dosed at 4g daily, provides a robust benefit in cardiovascular risk reduction. The mechanism of benefit, however, cannot be determined from the study. On the one hand, the benefit demonstrated in REDUCE-IT may have been a result of lowering triglycerides. If that is the case, alternative strategies for triglyceride lowering might result in similar findings. An ongoing clinical trial of pemafibrate, a novel agent in the fibrate class, will shed light on this question. Alternatively, however, REDUCE-IT's positive findings may reflect beneficial effects of EPA on the atherosclerotic process, and the selection of subjects with high triglycerides may have simply served as a means of identifying a high-risk group in whom benefit could be readily demonstrated. For now, the only certainty is that 4g of Vascepa daily is a powerful adjunct to statin therapy in high risk patients with elevated triglycerides.

Dr. Auerbach is a general cardiologist whose major interest is preventive cardiology and cardiovascular risk reduction.

Chronic Total Occlusions Can Be Opened

By Raj Chandwaney, MD FACC, FSCAI, FSVM

Chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is very challenging. The initial step required during PCI involves advancing an intracoronary guidewire across the blockage. During CTO PCI, this initial step is usually difficult and sometimes impossible to achieve. The CTO is often densely fibrotic and impassable. Additionally, it is sometimes difficult for the interventional cardiologist to understand which direction the guidewire should be directed because the distal coronary artery is not adequately visualized (due to the more proximal CTO preventing flow to the distal segments of the artery). Because of these challenges, PCI in CTOs are often regarded as the "final frontier" in the field of PCI.

The optimal approach to CTO PCI continues to evolve. In January 2011, several high volume CTO operators met in Bellingham, Washington and created a consensus algorithmic approach to CTO PCI.[1] This approach was named the "hybrid algorithm." The hybrid algorithm is presented in Figure 1. It integrates all possible wire crossing strategies (antegrade wire escalation, antegrade dissection/reentry, and retrograde). The algorithm directs physicians to the safest, most effective, and most efficient strategy based on the anatomy of the CTO. A fundamental principle of the hybrid algorithm requires that operators master all the skillsets of CTO PCI and be able to alternate between these techniques during the same CTO PCI procedure in order to recanalize the CTO.[2]

The hybrid CTO algrorithm has made a major impact on the dissemination and application of CTO PCI techniques in recent years.[2] An initial single operator experience with the hybrid CTO algorithm was presented at a professional meeting in 2013 and reported a procedural success rate of 90.4% during 73 consecutive PCI cases.[3] This success rate was much better than the previously expected success rate expected during CTO PCI that had historically approximated 75%.[4] Shortly thereafter, a "hybrid registry" of 144 cases performed by five different centers was presented at a CTO summit meeting and reported a procedural success rate of 94% using the hybrid algorithm.[5]

Recently, several publications in peer reviewed medical journals confirm overall procedural success rates that exceed 90% with low complication rates using the hybrid CTO algorithm.[6-8] The CTO PCI procedural success rates reported in the studies utilizing the hybrid CTO alogorithm seem to far exceed those reported during the same era performed without the hybrid algorithm.[9]

The first and most important step of the hybrid approach to CTO PCI is to perform simultaneous dual guide catheter coronary angiography. Dual guide catheter angiography allows complete anatomic assessment of the CTO. The hybrid algrorithm requires operators to assess four anatomic characteristics of the CTO:

- Clear or ambiguous proximal cap anatomy
- Lesion length (< or > 20 mm length)
- Quality of the distal target
- Presence or absence of "interventional" collaterals

Figure 1

The hybrid CTO algorithm[1]

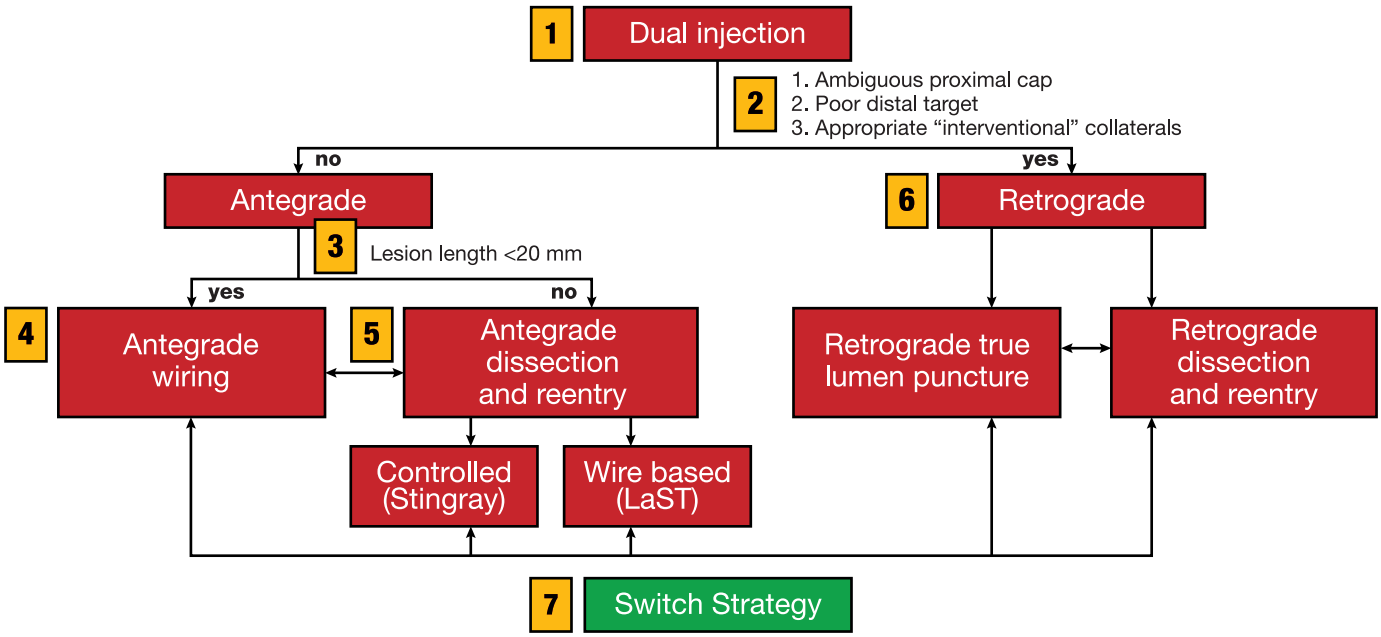
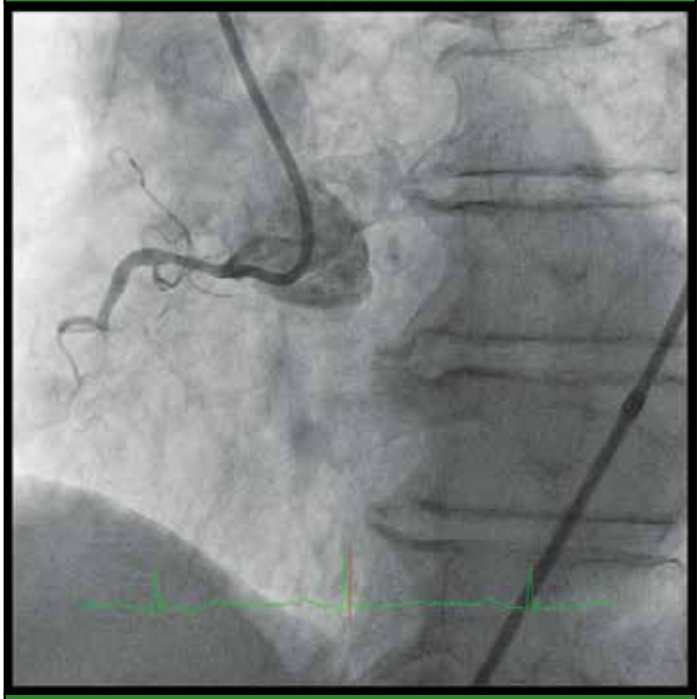
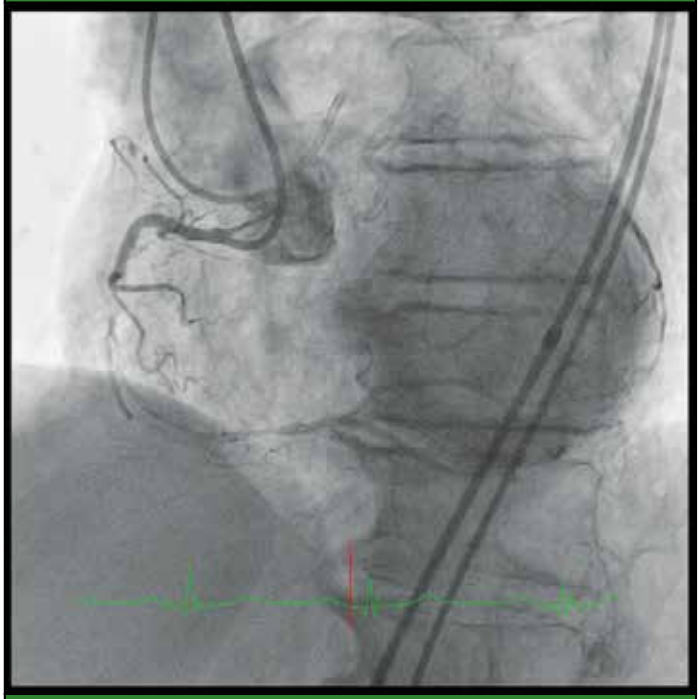


Figure 2



Single guide angiogram of RCA CTO.

Figure 3



Dual guide catheter angiogram of RCA CTO facilitates procedure planning.

By incorporating these four anatomic characteristics of the CTO, the hybrid algorithm directs the operator to the best initial crossing strategy and also provides guidance for subsequent strategies that may be utilized if the initial strategy is not successful.

For example, a CTO with a clearly defined (tapered) proximal cap, 15 mm length, good distal target, and absent "interventional" collaterals (too small or tortuous for retrograde crossing) is best approached with an initial strategy involving antegrade wire escalation, and a secondary strategy involving antegrade dissection/reentry. On the other hand, a CTO with an ambiguous proximal cap, 25 mm length, poor distal target, and good "interventional" collaterals is best approached with an initial retrograde dissection/reentry strategy.

Alternating between different CTO strategies, is at the heart of the hybrid algorithm.[2] Should one approach fail, another approach should be utilized. Every CTO case is unique and may require a different set of strategies for success.

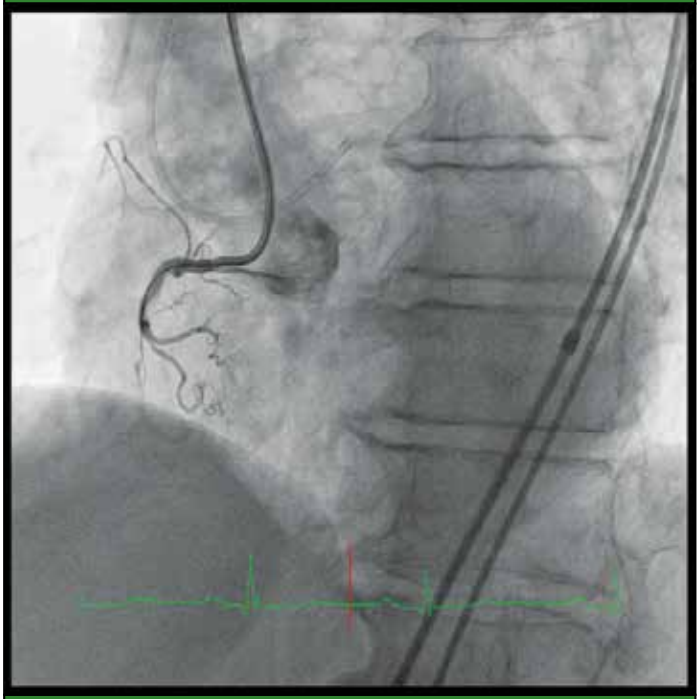
The following case illustrates a situation in which the primary crossing strategy directed by the hybrid CTO algorithm (antegrade wire escalation) was unsuccessful. However, by efficiently moving forward with the planned secondary crossing strategy (antegrade dissection/reentry) we were able to achieve a successful outcome for the patient.

CASE REPORT:

A 70 year-old gentleman was referred to another cardiologist in our community due to complaints of severe dyspnea on exertion and an abnormal myocardial perfusion study that revealed nontransmural infarct and ischemia in the inferior and inferolateral segments of the left ventricle with an ejection fraction of 45%. Several weeks after initiating medical therapy, the primary

(continued on p. 8)

Figure 4



Fielder XT guidewire advances past the proximal cap into the subintimal space during initial attempts with antegrade wire escalation.

Continued from p. 7

cardiologist performed coronary angiography that revealed a right coronary artery (RCA) CTO, and a subtotal occlusion in the first obtuse marginal. An ad hoc attempt at PCI using a single guide catheter approach was unsuccessful. Ultimately, the patient was referred for PCI of the RCA CTO and possibly the OM.

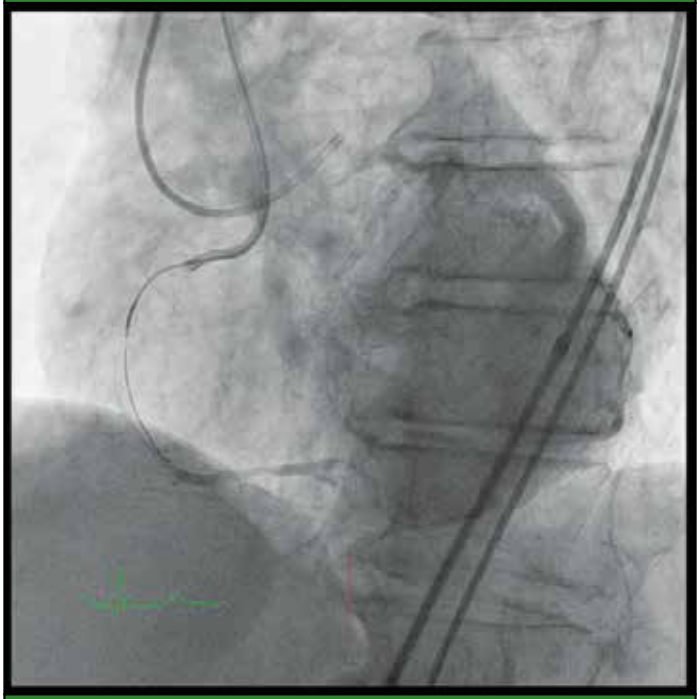
By the time of referral, attempts were undertaken to optimize the patient's medical therapy with aspirin, metoprolol, amlodipine, imdur, and atorvastatin. Despite attempts to optimize medical therapy, the patient continued to report severe, class 3 anginal variant symptoms of dyspea with minimal exertion. Therefore, the patient was scheduled for RCA CTO PCI. Our plan was to stage PCI of the OM on a later date if the PCI of the RCA CTO was successful.

Although antegrade wire escalation was the primary crossing strategy, our wires entered the subintimal space. Therefore, we moved forward with the planned secondary strategy of antegrade dissection reenty with the Stingray system. Balloon assisted microdissection (BAM) and an anchor balloon technique were required to deliver the Stingray beyond the proximal cap.

Angiograms of the RCA CTO are shown in Figures 2 and 3 using single guide, and dual guide techniques, respectively. The angiograms suggested a short segment (< 20 mm) CTO with an inviting tapered proximal cap. The distal segment past the distal cap appeared healthy and does not involve a major bifurcation. No obvious interventional collaterals were observed.

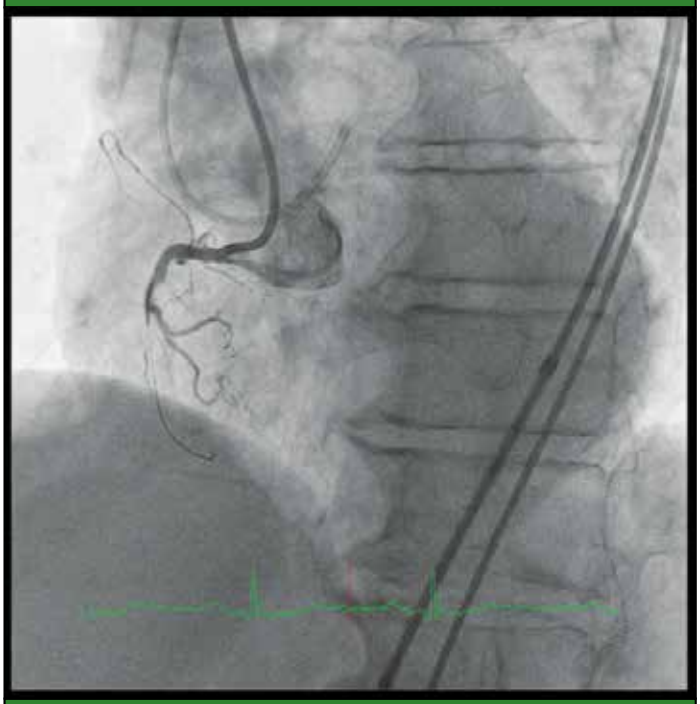
As suggested by the hybrid CTO algorithm, we established antegrade wire escalation to be the primary crossing strategy; antegrade/dissection reentry to be the secondary crossing strategy; and although no obvious interventional collaterals were observed, a retrograde approach via septal surfing through possible angiographically silent septal collaterals would be considered as the tertiary crossing strategy if necessary.

Figure 5



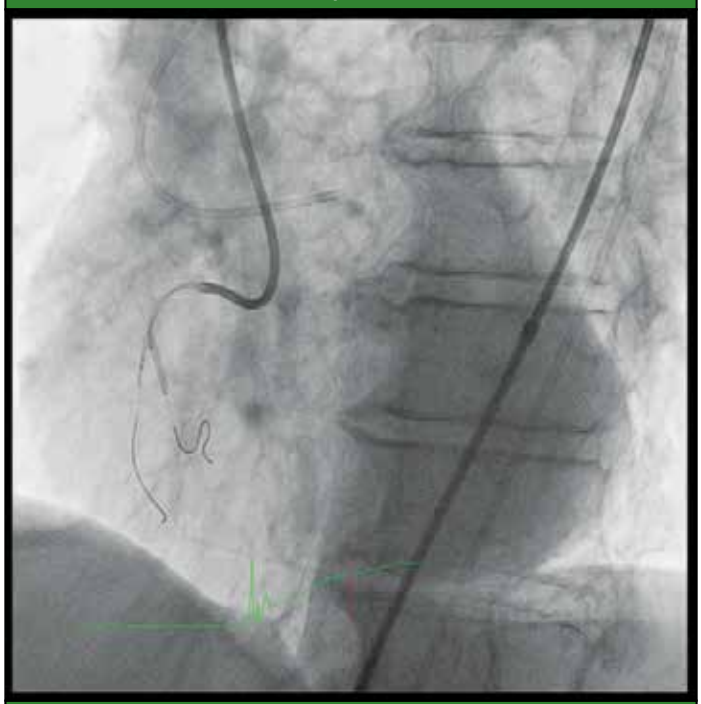
Pilot 200 guidewire advanced further within the subintimal space reaches the re-entry zone.

Figure 6



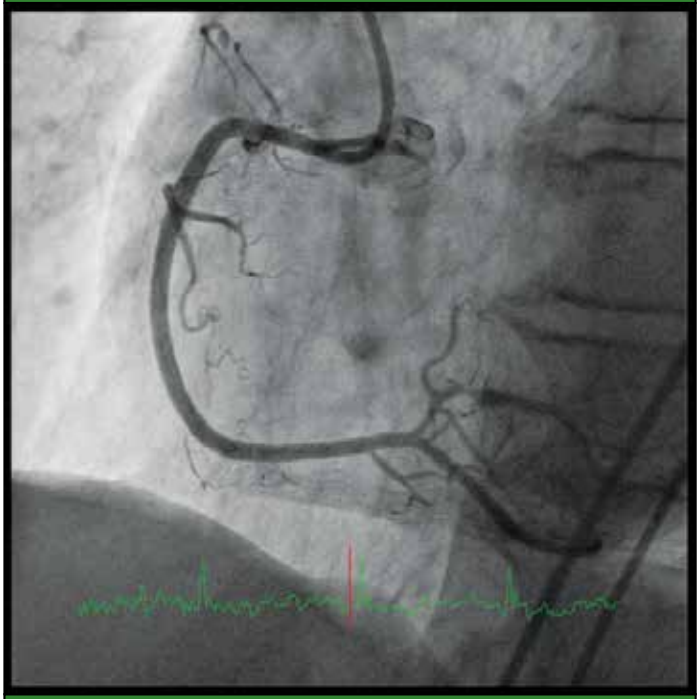
Turnpike catheter unable to advance through the proximal cap.

Figure 7



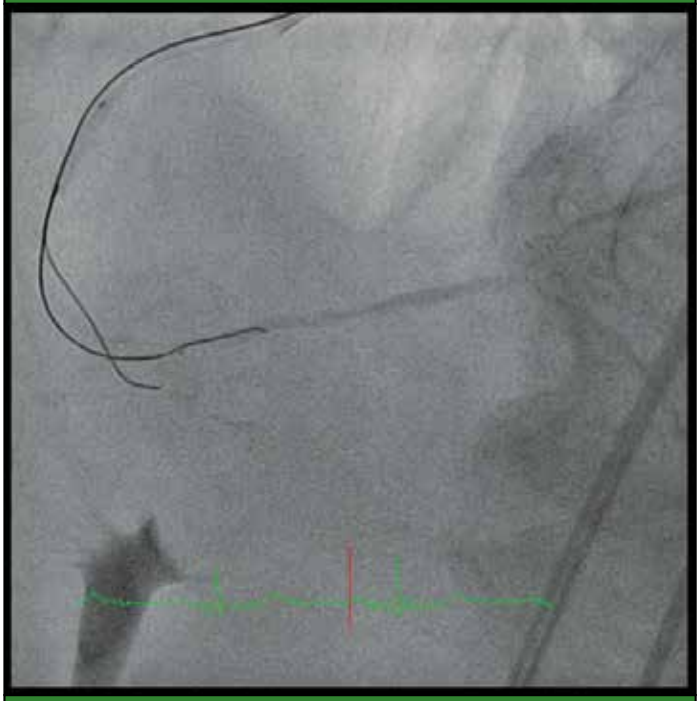
Anchor balloon technique allows second 1.2 mm balloon to advance across proximal cap for predilation (achieved after performing BAM with initial 1.2 mm balloon).

Figure 9



Final angiogram after deploying drug eluting stents in the RCA.

Figure 8



Stingray re-entry into true lumen of the distal RCA.

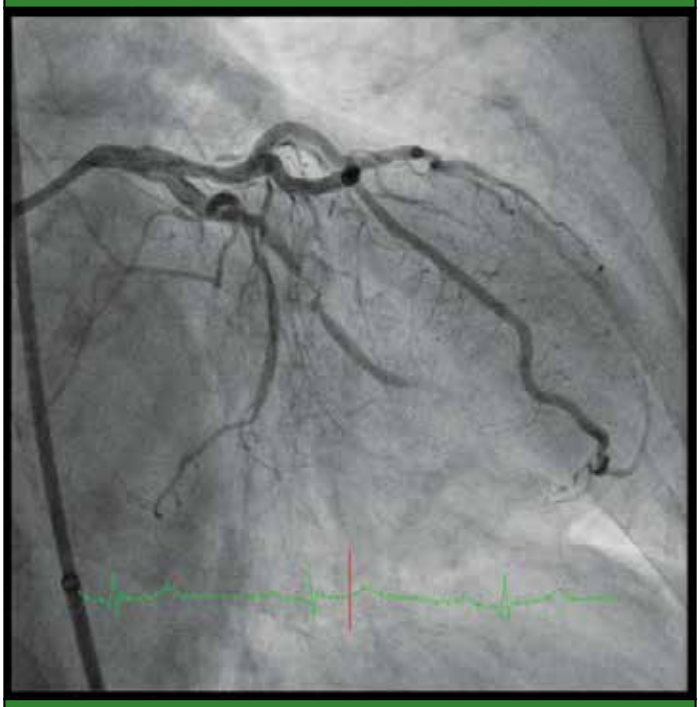
Occasionally, CTO cases that might appear straightforward, may become more complex than anticipated. With careful preprocedural planning that includes consideration of secondary and tertiary strategies that may be required, a high rate of success can be achieved.

On the date of the procedure bilateral femoral access was obtained. The RCA was engaged using an 8 french AL1 guide catheter. The left coronary artery was engaged using a 7 french EBU4 guide catheter. The RCA CTO was initially probed using a workhorse intracoronary guidewire with the support of a Turnpike catheter. The initial CTO wire used was a Fielder XT guidewire. Although the Fielder XT appeared to advance beyond the proximal cap, angiography revealed that the wire actually entered the subintimal space (see Figure 4). Despite briefly trying to redirect the wire towards the true lumen, the wire remained in the subintimal space. Due to lack of progress, we escalated to a Pilot 200 intracoronary guidewire. After again trying to redirect the wire, it appeared to advance further, but angiography again confirmed subintimal positioning of the wire. The wire now appeared to reach a segment of the vessel that appeared suitable for re-entry (see Figure 5). Therefore, we elected to move forward with an attempt towards Stingray reentry into the distal true lumen.

At this stage of the procedure, we were hoping to advance the Turnpike catheter to the reentry segment so that we could exchange the Pilot 200 wire for a stiffer Miracle 12 wire to facilitate delivery of the Stingray reentry device. Unfortunately, the Turnpike catheter could not be advanced past the proximal cap of the CTO (see Figure 6). We then attempted to advance a 1.2 mm Trek angioplasty balloon across the lesion for predilation but it also could not be advanced through the proximal cap. To improve our chances of eventually crossing the lesion with the Singray balloon, balloon assisted microdissection (BAM) was performed by inflating the 1.2 mm balloon until it intentionally ruptured. To optimize guide support, we elected to position a 2 mm Trek angioplasty balloon in the right ventricular branch over a workhorse wire. By optimizing guide support with the anchor balloon technique, a second 1.2 mm Trek balloon could be advanced across the proximal cap.

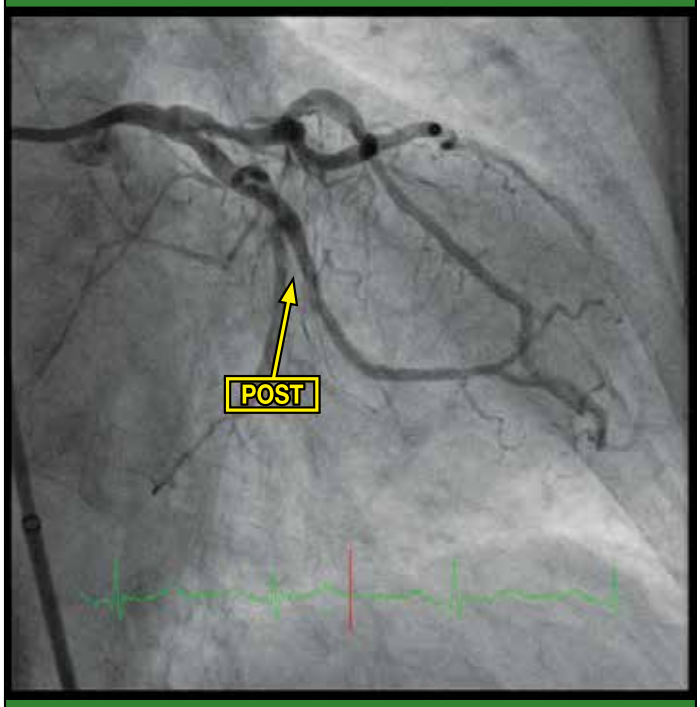
(continued on p. 10)

Figure 10



Initial angiogram of severe stenosis in the obtuse marginal that was addressed several weeks after the RCA CTO procedure.

Figure 11



Final angiogram of obtuse marginal after drug eluting stent placement.

Continued from p. 9

The 1.2 mm Trek balloon was inflated to 14 ATM (see Figure 7). After predilating the mid segment of the RCA, the Stingray reentry device was delivered to the distal segment of the vessel. The Stingray balloon was inflated to 4 ATM. Successful reentry into the distal true lumen was achieved with the Stingray wire using the "stick and drive" technique (see Figure 8). After predilating across the length of the CTO with a 2.0 x 30 mm Trek angioplasty balloon, three Xience Alpine drug eluting stents (3.5 x 15 mm, 3.0 x 38 mm, and 2.75 x 33 mm) were deployed across the length of the CTO and the reentry location. An excellent result was achieved (see Figure 9).

Of note, the patient went on to undergo staged PCI to the severely stenosed first obtuse marginal approximately 1 month later without difficulty.

The patient was recently evaluated by his primary cardiologist. He continues to feel well more than 1 year after PCI. A repeat echocardiogram documents normal ejection fraction.

DISCUSSION:

This case highlights the benefits of applying the hybrid algorithm to CTO PCI. Occasionally, CTO cases that might appear straightforward, may become more complex than anticipated. With careful preprocedural planning that includes consideration of secondary and tertiary strategies that may be required, a high rate of success can be achieved.

Dr. Chandwaney is an interventional cardiologist with expertise in cardiac catheterization, coronary angioplasty and related interventional procedures such as coronary stents, atherectomy, intravascular ultrasound and peripheral vascular interventional procedures.

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- VATS (Video Assisted Thoracoscopy Surgery) for Biopsy and Treatment
- Minimally Invasive and Open Techniques for Diagnosis and Staging of Lung and Nonpulmonary Cancer in the Chest
- Minimally Invasive and Open Techniques for Therapeutic Lung Cancer Resection
- Surgical Treatment of Esophageal Cancer and Benign Esophageal Conditions

VASCULAR SURGERY

- Endovascular and Open Treatment of Aortic Aneurysms: Abdominal and Thoracic Diagnosis, Surgical, Interventional and Medical Management of Peripheral Arterial Disease (PAD)
- Surgical Treatment of Carotid Occlusive Disease
- Limb Salvage

MEDIASTINAL SURGERY

- Evaluation and Treatment of Mediastinal Masses

THYROID/ENDOCRINE SURGERY

- Full Spectrum of Thyroid Surgery (Total versus Near Total Thyroidectomy)
- Parathyroid Surgery with Intraoperative PTH monitoring
- Recurrent Nerve Monitoring

Oklahoma Heart Institute Hospital
1120 S. Utica Avenue
Tulsa, OK 74104
P) 918.574.9000

Oklahoma Heart Institute at Utica Physicians Offices
1265 S. Utica Avenue
Tulsa, OK 74104
P) 918.592.0999 • F) 918.595.0208

Oklahoma Heart Institute at Southpointe Physicians Offices
9228 S. Mingo Road
Tulsa, OK 74133
P) 918.592.0999 • F) 918.878.2408

Oklahoma Heart Institute At Hillcrest Hospital South
8801 S. 101st E. Avenue
Tulsa, OK 74133
P) 918.592.0999

THE DOCTORS OF OKLAHOMA HEART INSTITUTE

Wayne N. Leimbach, Jr., MD, FACC, FACP, FSCAI, FCCP, FAHA

Dr. Leimbach is a specialist in interventional and structural cardiology, including cardiac catheterization, coronary angioplasty, stents, atherectomy, laser, intravascular ultrasound imaging, and direct PTCA/stents for acute myocardial infarction. He also specializes in percutaneous closure of PFOs, ASDs, PDAs and percutaneous valve replacement or repair procedures such as TAVR and MitraClip. He is Director of the Cardiac and Interventional Laboratories at Oklahoma Heart Institute Hospital and also is Past Chief of Cardiology. Dr. Leimbach is Co-Founder of the Lipid and Wellness Clinic at Oklahoma Heart Institute. He is Director of the James D. Harvey Center for Cardiovascular Research at Hillcrest Medical Center, as well as Director of the Oklahoma Heart Research and Education Foundation. He also serves as Clinical Associate Professor of Medicine at the University of Oklahoma College of Medicine-Tulsa. Dr. Leimbach completed a Clinical Cardiology Fellowship and a Research Fellowship at the University of Iowa Hospitals and Clinics. He also completed his Internal Medicine Internship and Residency Programs at Iowa, where he was selected Chief Resident in Medicine. He received his medical degree from Northwestern University in Chicago and his Bachelor of Science degree from the University of Michigan.
Board certified in Internal Medicine, Cardiovascular Disease and Interventional Cardiology

Robert C. Sonnenschein, MD, FACC, ASE, RVT, RPVI

Dr. Sonnenschein specializes in echocardiography and noninvasive peripheral vascular imaging. He is Director of Echocardiography at Hillcrest Hospital South and past Director of Peripheral Vascular Ultrasound Imaging at Hillcrest Medical Center and Oklahoma Heart Institute and serves as Clinical Associate Professor of Medicine at the University of Oklahoma College of Medicine – Tulsa. He completed his Cardiology Fellowship at the State University of New York Upstate Medical Center in Syracuse, where he also completed his Internal Medicine Internship and Residency programs. Dr. Sonnenschein received his medical degree from Rush Medical College in Chicago and his Bachelor of Arts degree from the University of Pennsylvania.
Board certified in Internal Medicine, Cardiovascular Disease, and Adult Echocardiography Registered Vascular Technologist

James J. Nemec, MD, FACC

Dr. Nemec is a specialist in echocardiography, stress echocardiography and nuclear cardiology. He serves as Director of Nuclear Cardiology for Oklahoma Heart Institute. Dr. Nemec has served as Assistant Professor of Internal Medicine, Division of Cardiology, at Creighton University and as Assistant Professor, Department of Radiology, also at Creighton University. He completed his Clinical Cardiology Fellowship at the Cleveland Clinic Foundation and his Internal Medicine Internship and Residency at Creighton University. Dr. Nemec also completed a year of training in pathology at the University of Missouri, Columbia, MO. He received his medical degree from Creighton University, where he also received his Bachelor of Arts degree.
Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Gregory D. Johnsen, MD, FACC, FSCAI

Dr. Johnsen is an interventional cardiologist with expertise in cardiac catheterization, angioplasty and related interventional procedures, such as stents and atherectomy. He is Director of Cardiac Rehabilitation at Hillcrest Medical Center and Director of the Hillcrest Exercise and Lifestyle Programs. He completed his Clinical Cardiology Fellowship at the University of Oklahoma – Oklahoma City, where he then finished an extra year of dedicated training in interventional cardiology. He completed his Internal Medicine Internship and Residency training at the University of Oklahoma – Oklahoma City, where he also received his medical degree. Dr. Johnsen received his Bachelor of Science degree from Oklahoma State University.
Board certified in Internal Medicine, Cardiovascular Disease and Interventional Cardiology

Alan M. Kaneshige, MD, FACC, FASE, RPVI

Dr. Kaneshige is a noninvasive cardiologist with expertise in adult echocardiography, stress echocardiography and transesophageal echocardiography. He is Director of Congestive Heart Failure at Oklahoma Heart Institute and Past Chief of Cardiology at Hillcrest Medical Center. Dr. Kaneshige completed his Internal Medicine Internship and Residency at Creighton University School of Medicine, where he also received his medical degree. He received a Bachelor of Science in chemistry at Creighton University. Dr. Kaneshige completed his Clinical Cardiology fellowship at Creighton, where he also served as Chief Cardiology Fellow for two years. He completed an additional Cardiac Ultrasound Fellowship at the Mayo Clinic in Rochester. Dr. Kaneshige served as Assistant Professor of Medicine at Creighton University School of Medicine, where he was Director of the noninvasive Cardiovascular Imaging and Hemodynamic Laboratory.
Board certified in Internal Medicine, Cardiovascular Disease, Adult and Transesophogeal Echocardiography

Edward T. Martin, MS, MD, FACC, FACP, FAHA , FSCMR

Dr. Martin is a noninvasive cardiologist with subspecialty expertise in noninvasive imaging. He is Director of Cardiovascular Magnetic Resonance Imaging at Oklahoma Heart Institute and Hillcrest Medical Center. In addition, he is a Clinical Associate Professor of Medicine at the University of Oklahoma College of Medicine – Tulsa. Dr. Martin has specialty training in Nuclear Medicine, as well as additional training dedicated to Cardiovascular Magnetic Resonance Imaging. He completed his Cardiology Fellowship at the University of Alabama and Internal Medicine Internship/Residency training at Temple University Hospital in Philadelphia. He received his medical degree from the Medical College of Ohio. Dr. Martin completed his Master of Science degree in mechanical engineering at the University of Cincinnati and his Bachelor of Science degree in physics at Xavier University. Dr. Martin is a founding member of the Society of Cardiovascular Magnetic Resonance and is a past editorial board member of the Journal of Cardiovascular Magnetic Resonance. Dr. Martin has also been actively involved with the American College of Cardiology (ACC) on a national level participating on numerous committees, writing groups and leadership positions. He is also a past ACC Governor of the State of Oklahoma. He is also a two-time past President of the Board of Directors of Tulsa Metropolitan Division of the American Heart Association and past President of the Intersocietal Commission for the Accreditation of Magnetic Resonance Laboratories (ICAMRL). Locally, he is the current Director of Cardiovascular MRI at OHI and the current Chief of Staff at Hillcrest Hospital South.
Board certified in Internal Medicine and Cardiovascular Disease

Roger D. Des Prez, MD, FACC

Dr. Des Prez is a noninvasive cardiologist with specialty expertise in echocardiography, nuclear cardiology and cardiac computed tomography. He is Director of Cardiac Computed Tomography Services of the Cardiology Department at Bailey Medical Center. Dr. Des Prez received his medical degree and Bachelor of Arts degree from Vanderbilt University. He completed his Residency in Internal Medicine and Pediatrics at University Hospital of Cleveland. Dr. Des Prez practiced for six years as an internist with the Indian Health Services in Gallup, NM. He returned to Vanderbilt University as a member of the Internal Medicine Faculty, at which time he also completed his cardiology training.
Board certified in Internal Medicine, Cardiovascular Disease, Echocardiography, Pediatrics and Nuclear Cardiology

Christian S. Hanson, DO, FACE

Dr. Hanson is a specialist in Endocrinology, Metabolism and Hypertension at Oklahoma Heart Institute with expertise in diabetes, lipids and hypertension. He also serves as Clinical Associate Professor of Medicine in the College of Osteopathic Medicine – Oklahoma State University. He completed a Fellowship in Endocrinology, Metabolism and Hypertension at the University of Oklahoma in Oklahoma City. Dr. Hanson's Internal Medicine Residency and Rotating Internship were completed at Tulsa Regional Medical Center. He received his medical degree from Oklahoma State University and his Bachelor of Science degree from Northeastern Oklahoma State University in Tahlequah.
Board certified in Internal Medicine, Endocrinology and Metabolic Diseases

David A. Sandler, MD, FACC, FHRS

Dr. Sandler is a cardiologist with subspecialty expertise in electrophysiology, complex ablation, and atrial fibrillation management. Dr. Sandler is Director of Electrophysiology at Oklahoma Heart Institute Hospital. He completed his Cardiac Electrophysiology Fellowship and his Cardiovascular Medicine Fellowship at New York University Medical Center, New York, NY. Dr. Sandler performed his Internal Medicine Internship and Residency at Mount Sinai Medical Center, New York, NY. He earned his medical degree from Georgetown University School of Medicine in Washington, DC. Dr. Sandler received his Bachelor of Arts degree at the University of Pennsylvania in Philadelphia.
Board certified in Internal Medicine, Cardiovascular Disease and Cardiac Electrophysiology

Raj H. Chandwaney, MD, FACC, FSCAI, FSVM

Dr. Chandwaney is an interventional cardiologist with expertise in cardiac catheterization, coronary angioplasty and related interventional procedures such as coronary stents, atherectomy, intravascular ultrasound and peripheral

vascular interventional procedures. Dr. Chandwaney is Chief of Cardiology and Director of the Chest Pain Center and Cardiology Telemetry Unit at Oklahoma Heart Institute Hospital. He completed his Clinical Cardiology Fellowship at Northwestern University Medical School in Chicago, IL., where he also completed an Interventional Cardiology Fellowship. Dr. Chandwaney's Internal Medicine Internship and Residency were performed at Baylor College of Medicine in Houston, TX. He received his medical degree from the University of Illinois at Chicago. Dr. Chandwaney completed his Master of Science degree at the University of Illinois at Urbana-Champaign, where he also received his Bachelor of Science degree.
Board certified in Internal Medicine, Cardiovascular Disease, Interventional Cardiology and Endovascular Medicine

D. Erik Aspenson, MD, FACE, FACP
Dr. Aspenson is a subspecialist in Endocrinology, Metabolism and Hypertension at Oklahoma Heart Institute, with expertise in diabetes, lipids, hypertension and thyroid diseases. He completed a fellowship in Endocrinology at Wilford Hall Medical Center, Lackland AFB, Texas. Dr. Aspenson's Internal Medicine Internship and Residency were completed at David Grant Medical Center, Travis AFB, California where he served as Chief Resident. He received his medical degree from the University of Oklahoma and his Bachelor of Science degree at Oklahoma State University.
Board certified in Internal Medicine, Endocrinology and Metabolic Diseases

Frank J. Gaffney, MD, FACC
Dr. Gaffney is an interventional and noninvasive cardiologist with subspecialty expertise in transesophageal echocardiography, nuclear cardiology, and coronary angiography. Dr. Gaffney is Director of Cardiology at Bailey Medical Center. He completed his Cardiovascular Medicine Fellowship at Scott & White Memorial Hospital in Temple, Texas. Dr. Gaffney completed his Internal Medicine Internship and Residency at Brooke Army Medical Center in San Antonio. He then remained on staff at Scott & White Memorial Hospital for several years, before entering his Fellowship in Cardiovascular Medicine. Dr. Gaffney earned his medical degree from New York Medical College, Valhalla, New York, and he received his Bachelor of Arts degree at Hofstra University in Hempstead, New York.
Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Eric G. Auerbach, MD, FACC
Dr. Auerbach is a general cardiologist whose major interest is preventive cardiology and cardiovascular risk reduction. He completed his Cardiology Fellowship at the University of Miami/Jackson Memorial Hospital in Miami, FL, following which he obtained additional subspecialty training in cardiovascular MRI, nuclear cardiology, and cardiac CT imaging. His areas of expertise also include echocardiography, stress testing and management of lipid disorders. In addition to holding board certification in cardiovascular disease, he is a diplomat of the American Board of Clinical Lipidology. Dr. Auerbach's Internal Medicine Internship and Residency were performed at the University of Miami/Jackson Memorial Hospital. He earned his medical degree at the University of Miami, Miami, FL, and his Bachelor of Arts degree at Princeton University, Princeton, NJ. Dr. Auerbach is the Director of Preventive Cardiology at Oklahoma Heart Institute, the medical director of The Weight Loss & Wellness Center at Oklahoma Heart Institute and a Clinical Associate Professor of Medicine at the University of Oklahoma College of Medicine – Tulsa.
Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Robert L. Smith, Jr., MSc, MD, FACC, FSCAI
Dr. Smith specializes in interventional cardiology including cardiac catheterization, coronary angioplasty, and related interventional procedures such as coronary stents, atherectomy, intravascular ultrasound, and peripheral vascular interventional procedures. Dr. Smith is Director of Cardiology and the Cardiac and Interventional Laboratories at Hillcrest Hospital South. He completed an Interventional Cardiology Fellowship at the University of Florida College of Medicine in Jacksonville, FL. Dr. Smith performed his Clinical Cardiology Fellowship at Vanderbilt University School of Medicine in Nashville, TN and Tulane University School of Medicine in New Orleans. He received his medical degree from the University of Oklahoma College of Medicine in Oklahoma City and then completed his Internal Medicine Internship and Residency at Emory University School of Medicine in Atlanta, GA. Dr. Smith received his Bachelor of Arts, Bachelor of Science and Master of Science degrees at the University of Oklahoma in Norman, OK.
Board certified in Internal Medicine, Cardiovascular Disease, Interventional Cardiology and Nuclear Cardiology

Craig S. Cameron, MD, FACC, FHRS
Dr. Cameron is a specialist in cardiac electrophysiology, including catheter ablation of arrhythmias, atrial fibrillation management, pacemakers, implantable defibrillators, and cardiac resynchronization devices. Dr. Cameron is Director of Electrophysiology at Hillcrest Hospital South. He completed his Cardiac Electrophysiology Fellowship and his Cardiovascular Disease Fellowship at Baylor University Medical Center in Dallas, TX. Dr. Cameron's Internship and Internal Medicine Residency were performed at Baylor College of Medicine in Houston. He earned his medical degree from the University of Kansas School of Medicine in Kansas City, KS. Dr. Cameron received his Bachelor of Science degree at Pittsburg State University in Pittsburg, KS.
Board certified in Cardiovascular Disease and Cardiac Electrophysiology

Eugene J. Ichinose, MD, FACC
Dr. Ichinose specializes in interventional cardiology including cardiac catheterization, coronary angioplasty and related interventional procedures such as coronary stents, atherectomy, intravascular ultrasound and peripheral vascular interventional procedures. Dr. Ichinose is Director of Vein Services at Hillcrest Medical Center. He completed his Interventional and Clinical Cardiology Fellowships and his Internal Medicine Residency at the University of Massachusetts Memorial Health Care Center in Worcester, MA. Dr. Ichinose received his medical degree from Louisiana State University in New Orleans. He earned his Bachelor of Science degree from Texas Christian University in Fort Worth, TX.
Board certified in Internal Medicine, Cardiovascular Disease, Interventional Cardiology and Nuclear Cardiology

Cristin M. Bruns, MD
Dr. Bruns is a specialist in Endocrinology, Diabetes and Metabolism at Oklahoma Heart Institute, with expertise in diabetes, thyroid disease (including thyroid cancer) and polycystic ovary syndrome. She completed her Internal Medicine Internship and Residency and Endocrinology Fellowship at the University of Wisconsin Hospital and Clinics in Madison, WI. Dr. Bruns earned her medical degree from Saint Louis University School of Medicine in St. Louis, MO and her Bachelor of Arts and Bachelor of Science degrees in biology from Truman State University in Kirksville, MO. Prior to joining Oklahoma Heart Institute, Dr. Bruns worked as a clinical endocrinologist at the Dean Clinic in Madison, Wisconsin.
Board certified in Internal Medicine, Endocrinology and Metabolic Diseases

John S. Tulloch, MD
Dr. Tulloch is a noninvasive cardiologist with expertise in adult echocardiography, peripheral vascular imaging, nuclear cardiology, cardiac computed tomography and MRI. Dr. Tulloch is Director of the Cardiac and Vascular Ultrasound Department of Oklahoma Heart Institute/Hillcrest Medical Center's Cardiovascular Diagnostics. He completed his Cardiovascular Fellowship at the University of Kansas Medical Center in Kansas City, KS. Dr. Tulloch's Internal Medicine Internship and Residency also were completed at the University of Kansas Medical Center. He earned his medical degree from Ross University School of Medicine in New Brunswick, NJ and received his Bachelor of Science degree in biology from Avila University in Kansas City, MO.
Board certified in Internal Medicine, Cardiovascular Disease, Cardiovascular Tomography, and Nuclear Cardiology

Anthony W. Haney, MD, FACC
Dr. Haney is a noninvasive cardiologist with expertise in nuclear cardiology, echocardiography, peripheral vascular imaging and MRI. He also performs diagnostic cardiac catheterization. He completed his Cardiovascular Fellowship at the Medical College of Virginia in Richmond. Dr. Haney's Internal Medicine Internship and Residency were completed at the Mayo Clinic in Scottsdale, AZ. He earned his medical degree from the University of Oklahoma School of Medicine.
Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Douglas A. Davies, MD, FACC, FASNC
Dr. Davies is a hospital-based cardiologist who provides continuity of care for patients admitted to Oklahoma Heart Institute – Hospital. He completed a Clinical Cardiology Fellowship and additional training in nuclear cardiology at the Medical College of Virginia, where he also completed his Internal Medicine and Residency programs. Dr. Davies received his medical degree from Johns Hopkins University School of Medicine in Baltimore.
Board Certified in Internal Medicine, Cardiovascular Disease, Nuclear Cardiology and Cardiovascular Computed Tomography Angiography

Kamran I. Muhammad, MD, FACC, FSCAI
Dr. Muhammad is a subspecialist in interventional cardiology. In addition to expertise in traditional areas of interventional cardiology, such as coronary intervention (angioplasty, stent placement, atherectomy, intravascular imaging) and peripheral vascular and carotid artery intervention, Dr. Muhammad has a special interest and expertise in interventional therapies for structural and valvular heart disease including the percutaneous non-surgical replacement and repair of heart valves — TAVR and MitraClip. As such, he currently serves as the Director of the Structural Heart Disease Program at OHI.

With dedicated and advanced training in structural heart disease intervention from the world-renowned Cleveland Clinic, Dr. Muhammad has been a pioneer in this field in Oklahoma. He led a team of OHI physicians in performing the first transcatheter aortic valve replacements (TAVR) and first transcatheter mitral valve repairs (MitraClip) in Tulsa and the region. Under his direction, these programs are the most experienced and comprehensive programs of their kind in the state, providing our patients with expert care and class-leading technologies for the non-surgical treatment of structural and valvular heart diseases.

In addition to his clinical experience, Dr. Muhammad has authored many peer-reviewed articles and textbook chapters on important cardiology topics. He also serves as Clinical Associate Professor of Medicine at the University of Oklahoma College of Medicine — Tulsa.

Dr. Muhammad completed his Clinical Cardiology and Interventional Cardiology Fellowships at the Cleveland Clinic which included additional dedicated training in peripheral vascular and structural cardiac intervention. Dr. Muhammad completed his Internal Medicine Internship and Residency at Yale University where he was selected and served as Chief Resident. He earned his medical degree from the University of Massachusetts Medical School, graduating with top honors and election to the Alpha Omega Alpha (AΩA) honor society. Dr. Muhammad earned his Bachelor of Science degree in computer science from the University of Massachusetts, Amherst.

Board certified in Internal Medicine, Cardiovascular Disease, Nuclear Cardiology and Interventional Cardiology

Arash Karnama, DO, FACC

Dr. Karnama is a specialist in interventional cardiology, including cardiac catheterization, coronary intervention, nuclear cardiology, echocardiography (TEE/TTE), cardioversion, peripheral angiography, peripheral intervention, carotid angiography, intravascular ultrasound, atherectomy, and PTCA/stenting for acute myocardial infarction. He is Director of the Cardiology Department at Hillcrest Hospital Claremore. Dr. Karnama completed his Interventional and Clinical Cardiology Fellowships at Oklahoma State University Medical Center and his Internal Medicine Internship and Residency at the Penn State Milton S. Hershey Medical Center in Hershey, PA. Dr. Karnama received his medical degree from Des Moines University in Des Moines, IA and his Bachelor of Arts degree from the University of Iowa in Iowa City.

Board certified in Internal Medicine, Interventional Cardiology, Cardiovascular Disease, Nuclear Cardiology, and Cardiovascular Computed Tomography

Victor Y. Cheng, MD, FACC, FSCCT

Dr. Cheng joins Oklahoma Heart Institute after serving as cardiology faculty at Cedars-Sinai Medical Center and assistant professor at the University of California in Los Angeles. Dr. Cheng is Director of the Cardiac Computed Tomography Department at Oklahoma Heart Institute and Hillcrest Medical Center. He is a specialist in noninvasive heart and vascular imaging, particularly in cardiac computed tomography (CT), a topic on which he has published numerous original research publications addressing quality, clinical use, and novel applications. Dr. Cheng's training includes a Clinical Cardiology Fellowship and Advanced Cardiac Imaging Fellowship at Cedars-Sinai Medical Center, and an Internal Medicine Internship and Residency at the University of California in San Francisco. Dr. Cheng received his medical degree from Northwestern University in Chicago, IL and his Bachelor of Science degree from Northwestern University in Evanston, IL.

Board certified in Internal Medicine, Cardiovascular Disease, Nuclear Cardiology, Echocardiography and Cardiovascular Computed Tomography

Jana R. Loveless, MD

Dr. Loveless is a sleep specialist, with expertise in the diagnosis and treatment of sleep disorders. She is Director of the Sleep Medicine Program at Hillcrest Hospital Claremore, Hillcrest Hospital Henryetta, and Hillcrest Hospital South. Prior to joining Oklahoma Heart Institute, Dr. Loveless was with Nocturna of Tulsa. She completed her Internal Medicine Residency program at the University of Oklahoma, Tulsa, where she was Chief Resident. She also earned her medical degree from, the University of Oklahoma, Tulsa. Dr. Loveless completed graduate studies at Texas Tech University, and she earned her Bachelor of Arts degree at Davidson College in Davidson, North Carolina.

Board Certified in Internal Medicine and Sleep Medicine

Mathew B. Good, DO, FACC, RPVI

Dr. Good is an invasive/noninvasive cardiology specialist with expertise in adult echocardiography, nuclear cardiology, cardiac computed tomography, peripheral vascular ultrasound and MRI. He completed his Cardiovascular Fellowship at the University of Kansas Medical Center in Kansas City, KS, where he also completed his Internal Medicine Internship and Residency. Dr. Good received his medical degree from the Oklahoma State University Center for Health and Sciences in Tulsa and his Bachelor of Arts degree from the University of Colorado in Boulder.

Board certified in Internal Medicine and Cardiovascular Computed Tomography

Stanley K. Zimmerman, MD, FACC, FSCAI

Dr. Zimmerman is the Director of the Catheterization Laboratory and Peripheral Vascular Services at Hillcrest Hospital South. He is the medical director of OHI vascular imaging laboratory. He is a specialist in interventional cardiology, including cardiac catheterization, coronary angioplasty, and related interventional procedures such as coronary stents, atherectomy, vascular ultrasound, and peripheral interventional procedures. Dr. Zimmerman specializes in complex vascular interventions, endovascular repair of abdominal aortic aneurysms and complex aorto-iliac disease, treatment of critical limb ischemia, and vascular management of arterial and venous based wounds.

He completed his Interventional and Cardiovascular Fellowships at the University of Kansas Medical Center in Kansas City, KS, as well as his Internal Medicine Internship and Residency. In addition, Dr. Zimmerman received his medical degree from the University of Kansas Medical Center and his Bachelor of Arts degree from the University of Kansas in Lawrence.

Board certified in Internal Medicine, Cardiovascular Disease and Interventional Cardiology

Michael Phillips, MD, FACC, FACS

Dr. Phillips is a Cardiovascular Thoracic Surgeon at Oklahoma Heart Institute. He completed his fellowship at Mid America Heart Institute in Kansas City, MO and his general surgery residency at the Mayo Graduate School of Medicine. He earned his medical degree from the University of Missouri. Dr. Phillips received his undergraduate degrees in Biology and Chemistry at William Jewell College in Liberty, MO.

Board certified by in Thoracic and General Surgery

James B. Chapman, MD, FACC, FSCAI

Dr. Chapman is a specialist in interventional cardiology, including cardiac catheterization, coronary angioplasty and related interventional procedures such as stents, atherectomy, laser, intravascular ultrasound imaging and direct PTCA for acute myocardial infarction. He completed a Clinical Cardiology Fellowship at St. Vincent Hospital and Health Care Center in Indianapolis, IN. He also completed his Internal Medicine Internship and Residency programs at St. Vincent. Dr. Chapman received his medical degree from Indiana University School of Medicine in Indianapolis and his Bachelor of Science degree from Indiana University in Bloomington, IN.

Board certified in Internal Medicine, Cardiovascular Disease and Interventional Cardiology

Joseph J. Gard, MD, FACC, FHRS

Dr. Gard is a cardiologist who specializes in electrophysiology, complex ablation and atrial fibrillation management. He completed his Cardiac Electrophysiology Fellowship and his Cardiology Fellowship at the Mayo School of Graduate Medical Education in Rochester, Minnesota. Dr. Gard also performed his Internal Medicine Residency at Mayo. He earned his medical degree from the University of Nebraska in Omaha, Nebraska. Dr. Gard received his Bachelor of Science degree from Boston College in Chestnut Hill, Massachusetts.

Board certified in Cardiovascular Disease, Internal Medicine, Electrophysiology and Clinical Cardiac Electrophysiology

Michael B. Newnam, MD

Dr. Newnam is Director of Sleep Medicine at Hillcrest Medical Center and Hillcrest Hospital Cushing. He is a Board Certified specialist in the diagnosis and treatment of sleep disorders. He completed his Family Practice Internship & Residency programs at the Womack Army Medical Center in Ft. Bragg, NC. Dr. Newnam earned his medical degree from the University of Oklahoma and his Bachelor of Science degree from Oral Roberts University in Tulsa, OK.

Board Certified in Family Medicine and Sleep Medicine

John M. Weber, MD, RPVI

Dr. Weber is a Peripheral Vascular Surgeon at Oklahoma Heart Institute who specializes in complex vascular disease. He offers both open and endovascular treatment of arterial and venous disease. Areas of interest include open and endovascular treatment of aortic pathology, cerebrovascular surgery, limb salvage surgery, vascular access, and complex venous therapies. He completed his residency in Vascular Surgery at the Cleveland Clinic in Cleveland, Ohio. Dr. Weber earned his medical degree at the University of Oklahoma College of Medicine. He also completed his undergraduate degree at the University of Oklahoma.

Saran Oliver, MD

Dr. Oliver is an invasive/noninvasive cardiology specialist with specific interests in adult echocardiography, nuclear cardiology, and women's cardiovascular health. She completed her Cardiovascular Fellowship at Scott and White Memorial Hospital in Temple, TX. Dr. Oliver performed her Internal Medicine Internship and Residency at the University of Texas Southwestern Medical Center in Dallas, TX. She also earned her medical degree from the University of Texas Southwestern Medical Center. Dr. Oliver attended Rice University in Houston, TX where she received her Bachelor of Arts degree in Sports Medicine.

Board certified in Internal Medicine, board eligible in Cardiovascular Medicine

Lauren LaBryer, MD

Dr. LaBryer is a specialist in Endocrinology, Metabolism and Hypertension at Oklahoma Heart Institute. She completed her Endocrinology Fellowship at the University of Oklahoma College of Medicine. She also completed her Internal Medicine Internship and Residency Programs at Oklahoma, where she was selected as Chief Resident in Medicine. In addition, Dr. LaBryer earned her medical degree from the University of Oklahoma College of Medicine. She received her Bachelor of Science degree in Biopsychology and Cognitive Sciences from the University of Michigan.

Board certified in Internal Medicine, Endocrinology and Metabolic Diseases

Jordan A. Brewster, MD

Dr. Brewster is a specialist in electrophysiology, with expertise in electrophysiology, complex ablation, and atrial fibrillation management. He completed his Fellowship in Electrophysiology at Indiana University in Indianapolis, IN. Dr. Brewster performed his Fellowship in Cardiovascular Disease at the University of Kentucky Division of Cardiovascular Medicine in Lexington, KY, where he was Chief Fellow. He completed his Internal Medicine Internship and Residency at Vanderbilt University in Nashville, TN. Dr. Brewster received his medical degree from the University of Virginia School of Medicine in Charlottesville, VA. and his Bachelor of Science degree in Biochemistry from the University of Oklahoma.

Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Ahmad Iqbal, MD

Dr. Iqbal is an invasive/noninvasive cardiologist at Oklahoma Heart Institute who specializes in advanced heart failure patients, including those with left ventricular assist devices (LVAD) as well as patients with cardiac transplantation. His special interest is mechanical circulatory support options for patients requiring additional life support measures including ECMO, Impella, and LVADs. Dr. Iqbal also is a diplomate of the National Board of Echocardiography and specializes in adult comprehensive echocardiography, including stress echocardiography and transesophageal echocardiography. He also has an interest in nuclear and preventative cardiology. He completed his Advanced Heart Failure and Transplant Fellowship at Northwestern University Feinberg School of Medicine in Chicago, IL. Dr. Iqbal completed his Cardiovascular Disease Fellowship at Mid America Heart Institute at St. Luke's Hospital/University of Missouri-Kansas City, MO. Dr. Iqbal completed his Internal Medicine Residency at the University of Texas Southwestern in Dallas, TX. He received his medical degree from Tulane University School of Medicine and his Bachelor of Business Administration degree from Loyola University in New Orleans, LA, where he graduated summa cum laude.

Board certified in Internal Medicine, Cardiovascular Diseases, and Echocardiography. Board eligible in Nuclear Cardiology. Board eligible in Advanced Heart Failure and Transplant

Mrudula R. Munagala, MD, FACC

Dr. Munagala is Director of the Advanced Heart Failure program at Oklahoma Heart Institute. She specializes in Heart Failure, Mechanical Circulatory Support Devices (MCSD) and Transplant. Dr. Munagala is also experienced in managing patients with Pulmonary Hypertension and Cardiac Heart and Lung amyloidosis. She undertook advanced training in Heart Failure, MCSD and Transplant fellowship at UCLA-Ronald Reagan Medical Center in Los Angeles, CA after completing her Internal Medicine residency and Cardiovascular Diseases fellowship at Drexel University College of Medicine, Philadelphia, PA. She also completed a Heart Failure and Pulmonary Hypertension fellowship at Allegheny General Hospital, Pittsburgh, PA. Dr. Munagala received her medical degree from Sri Venkateswara Medical College in Andhra Pradesh, India. She has been involved in clinical research in Heart Failure, Ventricular Assist Devices (VAD) and Transplant and authored several articles and book chapters. She is an active member in various professional societies, including the American College of Cardiology, Heart Failure Society of America, International Society of Heart and Lung Transplant and American Medical Association.

Board Certified in Internal Medicine, Cardiovascular Diseases, Heart Failure and Transplant, Echocardiography and Nuclear Cardiology

Siva Soma, MD, FACC, FHRS

Dr. Soma is a specialist in electrophysiology, with expertise in complex catheter ablation of cardiac arrhythmias and management of atrial fibrillation, ventricular tachycardia, pacemakers, defibrillators and cardiac resynchronization devices.

He completed his Fellowship in Electrophysiology at the University of Pittsburgh Medical Center in Pittsburgh, PA. Dr. Soma performed his Fellowships in Cardiovascular Disease and Advanced Heart Failure/Transplantation at Allegheny General Hospital in Pittsburgh. He completed his Internal Medicine Internship and Residency at Hahnemann University Hospital, Drexel University College of Medicine in Philadelphia, PA.

Dr. Soma completed a Master's degree in public health and received his medical degree from Armed Forces Medical College in India.

Board certified in Internal Medicine, Cardiovascular Disease and Nuclear Cardiology

Ajit K. Tharakan, MD, M.Ch, FACS

Dr. Tharakan is a Cardiovascular Thoracic surgeon at Oklahoma Heart Institute. He was Chief Resident of Cardiothoracic Surgery at Massachusetts General Hospital, Harvard Medical School, Boston, MA, as well as Chief Resident of Cardiovascular Surgery at Boston Children's Hospital, Harvard Medical School, Boston, MA.

He was also Chief Resident for General Surgery at the Hugh E. Stephenson Department of Surgery, School of Medicine, University of Missouri, Columbia, MO, where he did his General Surgery Residency. He also was Chief Resident in Cardiothoracic Surgery at Christian Medical College & Hospital, Vellore, Tamilnadu, S. India. Dr. Tharakan has done additional training at St. John's National Academy of Health Sciences, Bangalore, India and Christian Medical College Hospital, Vellore, India where he secured the M.Ch (Master of Chirurgi) degree.

Dr. Tharakan performed his Internship at Sri Ramachandra Medical College & Research Institute, The Tamilnadu Dr. M.G.R. Medical University, Porur Madras, Tamilnadu, India, where he also earned his medical degree. Prior to joining Oklahoma Heart Institute, Dr. Tharakan was the Director of Cardiothoracic Surgery at the Hugh E. Stephenson Department of Surgery at the University of Missouri-Columbia. He has numerous publications, patents, and inventions. He was recognized as one of MU's Top Faculty Achievers in 2017.

Board certified in Thoracic and General Surgery

Allen Cheng, MD

Dr. Cheng is a cardiovascular surgeon who served as the Surgical Director of Heart Transplantation at Rudd Heart and Lung Center, Jewish Hospital, University of Louisville prior to joining Oklahoma Heart Institute.

He completed his general surgery residency at UCLA, cardiothoracic surgery training at Massachusetts General Hospital/Harvard Medical School, cardiovascular surgery postdoctoral fellowship at Stanford University and specialty training at University of Rochester.

Dr. Cheng specializes in heart transplantation, mechanical circulatory support, ECMO, minimally invasive cardiac surgery, atrial fibrillation surgery (MAZE), and transcatheter aortic valve replacement. He is also a scientific investigator at Cardiovascular Innovation Institute. Dr. Cheng has received multiple national awards including the Howard Hughes Medical Institute research award, American Heart Association (AHA) research award, Thoracic Surgery Foundation for Research and Education (TSFRE) research award and the Society of Heart Valve C. Walton Lillehei research award.

He has an extensive publication record in major international cardiovascular journals including Circulation, Annals of Thoracic Surgery, Journal of Heart and Lung Transplantation and ASAIO, and is also serving as a reviewer for the above journals.

Board certified in Surgery and Thoracic Surgery

Shahid Qamar, MD, FACC

Dr. Qamar is a cardiologist who specializes in advanced heart failure and mechanical circulatory support. Prior to joining Oklahoma Heart Institute, he served as Medical Director of the Heart Failure Clinic at Ascension Columbia St. Mary's Hospital in Milwaukee, WI.

He performed an Advanced Heart Failure Fellowship and a Transplant Fellowship at the University of Chicago in Chicago, IL. His General Cardiology Fellowship and Internal Medicine Residency were completed at Aurora Health Care in Milwaukee, WI

Dr. Qamar completed his General Surgery Residency at the Dow University of Health Sciences in Karachi, Pakistan, where he also earned his medical degree.

Board Certified in Internal Medicine and Cardiology

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He performed a Vascular Surgery Fellowship at Loyola University Medical Center in Chicago, IL. Dr. Barkat completed his General Surgery Residency at Louisiana State University Health and Sciences Center in New Orleans, LA. He earned his medical degree at Louisiana State University Medical Center.

Dr. Barkat completed his Bachelor of Science degree at Louisiana State University with a degree in Biochemistry.

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She performed an Advanced Heart Failure and Cardiac Transplant Fellowship at the University of Utah School of Medicine in Salt Lake City, Utah and completed her Cardiology Fellowship at Beaumont Hospital in Dearborn, Michigan.

Dr. Butrous completed her Internal Medicine Residency at the Loma Linda University Medical Center in Loma Linda, California. She earned her medical degree at Benha Medical School, Benha University, Egypt.

Board certified in Cardiovascular Disease and Internal Medicine

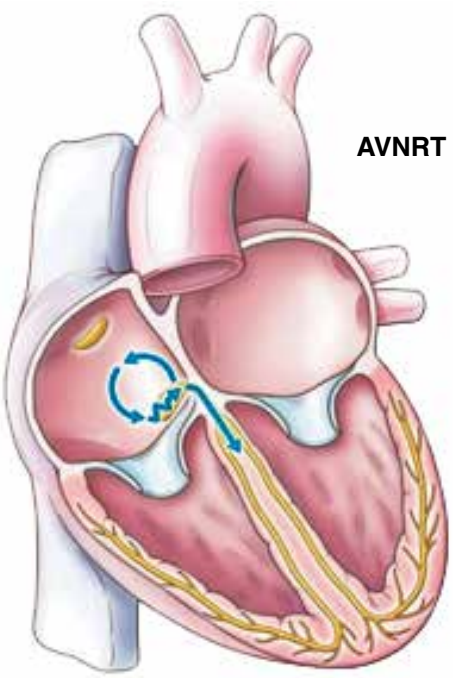
Adel E. Ghuloom, MD

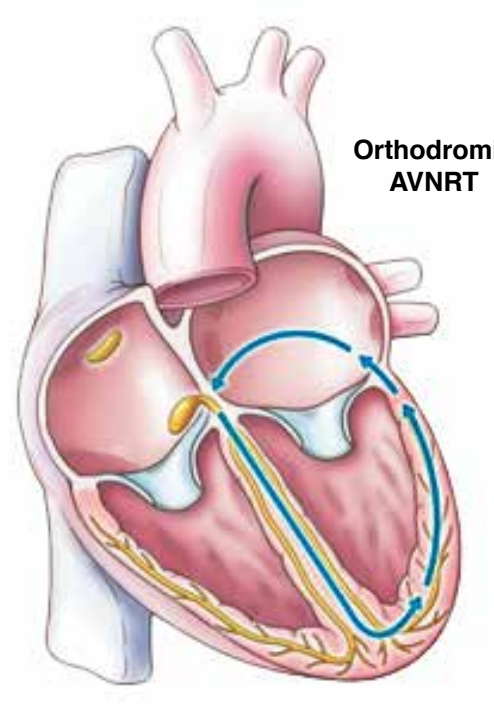
Dr. Ghuloom is a Cardiovascular Critical Care Intensivist at Oklahoma Heart Institute, with expertise in advanced heart failure, including mechanical circulatory support (LVAD and ECMO) and heart transplant cardiovascular intensive care.

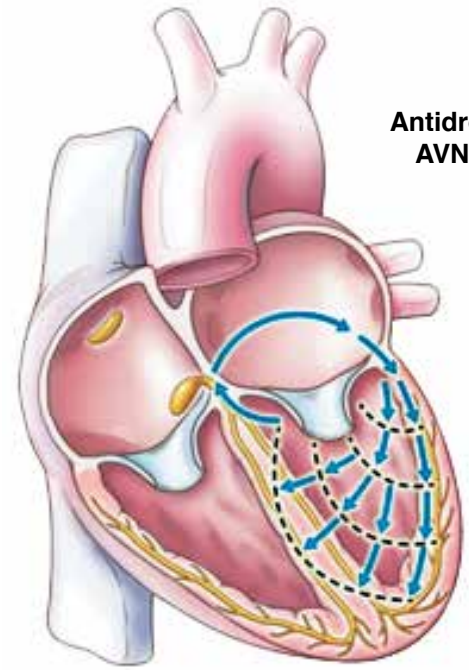
He performed a Fellowship in Critical Care at Baylor College of Medicine in Houston TX. Dr. Ghuloom completed his Internal Medicine Residency at Wayne State University in Detroit, MI.

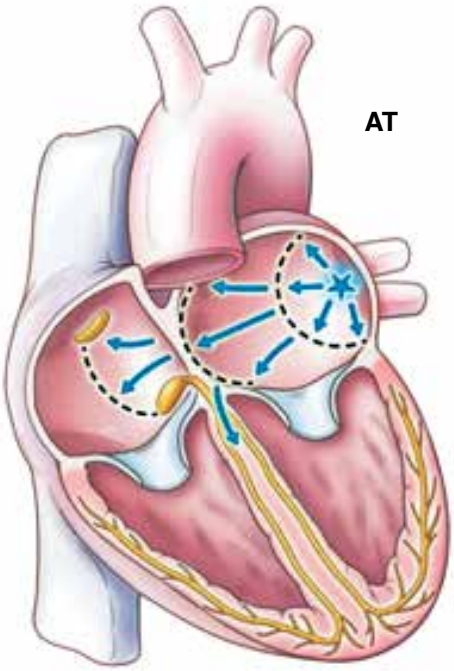
He earned his medical degree at Arabian Gulf University, Manama, Bahrain, where he also received his Bachelor of Science Degree. Prior to joining Oklahoma Heart Institute, he was a Cardiovascular Critical Care specialist at Tufts University.

Board certified in Critical Care and Internal Medicine









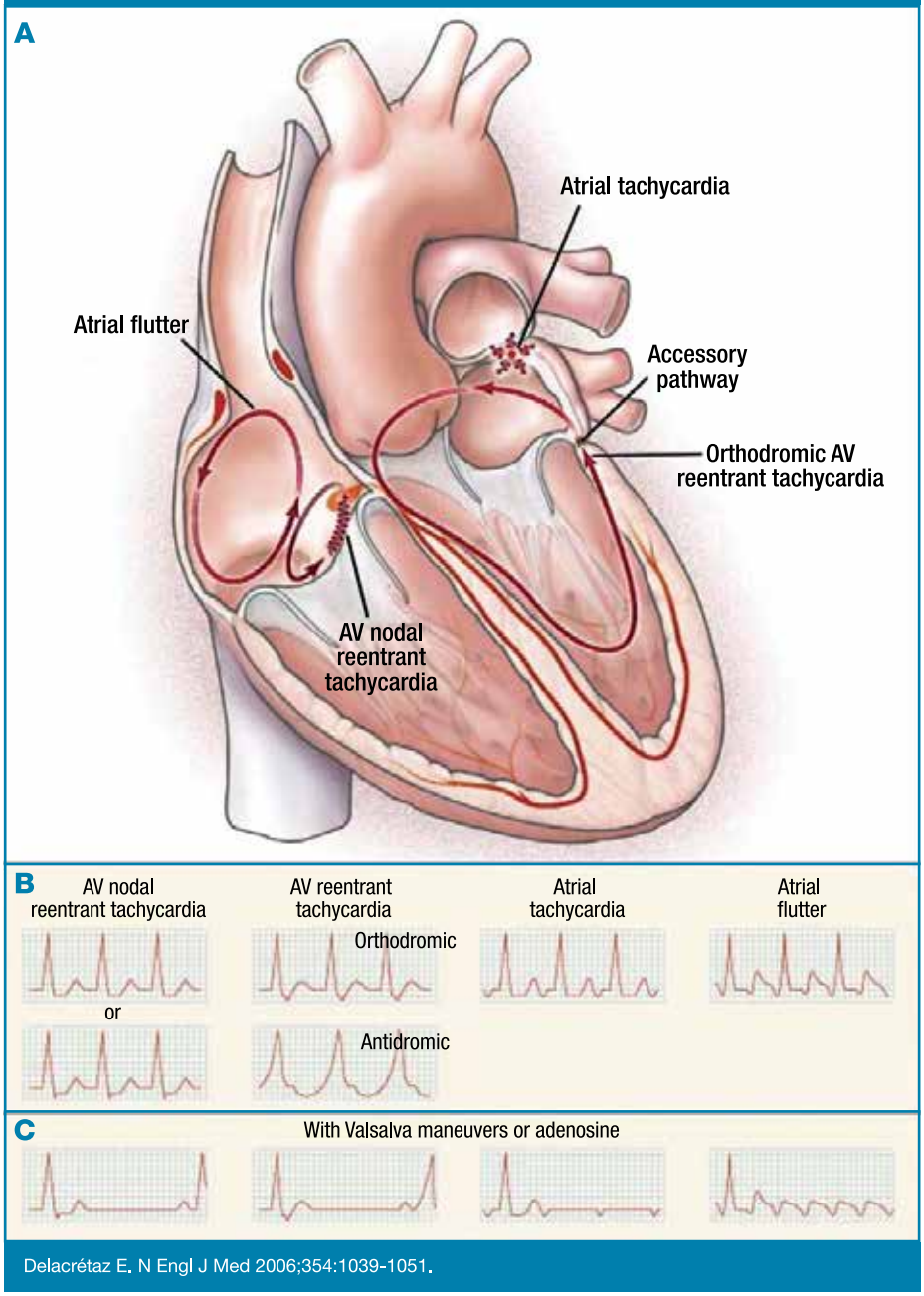
Why Live with SVT?

By Siva Soma, MD, FACC, FHRS

INTRODUCTION

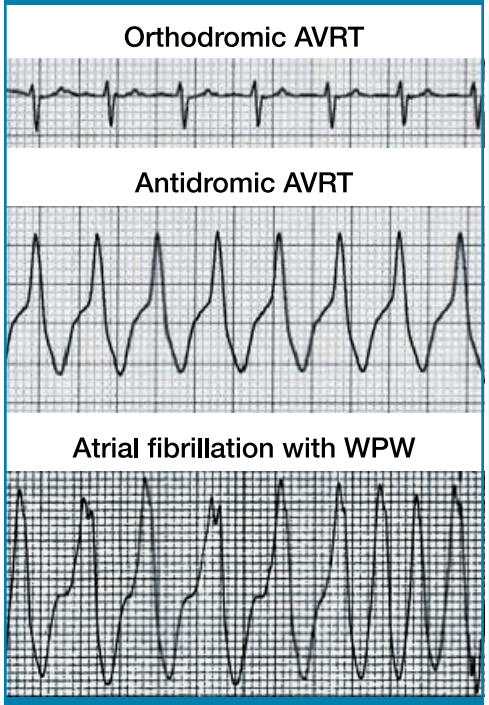
Supraventricular tachycardia (SVT) is an umbrella term used to describe any tachycardia that requires atrial or atrioventricular (AV) junctional tissue for its initiation and maintenance.[1] SVTs include inappropriate sinus tachycardia, atrial tachycardia (including focal and multifocal AT), macro reentrant AT (including typical atrial flutter), junctional tachycardia (JT), atrioventricular nodal reentrant tachycardia (AVNRT), and various forms of accessory pathway-mediated reentrant tachycardia (like atrioventricular reentrant tachycardia – AVRT). Paroxysmal supraventricular tachycardia (PSVT): A clinical syndrome characterized by the presence of a regular and rapid tachycardia of abrupt onset and termination. These features are characteristic of AVNRT or AVRT, and, less frequently, AT. PSVT represents a subset of SVT 2.

Figure 1



Delacrétaz E. N Engl J Med 2006;354:1039-1051.

Figure 2



Link MS. N Engl J Med 2012;367:1438-1448.

Atrial fibrillation and atrial flutter, though supra ventricular, generally are associated with structural changes in the atrium and other comorbid conditions. For the above reason, we will focus this discussion on the 3 most common SVTs — AVNRT, AVRT and AT. These SVTs occur in approximately 1 in 500 people in the United States.[3] AVNRT is most common among persons older than 20 years of age, whereas AVRT occurs more frequently in the pediatric population. AT is the least common of the three.[3]

Atrioventricular nodal reentrant tachycardia (AVNRT) is caused by a reentrant loop that involves the atrioventricular node and the atrial tissue (Figure 1). The atrioventricular node has two conduits, one of which conducts rapidly and the other slowly. A premature beat that results in longer delay in conduction through the slower pathway allows for a reentrant loop with conduction up the fast pathway. This perpetuating loop results in AVNRT.[3]

Atrioventricular reciprocating tachycardia (AVRT) is caused by cardiac musculature that bypasses the normal insulation afforded by the tricuspid and mitral valves between the atria and the ventricles (Figure 1). These bypass tracts may conduct in an anterograde (downward) direction only, in a retrograde (upward) direction only, or in both directions. A delta wave, an initial slurring of the QRS complex, is present on the surface ECG in most cases of anterograde bypass tracts and indicates partial depolarization of the ventricular tissue from conduction over the bypass tract. Patients who have both tachycardia and a delta wave have the Wolff–Parkinson–White syndrome. Three arrhythmias are seen with bypass tracts: a narrow regular QRS complex (orthodromic AVRT), a wide regular QRS complex (antidromic AVRT) and a wide irregular QRS complex (atrial fibrillation) (Figure 2). When atrial fibrillation occurs, the ventricular rate can be quite rapid and can lead to fatal ventricular arrhythmias.[3]

Atrial tachycardia (AT) is a focal tachycardia that may be a result of a micro-reentrant circuit or an automatic focus (Figure 1). There are two unique characteristics of AT: they may occur in repetitive short bursts, and they are frequently characterized by a warm-up phenomenon in which the atrial rate increases slightly over the first 5 to 10 seconds before stabilizing.[3]

PRESENTATION

In comparison to other cardiovascular diseases, patients who present with SVT are generally younger. Women have twice the risk

(continued on p. 18)

Continued from p. 17

of men of developing PSVT. The usual presentation of SVT on electrocardiography (ECG) is a narrow-QRS-complex tachycardia (a QRS interval of less than 120 msec), but in some cases (less than 10 percent), wide-complex tachycardia is seen. SVTs generally have a sudden onset and termination. Patients generally have "spells" during which they feel "heart pounding" or "neck pounding" that may be due to atrial contraction against a closed tricuspid valve (cannon a-waves). True syncope is infrequent with SVT, but complaints of light-headedness are common. Possible triggers include intake of alcohol, caffeine or other drugs.

MANAGEMENT

Acute Management

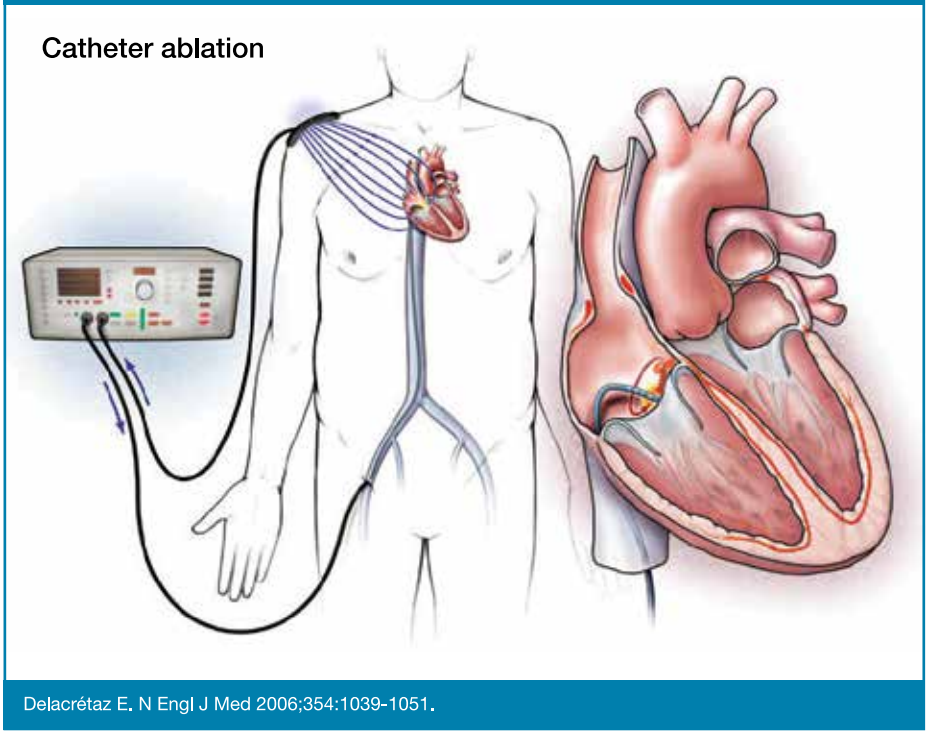
Vagal maneuvers — including a valsalva maneuver, carotid sinus massage, "bearing down," and immersion of the face in ice water — increase vagal tone and the resultant slowing conduction blocks the AV node. If the physical examination does not reveal a carotid bruit and there is no history suggesting carotid artery disease, pressure may be applied at the level of the cricoid cartilage for about five seconds with a firm circular movement. If the tachyarrhythmia persists, the procedure may be repeated on the opposite side.[4] These maneuvers can terminate AVNRT and AVRT.

Adenosine

As with vagal maneuvers, treatment with intravenous adenosine has both diagnostic and therapeutic value. Adenosine, a very short-acting endogenous nucleotide that blocks atrioventricular nodal conduction, terminates nearly all AVNRTs and AVRTs. In patients with atrial tachycardias, adenosine causes a transient atrioventricular nodal block or interrupts the tachycardia. Adenosine should be administered quickly at a dose of 6-12 mg, followed by a bolus of 20 ml of fluid. ECG monitoring is required during the administration of adenosine, and resuscitation equipment should be available in the event that the rare complications of bronchospasm or ventricular fibrillation occur.[4] Common side effects include chest tightness, flushing, and a sense of dread.[3] Adenosine should be used cautiously in patients with severe obstructive lung disease. Adenosine is also contraindicated in patients with tachycardia with a wide QRS complex (unless the diagnosis of SVT with aberrancy is certain).[4]

Although intravenous verapamil and diltiazem, which block the AV node, are of potential diagnostic and therapeutic use in narrow-complex tachycardia, they may cause hypotension and thus are not a first choice in the emergency setting. Electrical cardioversion is reserved for patients in unstable condition who are not having a response to adenosine. Antiarrhythmic agents are rarely necessary in the early management of SVT.[3] After the restoration of sinus rhythm, the 12-lead ECG should be examined for the presence of delta waves, which indicate an accessory pathway. In ambulatory patients with frequent episodes (two or more per month) of SVT, ECG recordings or event recorders (which record arrhythmias for up to seven days) may be useful to document arrhythmias. An echocardiogram should be considered to rule out structural heart disease, even though it is uncommon. Because electrolyte abnormalities and hyperthyroidism may contribute to SVT, it is reasonable to check potassium and serum TSH levels; however, the tests for these values appear to have a low yield.[4]

Figure 3



Delacrétaz E. N Engl J Med 2006;354:1039-1051.

Long Term Management

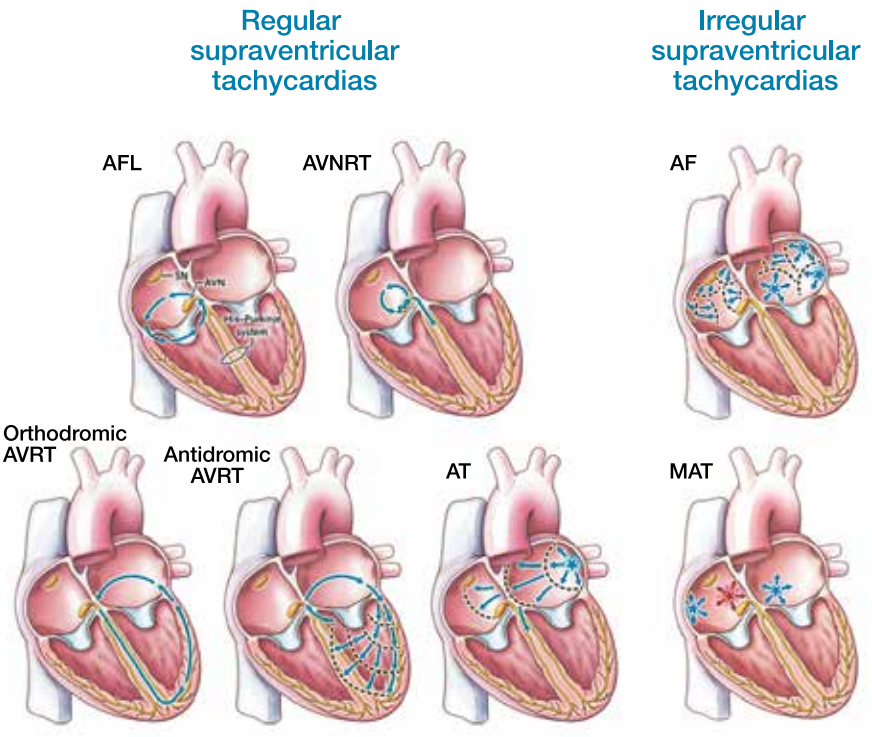
Options for medical management include AV node blocking agents (such as verapamil, diltiazem, beta-blockers) and antiarrhythmic drugs (such as flecainide, propafenone, sotalol, or amiodarone). Antiarrhythmic drugs act by either slowing conduction or lengthening the refractory period of cardiac tissue. Antiarrhythmic drugs and AV nodal blocking agents have recurrence rates of 20-60%. Long term usage is also limited due to side effects.[5,6]

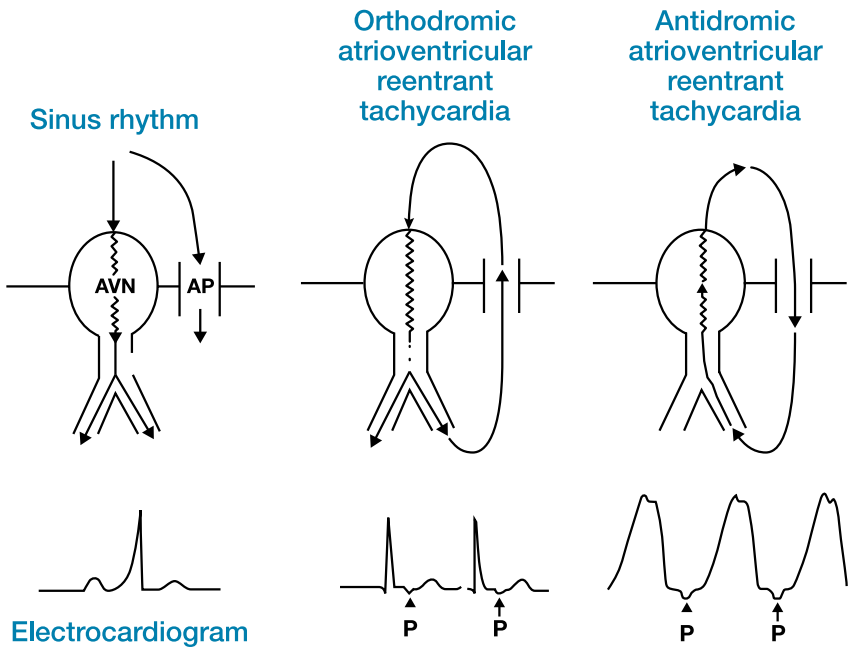
For the above reasons, catheter ablation is the mainstay in the long term management of SVTs. Since the early 1990s, catheter ablation has increasingly been used in the management of SVTs on the basis of its observed efficacy, very low recurrence rates and overall safety[3]. Most recent ACC/AHA/HRS guidelines recommend EP study and catheter ablation as the first line choice of treatment[2].

Catheter Ablation of Cardiac Arrhythmias

Catheter ablation is a minimally invasive procedure where catheter electrodes are passed though the femoral vein to access the right heart, under x-ray guidance (Figure 3). The procedure is generally performed under local anesthetic and with moderate sedation. An electrophysiological study (EPS) is performed first using a specifically designed pulse generator to perform programmed stimulation. The primary aim of the EPS is to induce tachycardia so that the activation sequence recorded by the diagnostic catheter electrodes can be used to determine the arrhythmia mechanism. A deflectable mapping/ablation catheter is then positioned on a portion of the re-entry circuit critical for maintenance of tachycardia. Once in a suitable location, radiofrequency (RF) energy is delivered to create small thermal injury lesions (2–4 mm3) in the myocardial tissue. This results in conductive and resistive heating, rendering a small area electrically inactive. Most patients do not feel the energy application but some patients feel warmth or occasionally pain. After RF delivery, a further limited EPS is then performed to confirm successful ablation of the re-entry circuit. Most ablation procedures take one to three hours. Catheter ablation of SVT can be performed as a one-day outpatient procedure, or it may require overnight hospitalization.

Complication rates vary depending on the arrhythmia being ablated. Arrhythmia success for AVNRT and AVRT are around 93-98%, with complication rates of 0-2%.[2,5,6] Fluoroscopy doses/times from the procedure have drastically decreased with the advent of modern fluoroscopy equipment and non-fluoroscopic/[3] dimensional electroanatomic cardiac mapping systems. The studies comparing catheter ablation with drug treatment are limited because it has been generally accepted for





some years that catheter ablation has greater efficacy, and the evolution of techniques for catheter ablation has been very rapid. Studies have shown that catheter ablation has a higher success rate than drug treatment, patients have a higher quality of life after catheter ablation, and it is more cost effective than anti-arrhythmic drug treatment.[2,5,6]

Common misconceptions

Ablation of SVT is time consuming: Most catheter ablations take approximately 1-2 hours. Factors that may prolong the procedure are difficulty in inducing the tachycardia, multiple accessory pathways, or large, abnormal atria requiring unusual mapping/ablation catheters.

Ablation of SVT is traumatic: The procedure is performed with moderate sedation. Most patients do not feel pain with radio frequency energy application. More often, patients find lying on the x ray table for the length of time required for the ablation more troublesome than the actual procedure itself.

Ablation should be reserved for patients failing antiarrhythmic drugs: Ablation for most SVTs has very high success rates and low complication rates. It is safer and more cost effective than antiarrhythmic drugs. Moreover, it offers the chance for a curative treatment instead of lifelong antiarrhythmic drugs.

Dr. Soma is a specialist in electrophysiology, with expertise in complex catheter ablation of cardiac arrhythmias and management of atrial fibrillation, ventricular tachycardia, pacemakers, defibrillators and cardiac resynchronization devices.

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  - 300+ thread count sheets
- A continental breakfast in the morning

SUGARED CRANBERRY AND LEMON CURD PIE Serves 8

Doubly tart and perfectly sweet, this creamy lemon curd pie is topped with crunchy, sugar-coated fresh cranberries. It's a showpiece for your holiday table, so prepare for applause. Though this pie is a snap to assemble, be sure to plan ahead so the sugared cranberries have time to dry.

3 cups sugar
2 cinnamon sticks
6 whole cloves
3 cups fresh cranberries
1/2 cup heavy cream
1 1/2 cup homemade lemon curd (or 1 [11-ounce] jar)
4 ounces Neufchâtel cheese
1 (9-inch) frozen pie crust, in pan, baked accordingly to package instructions and cooled
1 cup superfine sugar

Mix sugar, cinnamon sticks and cloves with 3 cups water in a saucepan. Bring to a boil over medium heat. Simmer for 1 minute, stirring until sugar dissolves. Remove from heat and pour into a bowl. Stir in cranberries. Cover and refrigerate for about 8 hours.

Using an electric mixer on medium speed, beat heavy cream in a large bowl until stiff peaks form. In a second large bowl, beat lemon curd and Neufchâtel until well combined, and then fold in whipped cream. Transfer lemon mixture to pie crust, spread out evenly and chill for 4 hours.

Drain cranberries. (Reserve liquid as a simple syrup to add a holiday touch to cocktails.) Place superfine sugar in a bowl, add cranberries and gently toss to coat evenly. Place cranberries on a baking sheet to dry, about 1 to 2 hours.

Pile cranberries onto pie, cut into slices and serve immediately, spooning any tumbling cranberries back over the top.

PORCINI-WALNUT PÂTÉ

Makes about 4 cups

Simple and sophisticated, the earthiness of fresh and dried mushrooms, complemented by the delicate flavors of thyme and parsley is perfect before any meal. Serve with veggies and crackers.

1/2 cup walnuts
1/4 cup pine nuts
2 ounces dried porcini mushrooms
4 sun-dried tomato halves
1 onion, diced
1/4 cup low-sodium vegetable broth
1 pound cremini (baby bella) mushrooms, chopped
1 teaspoon minced fresh thyme
2 tablespoons dry sherry
1/4 cup chopped fresh parsley, plus more for garnish
1/4 cup nutritional yeast
1 teaspoon sea salt
1/2 teaspoon freshly ground black pepper

Place the walnuts and pine nuts in a small bowl and add water to cover. Let soak for at least 8 hours or up to overnight. Drain and rinse, then transfer to a food processor. Put the dried porcini mushrooms and sun-dried tomato halves in a heatproof bowl and add 1 cup very hot water. Let soak until soft, about 30 minutes. Pluck the porcinis and tomato halves from the water and transfer them to the food processor with the nuts; reserve the soaking liquid. Process the nuts, mushrooms and sun-dried tomatoes until finely chopped but not pureed.

Heat a large skillet over medium-high heat. When hot, add the onion and dry sauté, stirring often, until it begins to stick to the pan and lightly brown, 3 to 4 minutes. Add the broth and stir to deglaze the pan. Stir in creminis and thyme and cook until the mushrooms release their liquid and the liquid evaporates, about 5 minutes. Add the sherry and stir to deglaze the pan. Remove from the heat. Add the onion mixture to the food

processor and process until finely chopped. Scrape down the sides of the processor then, with the machine running, add just enough of the reserved mushroom-tomato soaking liquid to break the mixture down into a thick paste, 1/4 to 1/2 cup total. Pulse in the parsley, nutritional yeast, salt and pepper just until incorporated. Transfer to an airtight container and refrigerate until ready to serve, at least 30 minutes and up to 3 days. Serve garnished with a little parsley.

BOROUGH MARKET CHEDDAR POPOVERS

Serves 8

The sharp, lingering flavor of English Borough Market Cheddar makes it an exceptional addition to popovers. Serve them with soups or roasts (they're great for sopping up gravy!), or eat them for breakfast with a little apple butter. Popovers' lusciousness diminishes as they cool, so get them to the table as quickly as possible.

1 tablespoon canola oil
2 large eggs
3/4 cup whole milk
1 tablespoon unsalted butter, melted and cooled
1/4 teaspoon fine sea salt
pinch cayenne pepper
1 cup minus 2 tablespoons flour
3/4 cup grated Borough Market Cheddar, divided
1/4 cup chopped fresh chives

Preheat the oven to 425°F. Oil 8 cups of a standard muffin tin, using a paper towel to make sure the bottom and sides are thoroughly coated. Place the tin in the oven to get very hot while you make the batter.

In a large bowl, whisk together eggs, milk, butter, salt and cayenne, whisking for 1 minute. Slowly whisk in flour. Switch to a spoon and stir in 1/2 cup of the cheddar. Stir in the chives. Spoon the mixture into the hot muffin tin, filling each cup a little more than half full. Sprinkle the tops with the remaining 1/4 cup cheddar.

Bake for 15 minutes, then (without opening the oven door) reduce the oven temperature to 350°F and continue to bake until the popovers are puffed up and deeply browned, about 15 more minutes. (If you need to open the oven door to check the popovers, open it only an inch or two as a draft could cause them to deflate.) Run a knife around the edges of the muffin cups to release the popovers and serve hot.

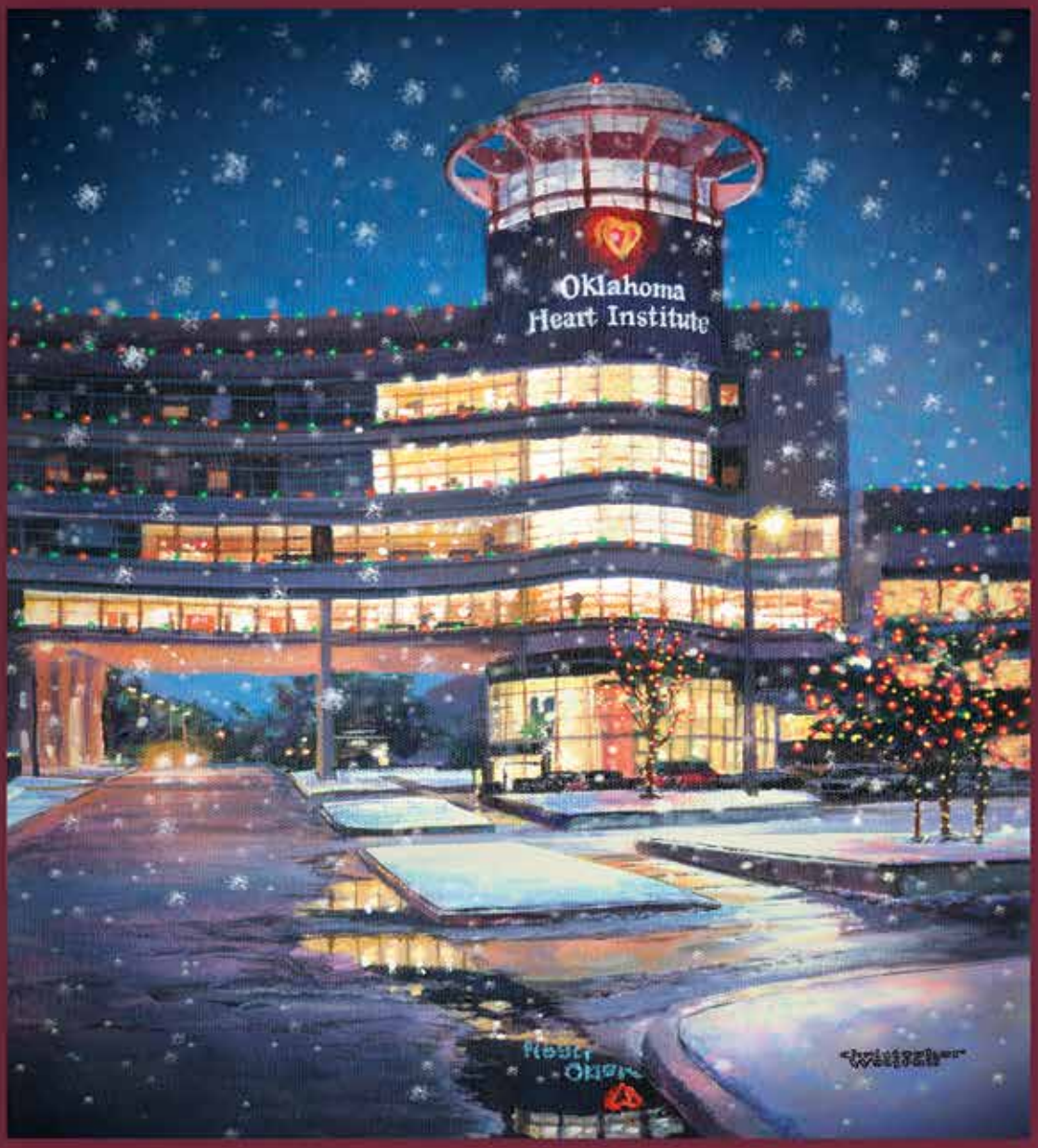
RUSTIC APPLE GALETTE Serves 6

Take your baking to the next level. This free-form pastry is easy to put together, and simple ingredients mean you don't have to do too much planning ahead.

1 1/2 cups 365 Everyday Value Organic All-Purpose Flour, plus 1 tablespoon for filling and extra for dusting
3 tablespoons cane sugar
1/4 teaspoon sea salt
1/2 cup unsalted butter, chilled and cubed
1/4 cup cold water
3 medium apples, peeled and sliced into 1/4-inch slices
1/4 cup dark brown sugar
1 teaspoon Simply Organic Pure Vanilla Extract
1 teaspoon Simply Organic Cinnamon
1/4 teaspoon Simply Organic Nutmeg
1/8 teaspoon Simply Organic Cloves
1 cage-free egg
Splash of water
1 tablespoon 365 Everyday Value Turbinado Raw Sugar
Parchment paper

Preheat oven to 425°F. To make the crust, whisk together flour, sugar and salt in a large bowl. Cut butter into flour mixture until mixture resembles tiny crumbs. Add cold water and knead ingredients together to form a ball. Lightly dust a sheet of parchment paper with flour. Using a lightly floured rolling pin, roll dough into a round about 14 inches in diameter and 1/4-inch thick. Roll out dough and transfer the parchment paper to a baking sheet. To make the filling, combine apples, brown sugar and vanilla in a bowl. Sprinkle in flour, cinnamon, nutmeg and cloves, then stir to combine. Arrange apple mixture in center of dough, leaving a space around outer edges of dough. Fold outer edges of dough one fourth of the way over filling. Beat egg and water together. Brush egg wash over crust and sprinkle with turbinado sugar.

Bake for 35 minutes, until apples are soft and the center bubbles. Allow to cool slightly, about 10 minutes, then slice and serve. Enjoy!



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