ASSIST MAGAZINE

Innovative Interventional Treatments

Precision Therapy

PERFORM ABLATIONS IN THE ANGIO SUITE

USE 3D PRINTING IN NEURORADIOLOGY

BUILD AN EFFICIENT PAE PROGRAM

Magazine#4

Chantal Le Chat
General Manager Global,
Interventional

Dear Reader,

As you daily push the boundaries of minimally invasive clinical care, your procedural dependence on imaging, technology and multi-disciplinary care teams grows.

Precision Therapy ensures that the right actions are taken at the right time, for each and every patient. Done right, and done at scale, Precision Therapy delivers on healthcare's triple aim: better quality, at lower cost, and with access for millions more people.

Our solutions show how technology such as Augmented Image Guidance (ASSIST), Data Analytics or Additive (3D printing) help healthcare providers improve patient outcomes, drive productivity and efficiency, and reduce cost of delivering care.

In this ASSIST magazine, we aim to provide examples of how GE's Image Guided Solutions are supporting physicians worldwide in setting up new clinical programs for procedures such as Prostate Arterial Embolization, Valves and Liver Oncology. In addition, physicians share how advanced visualization solutions provide insights and workflow improvements enabling multi-disciplinary teams in their quest to drive better patient care.

We would like to thank all our clinical partners for their continuing support and active contribution to this ASSIST magazine. We savor the challenge and the trust you place in us to continuously Elevate the field of Minimally Invasive Therapy.

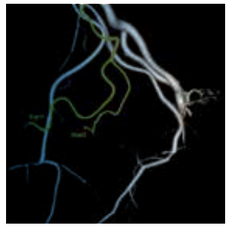
Chantal Le Chat

Table of Contents

ASSIST MAGAZINE

08 _ Improve Patient Outcomes

24 _ Improve Productivity & Efficiency



36 _ Reduce Costs of Delivering Care

Local Contact Information:

GE Healthcare Buc
283, rue de la Miniere
78533, Buc Cedex, France

Chief Editor: Dustin Boutboul
dustin.boutboul@ge.com

Editorial Team: France Schwarz, Mathilde Dauchez, Miranda Rasenberg, Jean-François Drouet, Paul Ayestaran, Thijs ter Mors, Erika Saillant, Philippe Karam, Julie Merandon, Bertrand Raulet

Design: Nathalie Ollivier

Printer: Groupe Lecaux Imprimeries HandiPRINT

Many thanks to our contributors:

Dr. Charles Nutting*, USA

Prof. François Cornelis*, France

Dr Marcelo Guimaraes*, USA

Dr. Ali Malek*, USA

Dr. Ib Erik Jensen, Denmark

Dr. Kent Christensen, Denmark

Dr. Daniel O’Hair*, USA

Dr. Tanvir Bajwa*, USA

*Speakers are paid consultants for GE Healthcare but here they have not been paid for the interviews and they did not receive orientations for them.

ASSIST Solutions

www.gehealthcare.com/assist

POWER UP PATIENT CARE

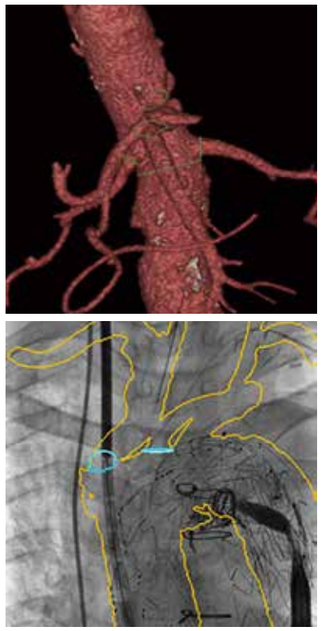
Your patients benefit from greater diagnostic accuracy and therapeutic effectiveness with minimal exposure.

POWER UP YOUR CLINICAL CAPABILITIES AND SERVICE LINE

ASSIST gives you the clinical information to let you plan, guide and assess interventional procedures.

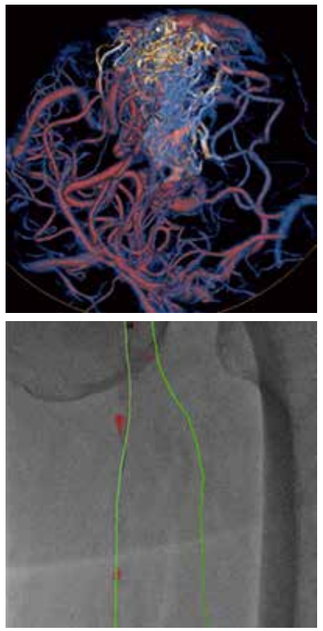
POWER UP PRODUCTIVITY

The ASSIST portfolio provides intuitive planning, designed to make your procedures easier and more efficient.



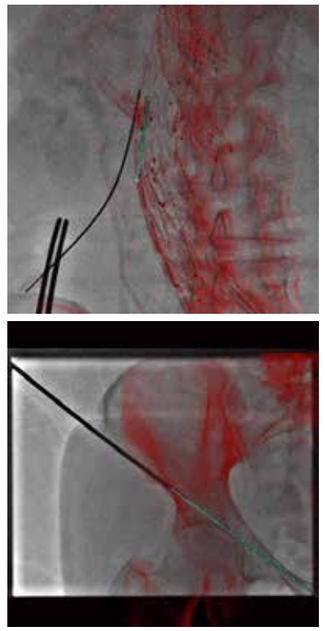
EVAR ASSIST 2 *

Designed by surgeons and interventional radiologists, EVAR ASSIST 2 provides a fully integrated workflow to plan, guide, and assess complex EVAR procedures. EVAR ASSIST 2 consists of a dedicated planning application to perform and save key anatomical information and measurements for sizing, along with a dedicated image fusion application to provide 3D guidance during the procedure.



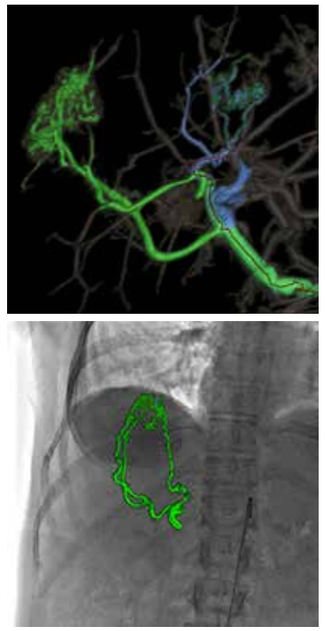
Vessel ASSIST **

Designed by surgeons and interventional radiologists, Vessel ASSIST provides easy to use and accurate planning and guidance tools. For example, Vessel ASSIST enables you to create and edit a vessel centerline, trace through an occlusion, and fuse it on the live fluoroscopy with 2D/3D fusion.[1]



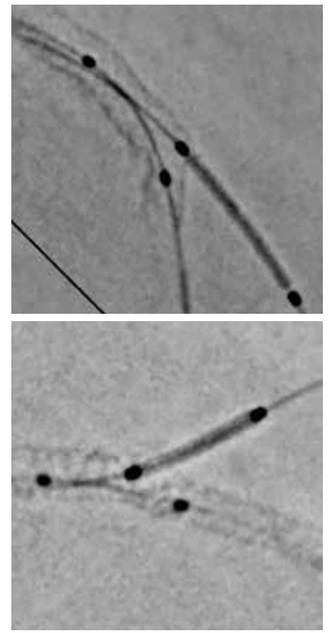
Needle ASSIST ***

With Needle ASSIST, you can perform complex percutaneous procedures in the angio room. It provides real-time visualization of needle positions in the 3D space by automatically fusing CBCT data over live fluoroscopic images. This enables precise needle trajectories, with over 1mm accuracy[2]. With the guided-workflow instructions, you can reconstruct a needle in 3D with only two fluoroscopic images in less than 1 minute.[3]



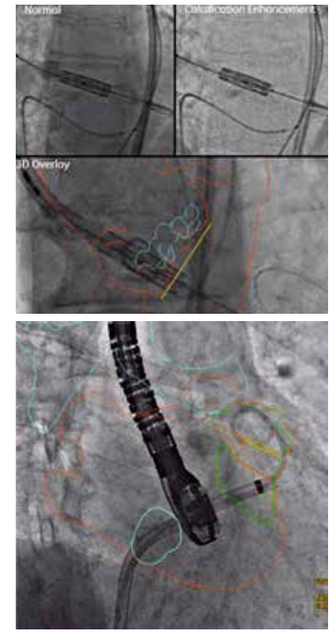
Liver ASSIST V.I.****

Liver ASSIST V.I. significantly improves sensitivity of identifying tumor feeding vessels so you can diagnose and perform sophisticated TACE procedures with far greater confidence. Liver ASSIST V.I. delivers excellent performance in tumor-feeding vessel identification and inter-operator agreement[4].



PCI ASSIST *****

Now you can perform long, complex PCI procedures with the same precision and confidence as routine cases – without increasing dose[5]. PCI ASSIST significantly helps to improve contrast and visibility. You can clearly see even small details to accurately position and deploy stents thanks to advanced stent visualization softwares. It all adds up to more efficient PCI procedures.

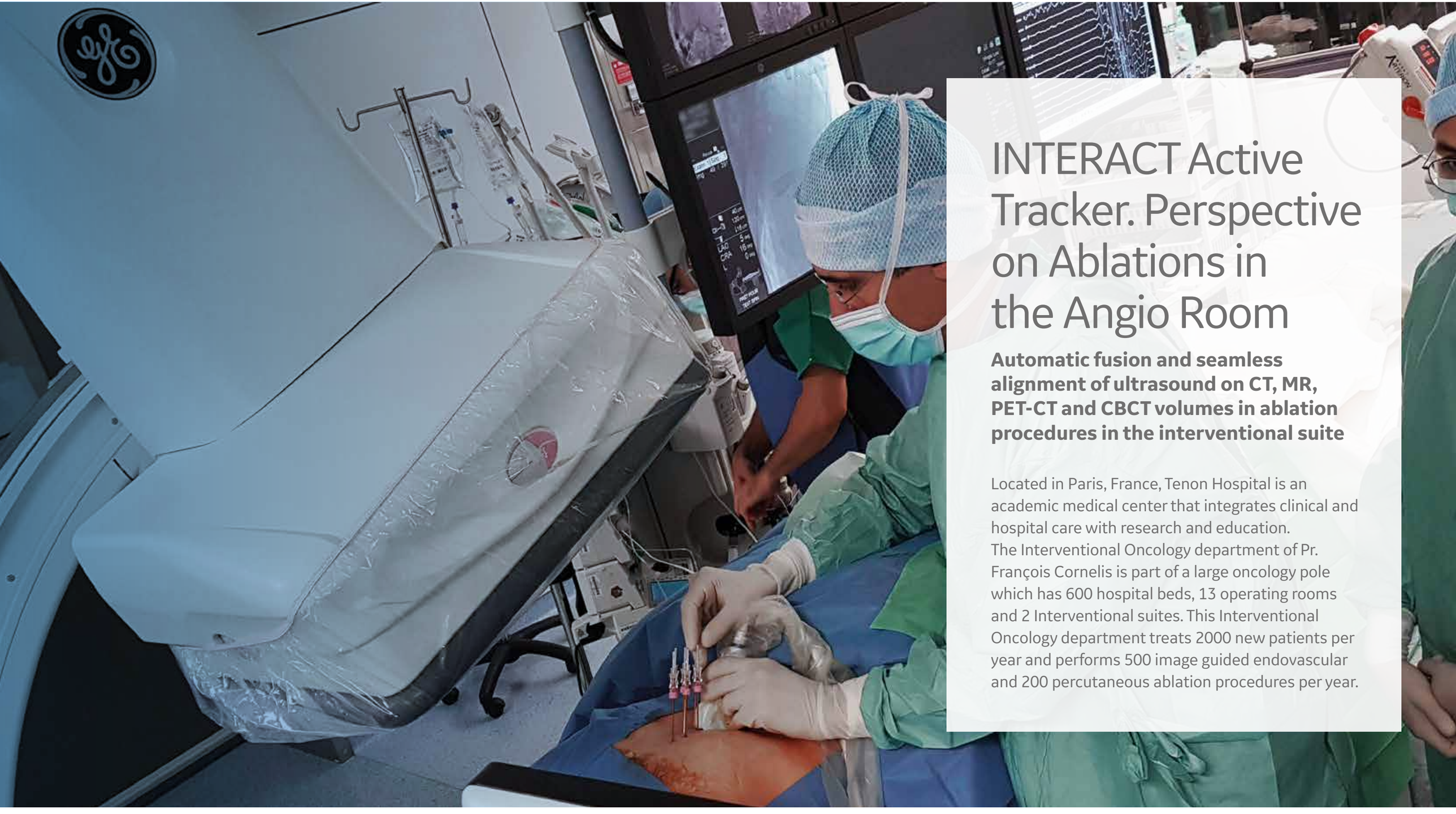


Valve ASSIST 2 ******

Valve ASSIST 2 provides enhanced planning and real-time visualization enabling you to position the valve and guide devices with precision. 3D contour rendering further improves intra-aortic visualization. You can choose the appropriate x-ray projection with no use of contrast media and minimal radiation dose.[6]

* EVAR ASSIST 2 solution includes FlightPlan for EVAR CT, EVARVision and requires AW workstation with Volume Viewer, Volume Viewer Innova, VesselIQ Xpress, Autobone Xpress. These applications are sold separately. ** Vessel ASSIST solution includes Vision 2, VesselIQ Xpress, Autobone Xpress and requires AW workstation with Volume Viewer, Volume Viewer Innova. These applications are sold separately. (1) Based on the dose of the procedure step needed using a CBCT acquisition to register pre-operative data vs. a Bi-View registration process. The stated dose reduction does not reflect the entire interventional procedure, rather a specific step in the procedure.*** Needle ASSIST solution includes TrackVision 2, Stereo 3D and requires AW workstation with Volume Viewer, Volume Viewer Innova. These applications are sold separately. (2) Measurement conditions: system with Innova-IQ table or Omega V table, rigid geometric phantom, CBCT data, frontal plane, L-arm at 0 degree, region of interest of 10cm. (3) Time to reconstruct the object may vary depending on user experience and case complexity.**** Liver ASSIST V.I. solution which includes Hepatic VCAR and FlightPlan For Liver that can be used independently. It also requires an AW workstation with Volume Viewer and Volume Viewer Innova. These applications are sold separately. May not be available in all markets. (4) Liver ASSIST V.I. performance in this article reflects results by using a prototype of a previous version of FlightPlan for Liver software. Computed Analysis of Three-Dimensional Cone-Beam Computed Tomography Angiography for Determination of Tumor-Feeding Vessels During Chemoembolization of Liver Tumor: A Pilot Study – Deschamps et al. Cardiovasc Intervent Radiol. 2010.. ***** PCI ASSIST solution includes StentViz and StentVesselViz. (5) IQ improvement is measured on Innova IGS530 with phantoms using various PlexiglasThicknesses, acquisition parameters and the NEMA spoke wheel tool (ref 1), calculating the ratio of the contrast of the moving wires to the background noise level. The amount of IQ improvement related to HCF depends on the acquisition parameters, clinical task, patient size, amount of motion in the image, anatomical location, and clinical practice. Ref1: A new tool for benchmarking cardiovascular fluoroscopes; S. Balter, Radiation Protection Dosimetry, Vol. 94, No. 1–2 pp. 161–166 (2001). Applicable to Innova IGS 5 (IGS 520, IGS 530 configurations), Innova IGS 6 and Discovery IGS 7 (IGS 730 configuration). ****** Valve ASSIST 2 solution includes TAVI Analysis, HeartVision 2 and requires AW workstation with Volume Viewer, Volume Viewer Innova. These applications are sold separately. (6) Compared to a workflow which does not involve image fusion.

Improve Patient Outcomes



INTERACT Active Tracker. Perspective on Ablations in the Angio Room

Automatic fusion and seamless alignment of ultrasound on CT, MR, PET-CT and CBCT volumes in ablation procedures in the interventional suite

Located in Paris, France, Tenon Hospital is an academic medical center that integrates clinical and hospital care with research and education.
The Interventional Oncology department of Pr. François Cornelis is part of a large oncology pole which has 600 hospital beds, 13 operating rooms and 2 Interventional suites. This Interventional Oncology department treats 2000 new patients per year and performs 500 image guided endovascular and 200 percutaneous ablation procedures per year.

Professor François Cornelis, MD, Ph.D., FCIRSE is Head of the Interventional Oncology Department at Tenon Hospital, Sorbonne University, Paris, France. He is specialized in cancer treatment, in particular in the liver and performs all types of image guided endovascular & percutaneous ablation procedures.

Optimal image guidance plays a critical role to achieve correct ablation and success of treatment. If CT fluoroscopy is among the most popular methods for performing ablations in the liver, ultrasound-guided puncture is another well-established method.

Introducing Ultrasound to the equation allows to overcome the main limitations associated with CT-guidance in percutaneous procedures, such as limited access to the lesion[1], limited space in the CT bore to access the patient, dose management[2], accessibility to CT room for IR team[3]. But because some lesions remain poorly visible under Ultrasound, physicians may have to fuse information from Ultrasound with other imaging guidance modalities, such as cone-beam computed tomography (CBCT), computed tomography (CT), magnetic resonance (MR) and positron emission tomography (PET)[4].

For fusion of Ultrasound and 3D volumes (CT/MR/PET) a variety of methods are available, including manual, image-based, and electromagnetic tracking-based fusion.

How many ablation procedures do you perform in your department?

Prof. Cornelis: *"We perform about four to six ablations a week, 200 a year. Most of our ablations are in the bone but we also ablate in the liver, kidneys and lungs."*

What are the main challenges encountered with CT-guided ablation?

Prof. Cornelis: *"CT guidance is very popular to perform ablations in the liver. The main limit I have right now is to access the CT room to perform IR procedures under general anesthesia."*

Do you have any dose-related concerns as an operator when you perform your ablations under CT guidance?

Prof. Cornelis: *"I never use CT fluoro live, I guide the probes knowing where the lesion is, then I get three slices to check the probes position using the Smart Step protocol. So, the dose remains minimal both for me and the patient. But everything depends on how you use the system. In our hospital we mostly work in the angiography suite, using CBCT-fluoroscopy guidance or ultrasound guidance, and in general taking advantage of both modalities fused together. The advantage of the angiography room is that the patient is more comfortable in this dedicated environment, the staff too, including the anesthesiologists, and you can reach the exact obliquity you need using trajectory guidance software, while monitoring the needle live."*

What about ultrasound-guided ablations?

Prof. Cornelis: *"When performing an ablation, we must have a fairly thorough knowledge of where the lesion is located and how we can reach it properly and accurately. Some lesions are not visible under ultrasound. And even if we see the nodule under ultrasound while positioning the needle, we will not see it anymore when we start to ablate.* ...

"The great interest of INTERACT Active Tracker [5] is that it provides seamless automatic fusion between CBCT & live ultrasound which helps save time and allows me to reach a higher fusion accuracy than what is achievable manually."

Pr. François Cornelis

During cryoablation for example, we can see the ice, but we do not see the nodule."

What are the benefits and challenges of using ultrasound fusion in combination with angiography?

Prof. Cornelis: *"I think image fusion is useful to better visualize the lesion and position the needle, but it also allows us to address the issue of immediate evaluation of the ablation area. If you do an adequate image fusion initially, even if you lose the tumor visibility on live ultrasound during the ablation, you can still assess tumor coverage using fusion with previous imaging or intraprocedural CBCT. But if we were using another ultrasound system, we would have to constantly switch between live guidance under ultrasound and verification under CBCT."*

What interests me in the GE Healthcare's solution (INTERACT Active Tracker) is that the ultrasound and the angiography are integrated, so the fusion between CBCT and live US ultrasound is automatic, which helps me save time and allows me to reach a higher fusion accuracy than what is achievable manually. Before INTERACT Active Tracker, it was not easy. We would sometimes have to redo the CBCT to fit both the tracker device and the lesion in the reconstructed field. Sometimes it would take us twenty minutes to be in a position to treat."

Do you think INTERACT Active Tracker is providing you with the right solution?

Prof. Cornelis: *"I believe so. If we get rid of the challenge of centering the tracker device in the same CBCT volume as the lesion, which was one of the major challenges with the previous workflow, it is a major improvement. I think this solution will fill the gap, making the setup and use of US-CBCT/CT/MR/PET fusion seamless and accessible to anyone. In terms of training, I think the operator must be fully involved in the process to become completely autonomous. We must not only train the technologists. The one holding the needle must be fully aware and trained on the solution. If the physician is involved, then the team will follow."*

1. Kambadakone A, Baliyan V, Kordbacheh H, Uppot R, Thabet A, Gervais D, Arellano R. Imaging guided percutaneous interventions in hepatic dome lesions: Tips and tricks. World J Hepatol 2017; 9(19): 840-49

Toyoda M, Kakizaki S, Horiuchi K, Katakai K, Sohara N, Sato K, Takagi H, Mori M, Nakajima T. Computed tomography-guided transpulmonary radiofrequency ablation for hepatocellular carcinoma located in hepatic dome. World J Gastroenterol 2006; 12(4): 608-611

2. Paulson E, Sheafor D, Enterline D, McAdams P, Yoshizumi T. CT Fluoroscopy-guided Interventional Procedures: Techniques and Radiation Dose to Radiologists. Radiology 2001 220:1, 161-167 Saidatul A, Azlan C, Megat Amin M, Abdullah B, Ng K. A survey of radiation dose to patients and operators during radiofrequency ablation using computed tomography. Biomedical Imaging and Intervention Journal. 2010;6(1): e1. doi:10.2349/biij.6.1. e2.

3. Minami Y, Kudo M. Radiofrequency ablation of hepatocellular carcinoma: Current status. World J Radiol. 2010; 2:417-424.

4. Abdel-Rehim M., Ronot M., Sibert A., Vilgrain V. Assessment of liver ablation using cone beam computed tomography World J Gastroenterol. 2015 January 14; 21(2): 517–524. doi: 10.3748/wjg. v21.i2.517

5. INTERACT Active Tracker is an optional feature of 3DXR (part of GE interventional X-ray systems Innova IGS 5, Innova IGS 6 and Discovery IGS 7 or Discovery IGS 7OR). This feature supports only one 'Active Tracker' type: OmniTRAX™ Active Patient Tracker (sold separately by CIVCO). Requires availability of a Logiq E9 XDclear 2.0 or Logiq S8 XDclear 2.0 or Logiq E10 system into the GE angio suite. Automatic fusion of pre-operative images (CT, MR, PET) with live U/S requires Integrated registration which requires an AW workstation with volume Viewer and Volume Viewer Innova. This application are sold separately.

The Statements described here are Dr. François Cornelis' professional opinions.

Improve Patient Outcomes

Pioneering the Dual Hit Approach in Medical University of South Carolina

Interventional Oncology: the 4th pillar in Oncology Care[1]

Over the past years, Interventional Oncology (IO), the youngest and most rapidly growing branch of Vascular Interventional Radiology (VIR), has become the fourth pillar of cancer therapy, alongside chemotherapy, surgery, and radiation oncology. Driven by several technological innovations, IO has evolved into a comprehensive and structured new specialty which is in constant development, always looking for innovative ways to improve patient outcome in oncology. Medical University of South Carolina (MUSC) is a leading academic institution in Interventional Oncology, with a clear objective in mind: use all the technological innovations brought by the Imaging and Device companies to the market in order to find new ways to treat patients and improve their outcome.

[1]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5131521

Credit MUSC Digital Imaging

Dr. Marcelo Guimaraes started training in Vascular Interventional Radiology in 2003. After two years of practice in Brazil, he joined MUSC in 2008 and quickly started climbing the ladders of Academia from Assistant to Professor in a matter of six years.

In 2014 Dr Guimaraes became the Division Director of Vascular Interventional Radiology, working as an Attending and taking care of administrative aspect of the division.

About MUSC

Founded in 1824, The Medical University of South Carolina (MUSC) continues the tradition of excellence in education, research and patient care. MUSC educates and trains more than 3,000 students and 700 residents in six colleges and has nearly 13,000 employees, including approximately 1,500 faculty members. As the state's only academic health science center and largest non-federal employer in Charleston, MUSC operates a 1,050-bed medical center (Main Hospital and Ashley River Towers).

Building Best Practices in Interventional Oncology at MUSC

Let me start saying that a big part of the best practice that we are developing at MUSC today starts by being involved in the multidisciplinary discussions. The tumor board is a venue where different options can be discussed and where hopefully the best treatments are selected among all the multiple specialties that are present. We take part in the two liver-dedicated multidisciplinary conferences which take place every week at MUSC.

Regarding the referrals, internal oncologists and even external oncologists refer patients directly to us.

Developing these multidisciplinary relationships has helped our Interventional Oncology practice to grow over the past 5 years. We are performing around 7000 Vascular IR (VIR) cases per year and IO represents about 15% of the total volume. Among all the tools that we can use to treat patients, I believe that our strength is the combination of procedures like liver bland embolization, Y-90 radioembolization, chemo-embolization and chemo-embolization with Lipiodol combined with liver ablation. As an example, injecting Lipiodol and performing a Cone-Beam CT (CBCT), the tumor borders can be better defined which increases precision and accuracy during the insertion of ablation needles (microwave or radiofrequency antennas). The combination of techniques has provided superior outcomes when compared to using them individually and it is equivalent to liver resection in Hepatocellular carcinoma (HCC) patients. The current literature supports our results.

As we work our way to build up best practices in VIR at MUSC, we are bringing innovative approaches like CBCT on most of our complex VIR procedures for a more accurate patient care, as well as the radial access approach which is now part of our best practice in IO/VIR procedures for improved patient recovery. To standardize these best practices, we also acquired advanced technology like the Discovery IGS 740 which, thanks to its wide bore and greater flexibility, enables us to take advantage of CBCT on 99% of our patients (even obese patients) and to optimize the room set up to perform radial access whenever required. The Discovery IGS 740 equipment has been included in our best practices and allowed standardization of operations which resulted in less variability and better outcomes.

Introducing Radial Access as part of the Best Practice in Liver Cancer Treatment

We decided to change our practice and adopted trans-radial as our default arterial access for liver-directed therapies when major groin hematoma developed in a very obese

...

Improve Patient Outcomes

patient about five years ago. That day we decided to explore other alternatives for better access and it soon became obvious that trans-radial access was probably the best option. We started developing this approach for obese patients. Some of them had multiple interventions and some of them had femoral access procedure first and then radial. They started to spontaneously give us great positive feedback about radial access especially the ones that came multiple times during that transitional period where we were building our trans-radial best practice. Therefore, we decided to do a study[1] to make sure that what I was listening to in clinic was real and to ensure that I was not just getting anecdotal information. The clinical trial compared radial versus femoral access in liver embolization procedures (bland and chemoembolization). Every patient was randomized to have femoral and radial accesses. Most patients required three sessions of liver embolization. The arterial access for the third procedure was selected by the patient. If the patient did not need a third therapy session, we asked what would be the preferred access if the patient were to have a third session. We managed to analyze 124 procedures, enrolling 55 patients in the study, analyzed complete data from 36 patients who were treated by Dr Ricardo Yamada and myself[1].

The primary end-point was patient preference, secondary end-points were complications such as ischemia, stroke, access-related complications, radiation dose for patient and operator, contrast media volume and procedure time.

The primary end-point of the study confirmed what we were listening to in the clinic: four out of five patients preferred radial access. There was no clinically evident stroke, nor ischemia or any other major access-related complications.

It is important to emphasize the selection criteria used consistently to ensure patients are eligible for radial using Barbeau's test and measuring the antero-posterior diameter of the radial artery by ultrasound.

We cannot stress enough how important that has been in our practice to get great outcomes.

Another key result of the clinical trial was the more than two times reduction on the radiation exposure to the operator using the radial access with the arm in abduction from torso 75 to 90 degrees. This is the only left arm position that enabled us to conveniently place a shield between the radiation source and the operator that resulted in significant radiation exposure reduction. All the other secondary end-points had no statistically significant difference.

Evolution of the IO Practice towards Combined Approaches

Back in 2008, the VIR division at MUSC was already performing several IO treatments, mainly Y-90 radioembolization, bland embolization, chemoembolization and CT guided ablation. These procedures were performed separately. We introduced the concept of combining liver embolization with lipiodol and ablation to improve outcomes, a technique that I had started using while practicing in Brazil in 2005. It is now well stated in the literature that HCC survival rates after combined embolization (chemo or bland) plus ablation procedures are significantly higher, up to 75% at five years, than survival rates of patients who undergo chemoembolization only or ablation only. The results of this combined approach are very close to the best results of survival which are on transplant patients.

This is the main reason why we decided to follow this path. We now offer all of the procedures which are cutting edge in IO at MUSC: bland embolization, chemoembolization, Y-90 radioembolization but we also offer what we call the "Dual Hit" approach.

1 Transradial Versus Transfemoral Arterial Access in Liver Cancer Embolization: Randomized Trial to Assess Patient Satisfaction., Yamada et Al. JVIR (2018)

The “Dual Hit” Approach: Combined Chemoembolization & Ablation to Treat HCC

Courtesy of Dr. Marcelo Guimaraes, Medical University of South Carolina, United States

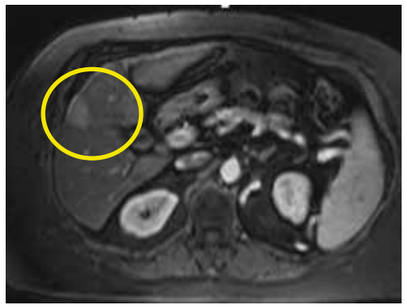


Fig. 1 Pre operative MRI showing the lesion

Patient History

This is a case of a female patient with a history of diabetes and fat liver disease, who was referred for consideration of TACE as a treatment approach for HCC in the context of cirrhosis.
A pre-op MRI showed a 2.1 cm x 3 cm subcapsular liver lesion in segment 5 consistent with HCC (Li-Rad 5).
She went to an oncologist, who oriented her towards a surgical approach. The patient had heard about other minimally invasive treatment options. She consulted with a surgeon and then decided to go for the minimally invasive treatment. During consultation at the VIR clinic, the Y-90 radioembolization and the “dual hit” TACE + RFA approach were discussed and the patient selected the treatment option which has historically shown higher grade of tumor necrosis and success rate.

Clinical challenge

The challenge about this case was that the lesion was at the periphery of the liver, translating into a risk of thermal injury to the very close gallbladder.

Procedure

Transarterial Chemoembolization (TACE)
An initial trans-radial selective right hepatic arteriogram, followed by Cone-beam CT, was performed. Liver ASSIST highlighted the tumor-feeding vessels. It facilitated the super-selective catheterization of the feeding vessels of the HCC and thus the injection of lipiodol in the lesion.

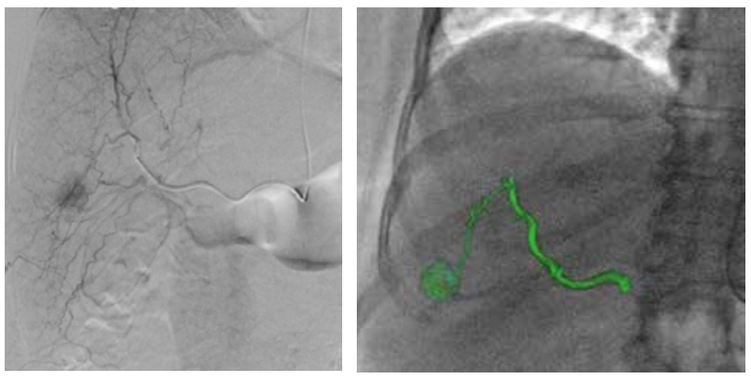


Fig. 2 Liver ASSIST[1] helps detect the tumor feeding vessels and overlay it over fluoro for super-selective catheterization and embolization

Radio-Frequency Ablation (RFA)
First, a 21G fine needle was inserted in the gallbladder and the bile aspirated. The same volume of chilled Dextrose 5% was injected to cool off the gallbladder wall and a continuous perfusion of 10cc/h was kept throughout the case. This protective technique has been successfully used at MUSC in dozens of other cases for thermal protection.

Then, using Needle ASSIST, two ablation antennas were introduced with the goal to have two overlapping ablations zones which induced not only tumor necrosis but also a significant ablation margin. The “Dual Hit” technique allowed the clinicians to focus on the ablation margins, which is directly correlated with lower residual disease/local recurrence rates when compared to liver ablations only.
The best workflow for the needle positioning was defined, starting with the bulls eye view to identify the target (yellow dot on Fig. 4), and then moving to the progress view (Fig. 4) to advance the antennas. Lastly, the bulls eye view helped to ensure proper needle placement on the target. A final CBCT was done after the ablation to rule out any complications.

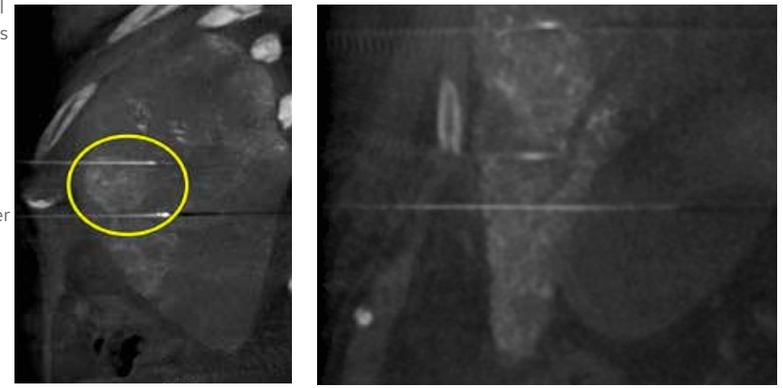


Fig. 3 Needle ASSIST helped plan the needle trajectory to cool down the gallbladder

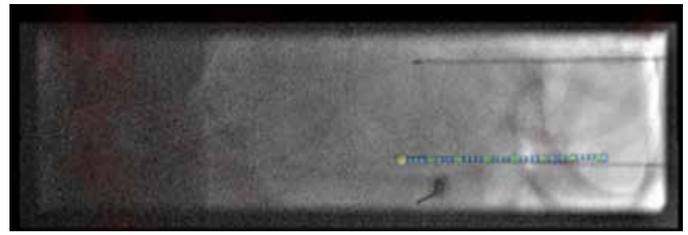


Fig. 4 Needle ASSIST allows to move back and forth between bulls eye and progress view

Conclusion

This patient had several follow-up visits in the last 18 months. The MRI has consistently showed post treatment changes of RFA in the segment 5 lesion without evidence of residual viable tumor.

[1]Liver ASSIST solution includes Hepatic VCAR and FlightPlan for Liver that can be used independently. It also requires an AW workstation with Volume Viewer and Volume Viewer Innova. These applications are sold separately. Liver ASSIST solution, requires Vessel ASSIST solution which includes Vision 2, VesselIQ Xpress, Autobone Xpress. Liver ASSIST and Vessel ASSIST are sold separately.

Improve Productivity & Efficiency

At the Forefront of Neuro Interventions with Advanced Solutions

St. Mary's Medical Center and the Palm Beach Children's Hospital

As a top-tier stroke hospital, the Comprehensive Stroke Center at St. Mary's Medical Center and the Palm Beach Children's Hospital pairs highly-skilled specialists with innovative technology in order to meet the needs of both hemorrhagic and ischemic stroke patients. St. Mary's Medical Center offers a full continuum of services to patients, including aggressive stroke management and acute rehabilitation.

For the past ten years, Dr. Ali Malek has led the comprehensive stroke program at St. Mary's Medical Center. Prior to this, Dr. Malek served as Director of the Neurosciences Intensive Care Unit at Tampa General Hospital and as an endovascular neurosurgery senior fellow at Providence Hospital in Southfield, Michigan. Dr. Malek was also a vascular and critical care neurology fellow at the University of Alabama at Birmingham.

What is your activity at St. Mary's Medical Center?

Dr. Malek: *"Demographics have changed a lot over time. When we started, it was all emergency cases- ischemic stroke and cerebral hemorrhages. Now we have an elective practice as well, so we treat about 10 to 20 arterio-venous malformations per year, 70 aneurysms per year and 100 to 150 ischemic strokes per year in the neuroradiology department.*

We see about 100 stroke patients per month, and everyone eligible receives endovascular rescue. When we first started, St. Mary's was the only hospital system in Florida to provide endovascular treatment for ischemic stroke. Before the DAWN study, many hospitals would not treat a stroke after the 6-hour cutoff. However, we have always worked within a 24-hour window to treat stroke. We do multimodal imaging with the GE Healthcare CT scanner, CT Angiography, CT Perfusion, and we go by tissue viability. If CT Perfusion shows that we have viable tissue, we treat the patient.

Of course, volume is not everything. We also do a lot of research. We were the first in Florida to get the Trevo device, and the third in the country. We are also the top enroller for the registry for the Solitaire device, and the third in the world for the Trevo registry."

Which imaging equipment do you use?

Dr. Malek: *"To move a hospital from a primary stroke center to a comprehensive stroke one, you have to have several champions in order to succeed – including the right staff and the right technology. GE Healthcare was the right vendor to provide the advanced technology necessary to support our stroke program.*

We purchased two Innova IGS 630 biplane systems, along with premium CT and MRI products from GE. I think the image quality of the biplane is fantastic. I am more comfortable with the workflow of this system - to me it is smoother than other manufacturers'. But the thing that really impresses me the most is how receptive the GE team is to helping me make things better. Every time we have a problem, the service team is so responsive and so rapid. What makes the GE room special is the GE people that I have worked with."

What is your opinion on the newly introduced Metal Artifact Reduction (MAR[1]) feature?

Dr. Malek: *"The difference metal artifact reduction provides is impressive (Fig.1). It is useful mostly for aneurysm repairs to check for residuals and recurrences. I use it first during the case to see whether or not I have covered everything I wanted. It makes a huge difference if you can tell whether or not there is any contrast medium penetration in the aneurysm or whether you have covered the neck sufficiently. I do think that before, the*

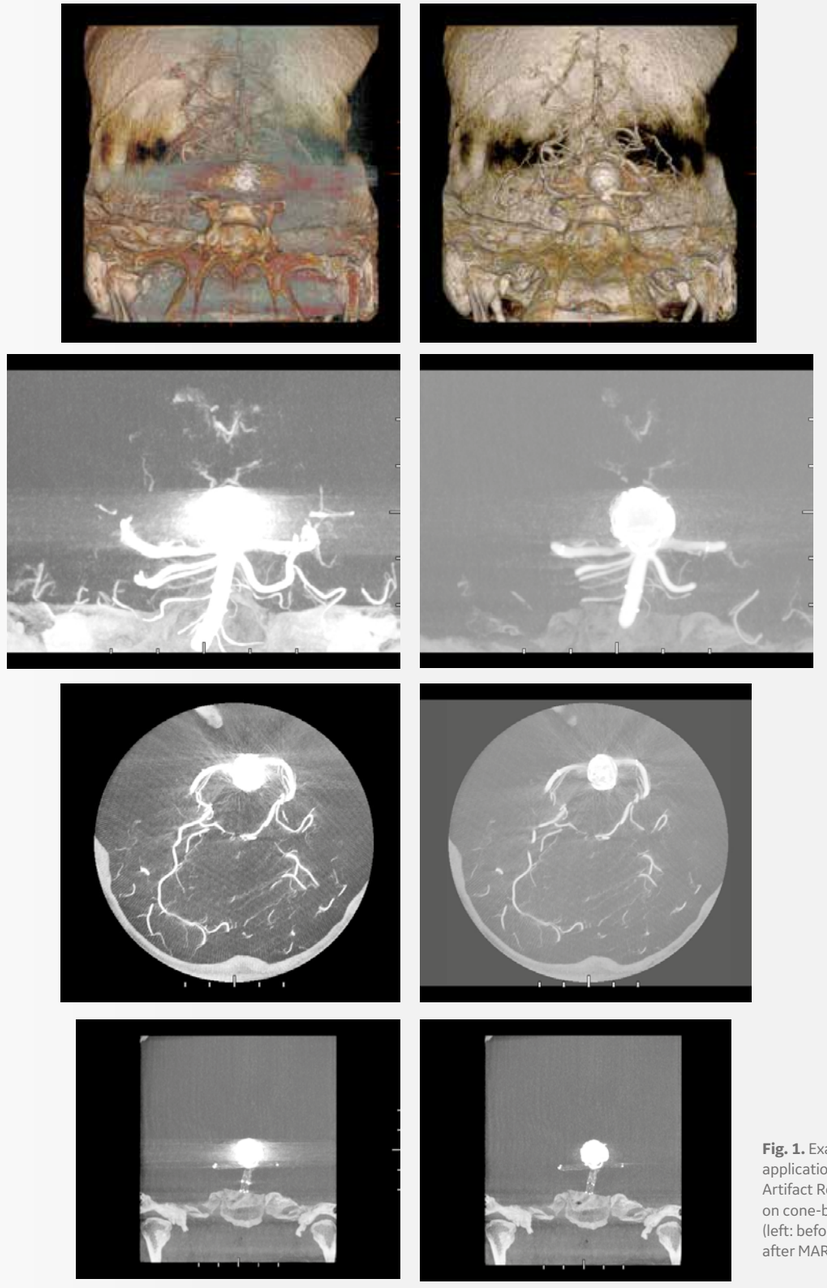


Fig. 1. Examples of applications of the Metal Artifact Reduction feature on cone-beam CT images (left: before MAR / right: after MAR)

[1]MAR is an optional feature of 3DXR (part of GE vascular systems Innova IGS 5, Innova IGS 6, Discovery IGS 7 and Discovery IGS 7 OR). Sold separately

artifact could sometimes hide whether or not there was a little of residual or if there was something else that needed to be done, so MAR helps a lot. And then, in my follow up, it is also useful to make sure that there is not some new recanalization or if there is a little daughter sac next to it. If there is a lot of artifact, it can be hard to see, and now it is a lot cleaner with MAR."

What is the value of 3D printing in your practice?

Dr. Malek: *"The new 3D printing feature has been kind of revolutionary for me. First, it is very useful for patient education. For a lot of people, an aneurysm is a bubble in their head, they do not really understand it, but when you physically show it to them, it makes a big difference. It helps not only educate the patient, but also give information to family and friends.*

But also for myself, it helps me figure out how severe a curve is going to be, if it is realistic to put this device or that device in. It has been really helpful for that. We always have a visual impression of what things look like in 3D, and we do that from a combination of our 2D images and the 3D rotations that we do, but holding a 3D print in your hand, and seeing the severity of some of the tortuosity, and seeing the complexities of the anatomy in real life., it is very helpful.

I think the future of what we're doing will be Virtual Reality (VR), Augmented Reality (AR) and 3D modeling.

Fig. 2. St Mary's Medical Center

Insights into the Emerging Role of 3D Printings in healthcare

3D printing is frequently presented as the next evolution of advanced visualization to help improve physician collaboration and patients understanding of their condition. 3D printed models provide a tactile feel about anatomy which elevates the clinician's insights, findings and recommendations. These tangible, life-sized anatomical models are helpful for facilitating multi-disciplinary collaboration. Additionally, chest and abdominal surgical procedures which require a team of subspecialty surgeons are seeing physical models as an exceptional facilitating tool for collaboration. All surgical and interventional procedures with complex pathology, extensive resection or reconstructions could benefit from this technology.

Fig. 3. Cross-section heart model. Image courtesy of Stratasys (WWW.STRATASYS.COM)

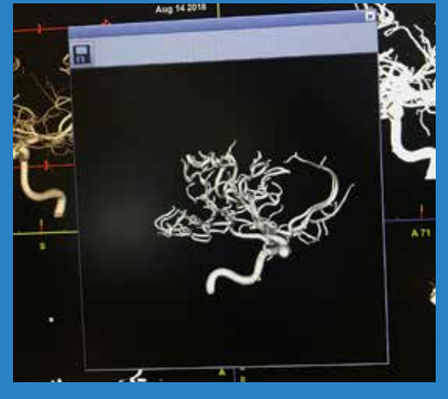


Fig. 4. New 3D printing feature available on Advantage Workstation with VolumeShare 7 allows you to extract any 3D anatomy from a 3D DICOM image (CT, MR, Cone Beam CT) and convert it into a standard 3D printing format (STL) recognized by most 3D printers.

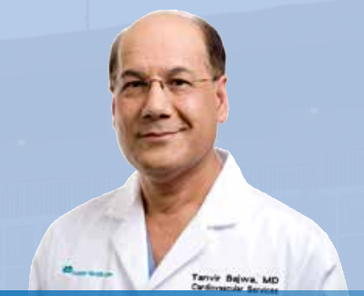
Improve Productivity & Efficiency

Building an Efficient and Optimized Heart Program at Advocate Aurora Health St Luke's Medical Center

Advocate Aurora Health operates 27 hospitals, more than 500 sites of care, employs about 3,300 physicians and 70,000 caregivers; it represents the largest health system in the Midwest and ranks amongst the top 10 largest health system in the US.
The vision and strategy of the institution is strongly focused on minimally invasive therapies, and on using artificial intelligence* to improve outcomes. Therefore, they have made significant investments to become one of the top cardiac programs in the country, with clear leadership in TAVR.

*Refers to https://www.biztimes.com/2018/industries/healthcare-wellness/aurora-health-care-to-roll-out-ai-powered-digital-concierge/

Dr. Daniel O'Hair
Cardiovascular Surgeon and Surgical Director of the Transcatheter Structural Heart Disease Program at Advocate Aurora Health St Luke's Medical Center



Dr. Tanvir Bajwa
Interventional Cardiologist, Head of the Interventional Program and Co-director with Dr. O'Hair of the Transcatheter Structural Heart Disease Program at Advocate Aurora Health St Luke's Medical Center

The Heart Program Activity in 2018, Procedures and Trials

Dr. Daniel O'Hair: *"We started formally working on this heart program in 2008, when it became clear that transcatheter technology was coming forward. We had our first transcatheter valve implantation in 2010. Since then, we have performed more than 1500 transcatheter aortic valve implantations."*

Dr. Bajwa: *"Early on, we were part of the initial trials of devices that were not commercially available. We participated in all the trials that assessed the outcomes of the transcatheter approach on high risk patients, as well as in the trials for inoperable and intermediate risk patients. Along with that, we have developed a robust program for the mitral valve as well as the pulmonary valve, and we are starting to work on the tricuspid valve."*

"Last year, we performed 376 TAVR procedures; if we add to that the mitral valve clips, pulmonary and tricuspid valves, we are close to 400 procedures a year. We do all of these procedures together in the hybrid room."

"The three main trials that we are involved in at this time are Medtronic's low risk TAVR trial[1], which is a global randomized trial, and another Medtronic trial for moderate aortic stenosis[2] ; we are also part of the Apollo trial[3], which is a mitral valve replacement trial using the Intrepid[4] valve."

"Concerning this last Apollo trial, we were fortunate to enroll the first patient in the world, having previously done about eight cases as a feasibility study."

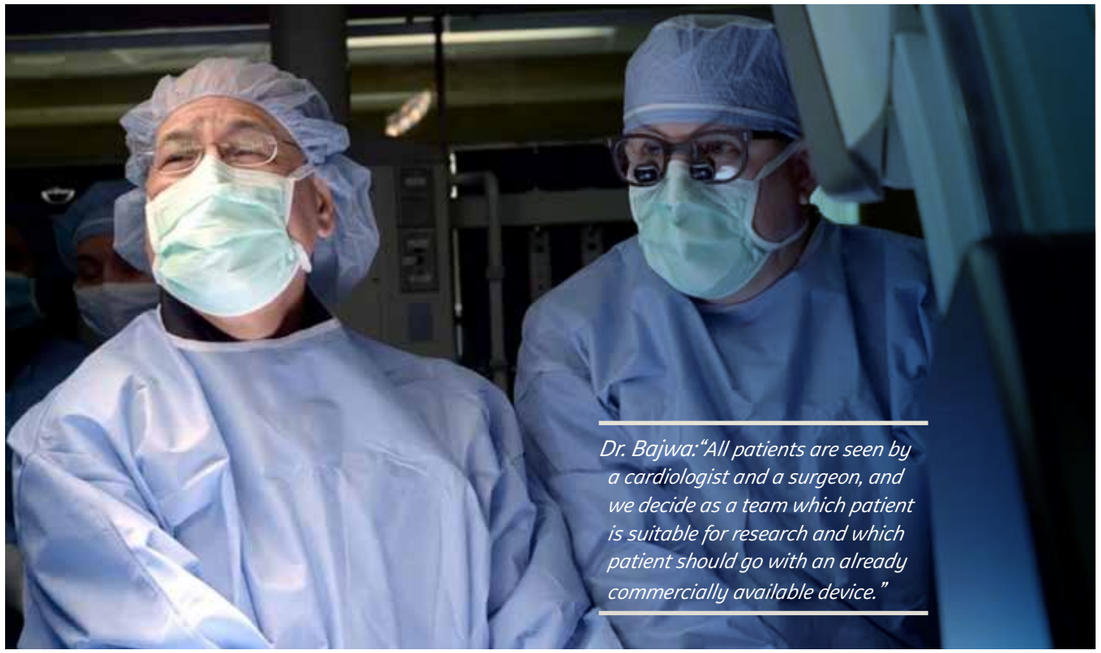
Working Together to Build a Heart Program

Dr. O'Hair: *"Prior to building this structural heart program, we already had a relationship, since we were working together in the care of heart patients, but we did not have a formal heart team until 2008, when we decided to team up to prepare for these clinical trials. Dr. Bajwa was kind enough to allow me to spend some time in his cathlabs and develop some skills. We did a lot of cases together, and that prepared us very well for the TAVR trials that followed."*

Dr. Bajwa: *"Back in 2008, we really believed that partnering with the surgeons was the right thing to do, because we knew that in a structural heart platform, a working heart team involving a surgical team, a cardiothoracic surgeon, and interventional cardiologists, was the perfect set up. It soon became very clear that if we wanted to get into mitral and tricuspid, building a working heart team was going to be very important."*

"Since we embarked on this program, we have our structural heart meetings every Monday morning from 6 to 7 am, driven by the surgeon and interventional cardiologist, assisted by multiple other members of the imaging department, including radiologists, imaging cardiologists, as well as nurses and nurse coordinators. We do believe that this is the key to success for any institution that is embarking on this valvular heart disease program."

Dr. O'Hair: *"Regarding the heart team, other important people we have included in the team are the research people. Research is a big cornerstone of our program, so when we have our heart meeting on Mondays, we also have our research team attend to help us screen all patients for all available options."*



Dr. Bajwa:"All patients are seen by a cardiologist and a surgeon, and we decide as a team which patient is suitable for research and which patient should go with an already commercially available device."

Dr. Bajwa: *"All patients are seen by a cardiologist and a surgeon, and we decide as a team which patient is suitable for research and which patient should go with an already commercially available device. As an example, for patients with mitral disease, we have two programs, mitral clip and the Apollo trial. So, we present the cases during our weekly meeting and we decide who is a suitable candidate for surgery, who is a suitable candidate for mitral clip; it's a collegial discussion."*

Interactions During the Procedure

Dr. O'Hair: *"The device requires two people, one to position and one to deploy, so we have changed roles in every possible manner over the years. Currently, I am upfront controlling the position and Dr. Bajwa does the deployment, and we are constantly communicating. We have done this so many times now that few words need to be spoken, but we work together and we are in agreement in everything we do, on the position or valve type and its deployment, so it really is a joint effort."*

Dr. O'Hair: "I just want to emphasize that in our case when the procedure goes smoothly the fluoroscopy time is as short as 5 minutes and the contrast volume is as little as 20cc. We are really proud of that and that has helped us drive excellent outcomes."

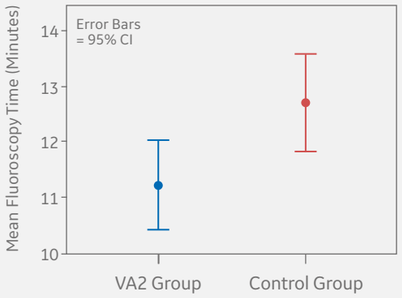
GE Technology & Solutions Help Improve Patient Outcomes

Dr Bajwa: *"Early on, patients were intubated, it was a very invasive procedure; like surgery. The procedures were longer and we had up to 25 people in the room. One of the main missions of the heart team was to find a way, as technology evolved (sheath size, new generation of devices, new generation of imaging systems), to make these procedures less invasive. We have a coordinator who works with us on how to get these procedures less invasive, in order to send the patient home as quickly as we can."*

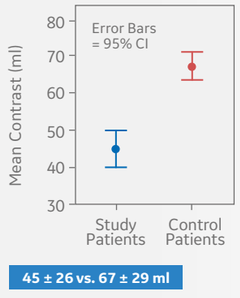
"The imaging piece is very important because we are dealing with very ill patients, as well as older patients. Our patient's age is around 84-85. They have all sort of comorbidities, especially renal insufficiency. Since then, our goal has been to decrease radiation, because we do a lot of procedures, and to reduce contrast because of the contrast-induced nephropathy and increased morbidity.

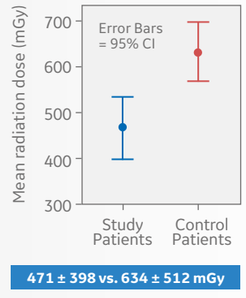
•••

1 Medtronic Transcatheter Aortic Valve Replacement in Low Risk Patients. Source: https://www.aurorahealthcare.org/aurora-research-institute/clinical-trials/nct02701283
2 Surgical Replacement and Transcatheter Aortic Valve Implantation (SURTAVI). Source: http://global.medtronic.com/content/dam/medtronic-com/c/surtavi-ctr-march2017/surtavi-data-acc-2017-reardon.pdf
3 Transcatheter Mitral Valve Replacement With the Medtronic Intrepid™ TMVR System in Patients With Severe Symptomatic Mitral Regurgitation (APOLLO). Source: https://www.aurorahealthcare.org/aurora-research-institute/clinical-trials/NCT03242642 zhtml?c=251324&p=irol-newsArticle&ID=2310361
4 Intrepid™ Transcatheter Mitral Valve Replacement (TMVR) System



Compared with the Control group, the Valve ASSIST 2 (VA2) group showed a significantly (p<0.05) reduced fluoroscopy time[6]





Compared with the Control group, the Valve ASSIST 2 (VA2) group showed significant (p<0.05) contrast and radiation dose reduction[6]

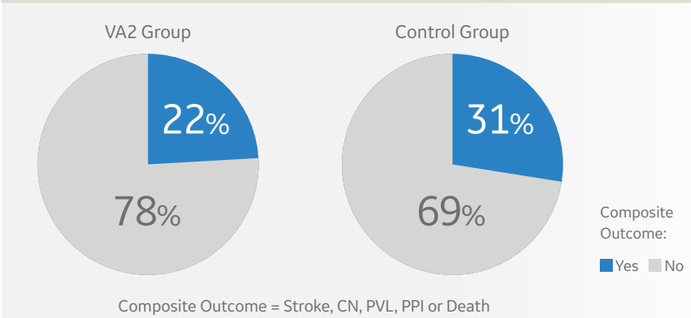
Indeed, in addition to our regular clinical practice, Valve ASSIST 2 really helped us achieve the lowest contrast use in activity registry in the whole country; our fluoroscopy times are off the chart (graphics above). 40% of our patients go back home on the second or third day, and imaging was very important for us to progress and make sure we use less contrast, less radiation for the physician and for the patient; imaging also made us more efficient."

Dr. O'Hair: *"I just want to emphasize that in our case, when the procedure goes smoothly, the fluoroscopy time is as short as 5 minutes and the contrast volume is as little as 20cc. We are really proud of that and that has helped us drive excellent outcomes."*

Dr. Bajwa: *"Back in the early days of this heart program, Dr. O'Hair and myself went to Buc - France (GE Healthcare, Global Headquarters – Interventional). At that time, we did not know how this procedure was going to evolve; therefore, we wanted a room that would be a real hybrid room in order to be able to switch to an open procedure in case of complications. We went to France, we interacted with the global engineering and product team, and we liked the equipment ; Dr. O'Hair was comfortable that in case of emergency procedure the room could become an OR."*

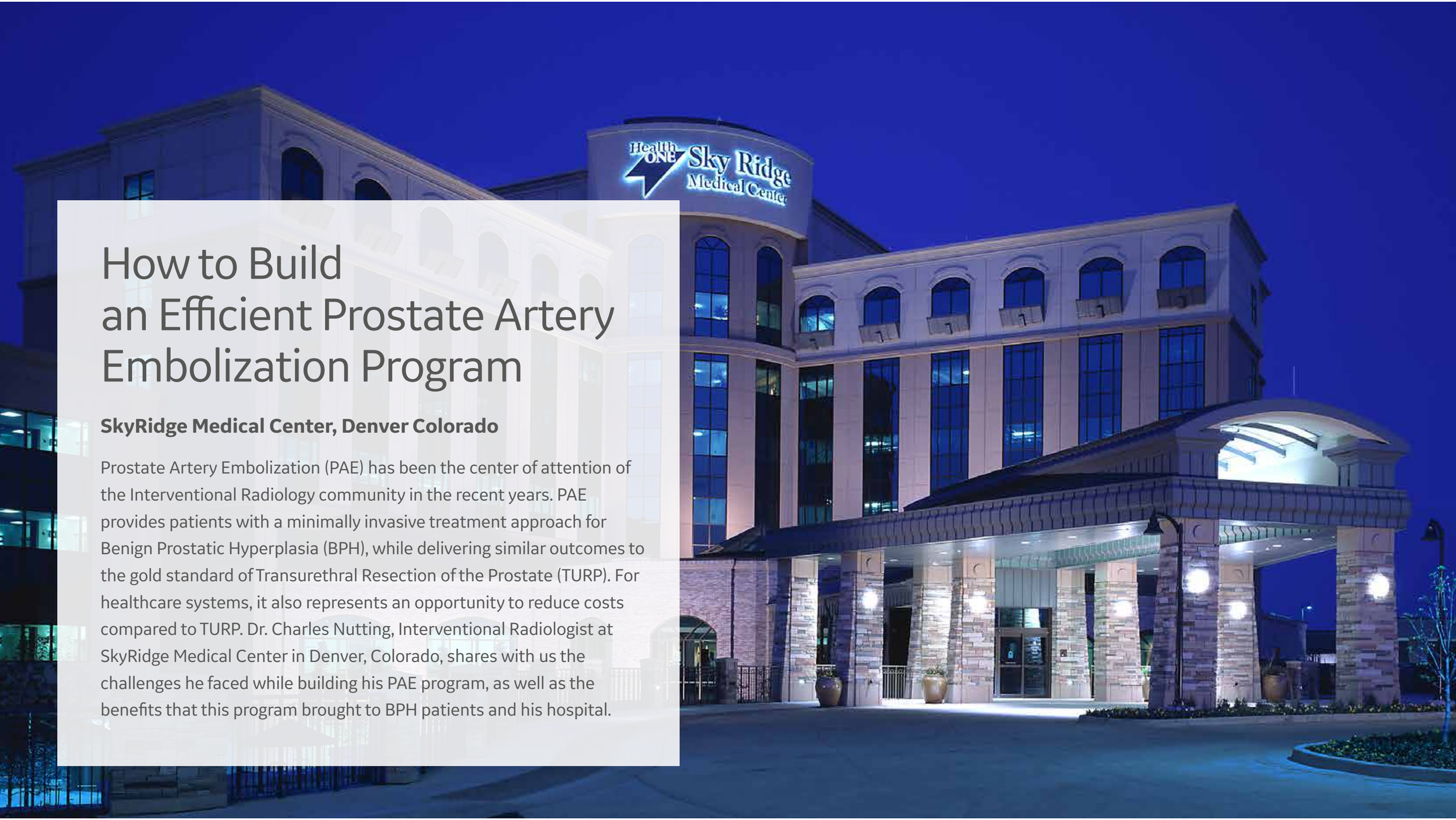
Dr O'Hair: *"That is a key asset of the Discovery IGS 730. We really like that system because we can get it out of the way if we need to do something more invasive. As an example, in the Apollo[5] trial, because the access is transapical, there is a bit of surgery first, then we can bring the system in for the procedure, and get it out again at the end to fix everything up. Lastly, the layout of our rooms , which are positioned in tandem with two GE systems and the control rooms in between, enables us to constantly see what is going on in the other room. We can get the next patient prepared for the upcoming procedure, and that setting really helps us improve our efficiency. We are a high-volume program; there are so many physicians and staff involved in these procedures that we want to make sure we do not waste anybody's time."*

5 Transcatheter Mitral Valve Replacement With the Medtronic Intrepid™ TMVR System in Patients With Severe Symptomatic Mitral Regurgitation (APOLLO).Source: https://www.aurorahealthcare.org/aurora-research-institute/clinical-trials/NCT03242642 zhtml?c=251324&p=irol-newsArticle&ID=2310361
6. Effect of a New Enhanced Fluoroscopy Technology (Valve ASSIST2) on Clinical Outcomes in Patients Undergoing Trans-Catheter Aortic Valvular Replacement, TCT 2017 (Oral presentation)



A recent study driven by Advocate Aurora Health St Luke's Medical Center demonstrated 29% reduction in composite outcome (Stroke, CIN, PVL, PPI or Death) in the Valve ASSIST 2 (VA2) group vs. the Control group[6]

Reduce costs of delivering care



How to Build an Efficient Prostate Artery Embolization Program

SkyRidge Medical Center, Denver Colorado

Prostate Artery Embolization (PAE) has been the center of attention of the Interventional Radiology community in the recent years. PAE provides patients with a minimally invasive treatment approach for Benign Prostatic Hyperplasia (BPH), while delivering similar outcomes to the gold standard of Transurethral Resection of the Prostate (TURP). For healthcare systems, it also represents an opportunity to reduce costs compared to TURP. Dr. Charles Nutting, Interventional Radiologist at SkyRidge Medical Center in Denver, Colorado, shares with us the challenges he faced while building his PAE program, as well as the benefits that this program brought to BPH patients and his hospital.

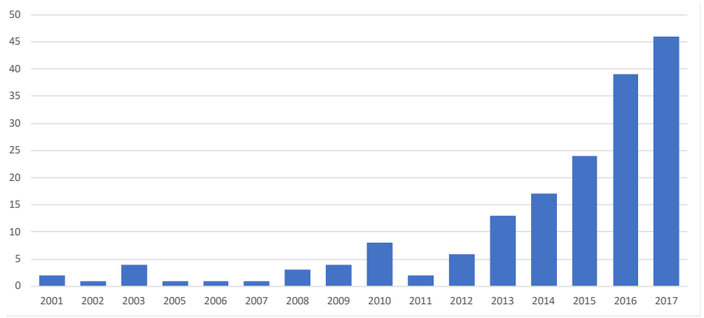
Benign Prostate hyperplasia (BPH) is a common condition as men get older. Benign prostatic hyperplasia affects about 50 percent of men between the ages of 51 and 60 and up to 90 percent of men older than 80[1].

An enlarged prostate gland can cause bladder, urinary tract or kidney problems. The quality of life of people suffering from this condition is compromized as common symptoms include increased urinary frequency, urgency, incontinence, and voiding at night.

Over the past years, urologists have developed several effective treatments to manage BPH including medications, minimally invasive therapies and surgery. Nevertheless, all those approaches are correlated to non-negligible side effects such as incontinence, erectile dysfunction and retrograde ejaculation amongst other side effects. Because of these associated side effects, as many as half of all men affected do not seek treatment.

At the dawn of the 21st century, a new minimally invasive procedure arose, called Prostate Artery Embolization (PAE), with promising initial results both on treatment efficacy and minimal side effects.

The principle of this technique consists in embolizing the arteries that feed the prostate gland, leading to a progressive shrinking of the gland. Since 2001, the number of publications assessing this procedure has increased exponentially.



Number of publications related to PAE since 2001 (extract from Pubmed with keyword "Prostate Artery Embolization")

[1]https://www.niddk.nih.gov/health-information/urologic-diseases/prostate-problems/prostate-enlargement-benign-prostatic-hyperplasia

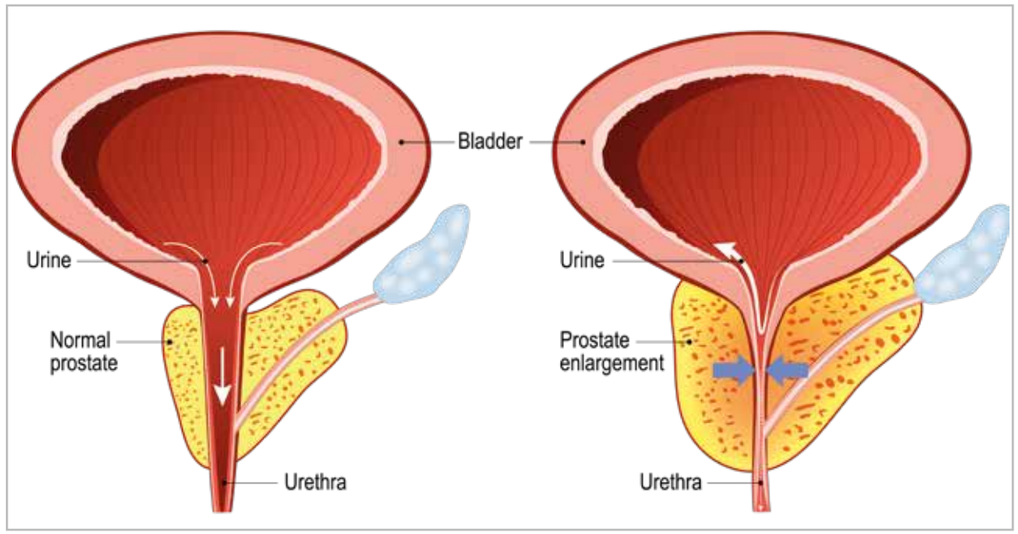


Fig.1 Illustration of benign prostate hyperpalsia (BPH), left side showing a normal prostate, and right side showing a prostate enlargement

One of the early adopters in performing the PAE procedure in the United States

Dr. Charles Nutting
Interventional Radiologist at SkyRidge Medical Center in Denver, Colorado

Dr. Charles Nutting, Interventional Radiologist at SkyRidge Medical Center in Denver, Colorado tells us about about his experience of PAE.

What is your clinical background?

Dr. Nutting: *"I did my training in Chicago, started with an internship in Radiology Residency, and then one year fellowship in Interventional Radiology in Presbyterian Medical Center. I then moved to Phoenix to a large trauma center where I worked for about five years and fell in love with the field of Interventional Oncology."*

What drove you to work in the IO field?

Dr. Nutting: *"It is a field that allows us to help patients that might otherwise have no other options to treat their cancer. I performed the first SIR-sphere (Selective Internal Radiotherapy) radioactive embolization in the liver in 2001, I helped build an Interventional Oncology program in that facility, then moved to Denver."*

Then, how did you move to PAE?

Dr. Nutting: *"I joined a large radiology group in Denver, and over the last 10 years I have become very interested in treating BPH using embolization. I' have been fortunate enough to travel the world and learn from some of the pioneers and started up a prostate program in SkyRidge Medical Center. I performed my first PAE about 10 years ago, but it has really taken off over the last 2 years with the FDA approval of the embospheres for the treatment of the BPH."*

What is your current interventional equipment at Skyridge?

Dr. Nutting: *"We currently use two GE rooms for our Interventional Oncology practice and to perform our PAE procedures. One of them is a Discovery IGS 740, the other one is an Innova IGS 630 biplane shared with cardiologists. The image quality of those two rooms is superb, we have Vessel ASSIST available on both systems, which helps me perform my embolizations. If it is a*

•••

larger patient, the wide bore of the Discovery IGS 740 is definitely an advantage to be able to perform the CBCT on all patients."

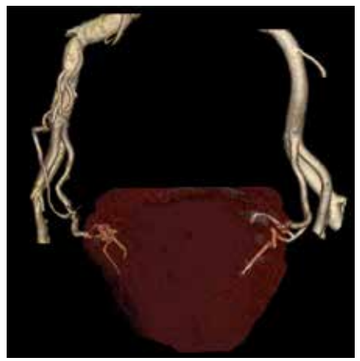
How do you split your activity in the cathlab?

Dr. Nutting: *"At this point in my career, I spend half of my time with PAE, the other half with Interventional Oncology. I do two to five PAE a week and about the same amount of Interventional Oncology procedures. So far I have performed more than 1400 liver related procedures and more than 140 PAE."*

How long does it take to perform a PAE today?

Dr. Nutting: *"I would say a very quick case for us is 45min, a long case would be around 3h30min. Our typical fluoro times are approximately 30min with less than 1 Gy. Obviously, it all depends on case complexity, vessel tortuosity and number of prostate arteries to be embolized."*

A sticking point in PAE can be patient recruitment, as they usually come from urologists who offer a surgical treatment for BPH.



3D rendering of the bilateral prostate arteries

How do you work with urologists?

Dr. Nutting: *"We now work collaboratively with urologists locally and around the country. We work closely with a urologist who sends us a lot of patients. She is always looking at the spectrum of therapies wich are available to treat her patients. She feels PAE is a reasonable alternative to surgical interventions. A large majority of patients could indeed benefit from PAE. For those who are not eligible to PAE, they can go for TURP, green light laser, or robotic prostatectomy.*

Today, the majority of patients we get are those who are not eligible for surgery. Indeed, a lot of patients are not eligible for TURP, because of very large prostates, anticoagulation treatments, or multiple comorbidities making these patients difficult surgical candidates. These patients are now getting PAE instead of surgical intervention. It reminds me of the time when we started with Y-90. We treated patients who were surgical failures, patients who were chemo-refractory, for whom everybody had tried everything but nothing worked.

However, not all urologists are favorable to PAE. Now that literature is bringing more and more outcomes, they start to look at it as a potential treatment option. Now that NICE (National Institute for Health and Care Excellence, United Kingdom) has approved it, each additional study or approval from a country gives more credibility. In our institution, urologists and IR's are not working in competition, but in collaboration to provide the best patient care."

What are the clinical challenges to perform a PAE?

Dr. Nutting: *"One of the main challenges is the difficult anatomy. The arterial blood supply to the prostate is variable with different blood supplies from each side of the prostate itself. There can be collateral vessels that go to unintended areas like the rectum, the penis and the bladder so it is very important to understand the normal arterial anatomy and collateral blood supply.*

Planning is also a crucial part of PAE. Before performing a PAE procedure, I want to make sure thai I will be able to identify the blood vessels that supply the prostate, catheterize these vessels and deliver the embolic agent safely."

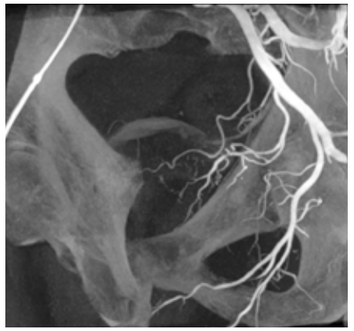
How does the imaging technology available in your cathlab help you perform your procedure with more confidence?

Dr. Nutting: *"From an imaging standpoint, we need to see very tiny vessels. Indeed, the average size of a prostate artery is 1.4mm which makes it critical to see on a regular CT. That is why we always perform a Cone-Beam CT at the beginning of the procedure to understand the prostatic anatomy and know whether there is a single or double blood supply to the prostate. We then use Vessel ASSIST to extract the prostatic arteries. We can then use this data and superimpose the CBCT on top of the fluoroscopy to have a roadmap of the prostatic artery, thus allowing a real time visualization of these vessels during the angiography and catheterization. 3D roadmap also...*

2D angiography of the pelvis showing the complex vascular anatomy

allows us to perform less DSA, thereby reducing the radiation dose to operator and patient.

While before we used magnification to switch to a bigger field of view, we now use the digital zoom to have a better understanding of the anatomy without increasing radiation dose to the operator and patient."



CBCT provides the required spatial resolution to accurately assess the complex vasculature of the pelvis area

"Most of what we do in IO is complex microcatheter work with 3D visualization, either in our mind or using Cone Beam CT. People who do different cancer work are very well suited to perform Prostate Artery Embolization"

Prostate Artery Embolization using Vessel ASSIST

Courtesy of Dr. Charles Nutting, Skyridge Medical Center

Patient History

A 70 year old male came up with a clinical background of benign Prostate Hyperplasia. He would wake up 5-8 times every night with an urgent need to urinate, facing constant fatigue and a worsening quality of life. He was ineligible for both prostatectomy or a trans urethral resection of the prostate (TURP) due to other health challenges, including diabetes and a pulmonary condition.

Clinical challenge

The bigger challenge with this patient is that there were two different vessels feeding the prostate on the left side. Therefore, it was critical to clearly find those two feeding arteries, differentiate them from other arteries and perform a selective embolization of those arteries.

Procedure

First, an angiography of the pelvis was performed to understand the vascular anatomy. As seen in Fig. 1, it led to some vessel overlapping and made it difficult to appropriately detect the two feeding arteries.
A CBCT with injection in the internal iliac artery was then performed (Fig. 2). This CBCT allowed to reformat the volume in different planes in order to have a spatial understanding of the artery trajectories.
A "two-click" vessel tracking was then performed thanks to Vessel ASSIST, in order to extract the prostatic artery and create a 3D roadmap (Fig. 3).
The two feeding arteries were then separated from the rest of the vasculature and fused on top of fluoroscopy (Fig. 4). This overlay helped catheterize the feeders and embolize them.

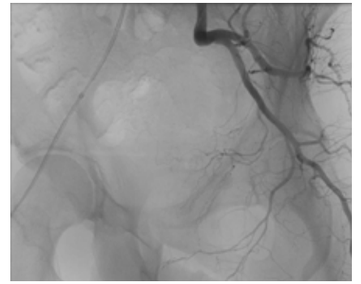


Fig. 1. 2D angiography is not optimal for appropriate feeder detection and localization

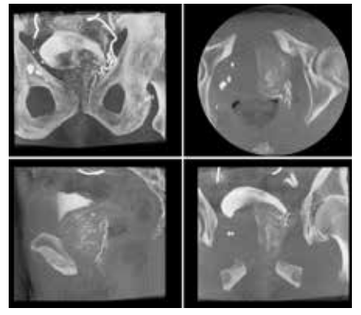


Fig. 2. CBCT helps understand the anatomy thanks to the multiplanar reconstructions and get better spatial information

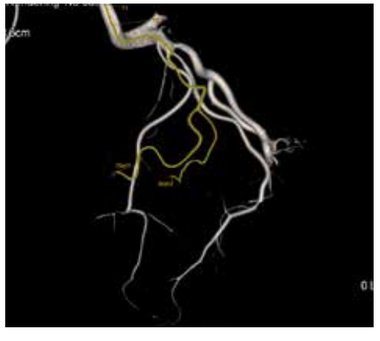


Fig 3. The whole vascular tree can be extracted as a 3D model and by using Vessel ASSIST, the two feeders can easily be segmented

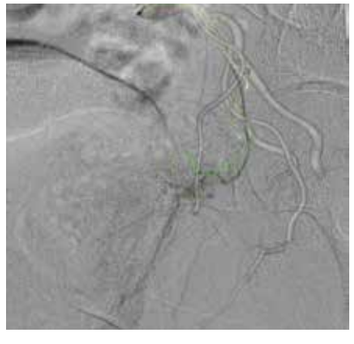


Fig 4. Using Vessel ASSIST, the segmented feeders can then be overlayed with fluoro to help catheterize and embolize the right vessels

"Prostate artery embolization has revolutionized the treatment of patients with BPH with LUTS. Using advanced imaging techniques allows me to treat my patients with more confidence, using less contrast and dose."

Reduce costs of delivering care

Embracing the Future: The Patient's Hospital First in Denmark to Install Hybrid Operating Room

Spotlight on the Vascular and Interventional Radiology department of Kolding Hospital, where Radiology Director Ib Erik Jensen, MD and Interventional Radiologist Johnny Kent Christensen, MD, discuss how their new hybrid operating room changed the way patients are treated.

Kolding Hospital in Denmark calls itself "The Patient's Hospital" because, no matter what, patients come first.

Located just 10 minutes by car from the old city of Kolding, the hospital is part of the three-hospital Sygehus Lillebælt system, specializing in emergency and trauma care, as well as pediatrics. It also boasts one of the largest vascular surgery departments in the country, treating more than 900 patients a year and performing more than 1,500 interventional procedures, primarily peripheral vascular interventions.

These are complex procedures that often require both surgical and interventional specialists. Until recently however, that meant double the hospital stay for the patient and a twofold increase in hospital resources. No more. In 2018, Kolding became the first center in Denmark to install a hybrid operating room.

The new room enables interventional clinicians and surgeons to work together in the same space on the same patient, providing groundbreaking flexibility and mobility, freeing up valuable resources, and, most importantly, says Dr. Jensen, providing the best treatments in Interventional Radiology to their patients.

Bringing the Hybrid Room to Reality

The hybrid room became possible thanks to the 32,000-square-meter extension of Kolding Hospital commissioned in 2010 as part of the country's €6.4 billion effort to modernize Denmark's hospital capacity with designated specialty hospitals. The addition included new inpatient units, an emergency room, and a new entrance to provide a sleek, modern environment for patients and their families based on the tenets of healing architecture.

When the hospital agreed to incorporate the hybrid room into the renovation, Dr. Jensen and his colleagues knew exactly what they wanted. *"We needed to bring the equipment very close to the patient at various working positions, so we could image the patient from all angles,"* he said. At the same time, it was important that the medical staff remain in close proximity to the patient, and easily get the system out of the way.

They also knew what they did not want: a ceiling-mounted gantry system. *"It is very difficult to keep the environment sterile with those systems,"* Dr. Jensen said. GE Healthcare worked closely with the hospital to design the ideal room. Today, it is equipped with the advanced Discovery IGS 7 OR, a unique laser-guided, mobile gantry that brings all the power of a fixed imaging system to the table yet can be moved aside to enable multidisciplinary teams to complete procedures with unobstructed access. It also enables high-quality 2D imagery as well as high definition Cone-Beam CT (CBCT) and multimodality 3D fusion imaging with opportunities for minimally invasive treatment.

Discovery IGS 7 OR also provides the first-of-its-kind robot gantry that is neither floor nor ceiling mounted. That was definitely an advantage over other hybrid solutions, said Dr. Christensen. One reason is that the room itself is relatively small, with ceiling-supported anesthesia columns and ceiling-mounted lamps, monitors, and other equipment such as laminar flow. *"It would be a problem for us if our gantry was also ceiling-mounted,"* he said. In addition, the Discovery IGS 7 OR's small footprint and easy maneuverability makes it easy to clean and maintain a sterile space.

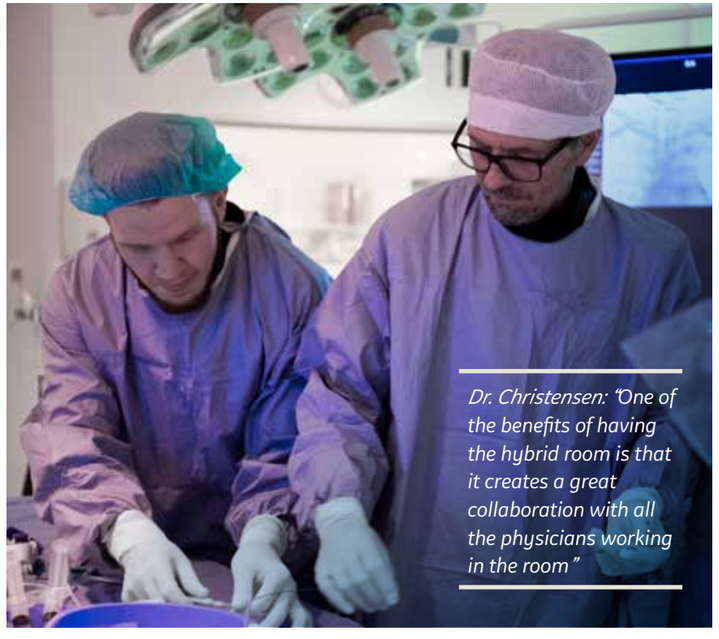
The room is also equipped with two high-definition large display monitors. These provide important mobility, swiveling, extending in or out, or adjusting up and down. *"This is very useful when we need to have access to both sides of the patient at the same time,"* said Dr. Christensen. The result is a single room that can now accommodate a wide range of endovascular, cardiac, hybrid, and open surgical procedures.

It also means the ability for four specialties—anesthesia, vascular surgery, nursing, and Interventional Radiology—to work together in the same room. *"Indeed, one of the benefits of having the hybrid room is that it creates a great collaboration with all the physicians working in the room,"* said Dr. Christensen. *"You feel more like a family."*

Working Together

The hybrid room has led to improved teamwork between surgery and interventional specialists. Each morning before a procedure, the vascular surgeon and interventional radiologist meet to discuss the patient. By the time the patient is admitted for the procedure, they have already undergone an MR or CT angiography (the hospital performs around 500 MR angiograms a year). The Vessel ASSIST solution available on Discovery IGS 7 OR enables better planning for vascular procedures from the CT or MR dataset, which, in turn, translates into a smoother, shorter procedure with less radiation exposure.

The team uses the hybrid room for numerous procedures. For instance, percutaneous transluminal atherectomy (PTA) procedures, in which femoral access is not possible. *"That is where our hybrid operating room provides such a great advantage,"* Dr. Christensen said, because the vascular surgeon can perform the atherectomy prior to stenting, then the interventionalist can take over. Before, procedures had to be performed in two parts: first the



Dr. Christensen: "One of the benefits of having the hybrid room is that it creates a great collaboration with all the physicians working in the room "

atherectomy and then the recanalization. "It could be weeks between both interventions," he said. It also meant two hospital stays for the patient of at least two days each.

In addition, the team had to rely on a mobile C-arm x-ray system. *"The image quality was poor and the ergonomics were not optimal,"* said Dr. Christensen. Today, he said, *"the surgeon can start the procedure with the Discovery IGS 7 OR in the hybrid room while we perform a PTA in the interventional room, then we return to the hybrid room when we finish the atherectomy."* This saves valuable time and enables the interventional radiologist to treat more patients.

The hospital also uses Discovery IGS 7 OR for its iliac stent/grafting procedures with pre-operative CT. They perform about 15 a year, said Dr. Christensen, and Discovery IGS 7 OR's CBCT allows them to assess stent deployment after the procedure. *"When we do a venous stenting with a patient suffering from venous thrombosis in the iliac, we always check the correct expansion of the stent at the end of the procedure by performing a CBCT,"* he said.

Another procedure is femoral bypasses to the popliteal artery. *"We can support the surgeons for those procedures because sometimes the run-off is not as optimal as it should be,"* he said. If the lower limbs are occluded and the femoral bypass to the popliteal artery is chosen, *"we sometimes re-treat the patient through the bypass with a PTA."* With the hybrid room, he said, *"we are ready to perform a PTA if needed."* The Discovery IGS 7 OR also provides good coverage of the sub popliteal region because it can be panned alongside the table while the patient is in the lateral position regardless of the access point.

Dr. Jensen also praises the versatility the room provides. *"You can treat patients coming for lower limbs thrombosis as well as for pancreatic diseases,"* he said. *"We can perform embolization, which is especially important for our trauma patients who may have splenic or renal trauma."*

The system may be particularly beneficial for patients with liver or pancreatic cancer and bile duct obstructions, said Dr. Christensen. *"If endoscopy will not work, we now puncture the liver with our catheter, cross the stenosis, and stent it."* However, this is a risky procedure and often results in post-procedural bleeding.

With the hybrid operating room, he envisions being able to thread the guidewire and endoscope to the stenosis itself, avoiding any trauma to the liver. *"It is much better for the patient,"* he said, with less risk of post-procedural bleeding.

Another example is lower gastrointestinal bleeding. While coil embolization is the first approach, the hybrid room enables immediate transition to open surgery if it does not work. *"Moreover, the staff feels more comfortable operating in this room, especially the anesthesiologists who benefit from excellent access to the patient,"* said Dr. Christensen.

Indeed, the ability to provide general anesthesia in the hybrid room is a major advantage. *"You have the space, you can get close to the patient, and you can bring in as much equipment as you need,"* Dr. Jensen said. With anesthesia booms on both sides of the table *"we can intubate the patient easily from any position,"* Dr. Christensen added.

The room is equipped with the Maquet* Magnus OR table system, which offers a variety of tabletops that enable clinicians to expand or perform additional surgical procedures through advanced patient positioning. The tables are adapted to meet the requirements of cardiology, heart surgery, vascular surgery, neurosurgery, orthopedics, and trauma, and are exchangeable at any time for increased productivity and patient preparation in the induction room.

The flat tabletop and Discovery IGS 7 OR function in tandem, with the gantry and table movements synchronized through a single user interface to achieve optimal anatomical coverage. *"It enhances our surgical capacity,"* Dr. Jensen said. Dr. Christensen agrees. *"For patients with lower limb disease, we can place them head or feet first depending on the location of the disease,"* he said. It also makes patient transport easier, and the segmented top is particularly valuable for orthopedic surgeons, he said.

The benefits of the hybrid operating room extend beyond the physician. "When the patient is awake, they can be much more comfortable than when we had to access them with a C-arm, Dr. Christensen said. That is thanks to the unique design of Discovery IGS 7 OR, including the offset C-arm and wide bore, he said.

Differentiating Factor

Just a few months after installing the hybrid operating room, it has already elevated the hospital above its counterparts in the country, Dr. Jensen said. *"They may have big radiology departments, but they do not do vascular interventions in the same room. Here, the hybrid room is one of the cornerstones of our department."* Although Kolding has only been using the hybrid operating room for six months, it has given the hospital room for more patients and improved its ability to provide more specialized treatments.

Easy Process from Start to Finish

As the person in charge of equipping the new hybrid operating room, Dr. Jensen did not hesitate to choose GE Healthcare. *"I chose GE because they listened to and understood our needs."* From the design of the equipment to the table to the ability to use the lowest possible radiation dose, all met the hospital's rigorous requirements. *"We worked hand-in-hand with the application engineer and medical physicist to optimize the image quality and the dose,"* Dr. Christensen said, both of which are ideal. One reason is that Discovery IGS 7 OR's image quality is customizable and adapts to the physician. Thus, the clinicians have the same "crispy" image they were used to with other imaging machines.

* Maquet Products are sold by Getinge. Refer to page 2 for more information

An added bonus was the experience itself, Dr. Jensen said. *"From purchasing to installing to training, it has been a very nice process."* Indeed, said Dr. Christensen, learning the system was quick and painless. *"We were familiar with it within two weeks."* That was important because he does not have technologists in the room when he is operating, so he handles the imaging himself.

The team is already planning for the future. Once the hospital adds a thoracic surgery department, they will be able to perform even more complex procedures in the hybrid room, including transjugular intrahepatic portosystemic shunts (TIPS) and aortic procedures. *"Now that we have the right equipment, the doors to expansions are open,"* Dr. Jensen said. Dr. Christensen says demand is already growing to make the room available 24/7 for emergencies.

"These kinds of projects reflect our core ethos to always put the patient at the center of the treatments"

Dr. Ib Jensen

Creating a Safe Space in Pediatrics

In addition to improving their patient workflow for vascular interventions with the new hybrid room, Kolding invested a lot into creating a safe space for children undergoing MRI.

The Children's Department at Kolding Hospital, with 36 pediatric beds and 19 neonatal beds, provides high quality care to children from birth to 15 years old, with 90 percent of patients admitted acutely.

Whether inpatient or outpatient, many of these patients require diagnostic radiology, including MRI. Undergoing an MRI, however, can be traumatizing for young children, and most require anesthesia. This, in turn, can lead to cognitive disturbances, attention deficit disorder, even aspiration and death.

To address this, the radiology team embarked upon an ambitious project to reinvent the MRI experience for children aged from 4 to 6. "Our goal was to create a very nice and safe environment, especially before they have an MRI," said Director of Radiology Ib Erik Jensen, MD. It includes four components:

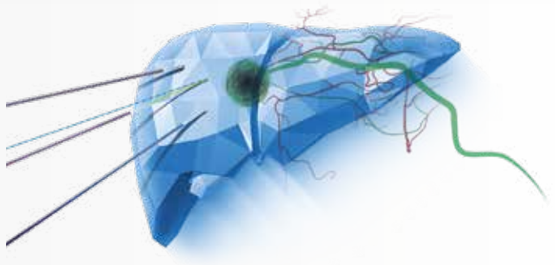
- A game-based app that sends children on a journey to learn about MRIs.
- A separate radiology lounge just for children where they can play with a mini-scanner and where they meet the radiographer
- A team of radiographers who receive special training in interacting with children
- Videos, soothing sounds, and other interventions to create a "fun" relaxing environment within the MRI itself

To demonstrate the effectiveness of this approach, Dr. Jensen and his team conducted a study comparing anesthesia rates in children before the program began and after. They found that of 57% of 40 children required anesthesia before, compared to 5% of the 41 children after. . The children were also more comfortable during the procedure and their parents felt a greater sense of security. The team presented their findings at the Radiological Society of North America meeting in Chicago in November 2017.[1]

1 Children centered care: Minimizing the need for anesthesia with a multifaceted concept for MRI in children aged 4–6 , Runge et Al., European Journal of Radiology (2018)
Patient experience solutions as outlined are owned and created by Kolding Hospital. They are not part of any commercially related to the MRI system referenced. Kolding's MRI system is not from GE Healthcare, therefore, GE Healthcare cannot verify any claims made herein. For more information on GE MR solutions focusing on children, please refer to https://www.gehealthcare.com/en/products/accessories-and-supplies/adventure-series-for-mr .

LIVER CARE - A Comprehensive Suite of Solutions

GE provides you with a comprehensive set of solutions to overcome your main challenges in Liver Care



Liver ASSIST V.I.

When

You need to locate the lesions & identify tumor feeding vessels, define the proper point of embolization ...

GE helps you

Optimize procedure selection & preparation thanks to automatic liver anatomy segmentation & evaluation, and get up to 97%[5] sensitivity in identifying tumor-feeding vessels and ~68% complete tumor response[8] with Liver ASSIST V.I. [9] for the planning, guiding, and assessment of your liver endovascular procedures".

Discovery™ IGS 7

When

39% (1.9 Billion) of the world's adult population is overweight (BMI>25) or obese (BMI> 30)[1]

GE helps you

Get uninterrupted CBCT up to BMI 40[2] and for almost all patients, even intubated and with arms down, with full organ coverage thanks to Discovery IGS 7

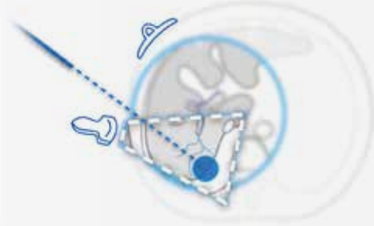
INTERACT Active Tracker

When

Accessing the CT room is challenging and when, in up to 35% of cases[10], automatic fusion of 3D volumes from Ultrasound & CBCT would be challenging

GE helps you

Expand your room utilization for more percutaneous procedures thanks to automated modality fusion using INTERACT Active Tracker[11]



Motion Freeze

When

the images are degraded because of involuntary respiratory motion artifacts[3]

GE helps you

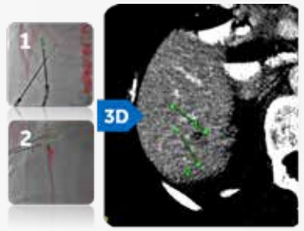
Potentially salvage up to 40% of CBCT affected by involuntary respiratory motion artifacts[3] with Motion Freeze[4]

Needle ASSIST

When

You need to plan your needle procedure using a simple multi-modality fusion of pre-operative images, including CBCT, navigate needle in complex structures to reach the region of interest & assess ablation margins

GE helps you



Get 3D space visualization at 98% less radiation dose[12] of a full CBCT at 1mm accuracy[13] with Needle ASSIST[14] for precise needle planning, guidance and assessment of percutaneous procedures in the liver.

1. https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity
2. Valid for IGS 740 configuration. Tested on a patient model based on published anthropometric data : C. Bordier*, R. Klausz and L. Desponds, Patient Dose Map Indications on Interventional X-Ray Systems and Validation with Gafchromic XR-RV3 Film, Radiation Protection Dosimetry (2014), pp. 1–13, doi:10.1093/rpd/ncu181
3. Based on the quantitative assessment of 6 recognized Interventional Radiologists specialized in the field of Interventional Oncology, using various intervention angiography systems from different vendors
4. Motion Freeze is a feature of 3DXR. The improvement related to Motion Freeze depends on the acquisition conditions, table position, patient, type of motion, anatomical location and clinical practice, it has been assessed visually on a physical phantom.
5. The above Liver ASSIST V.I. performances aspects reflect the results of three published journal articles conducted by using a previous version of FlightPlan for Liver software (B) (C) or its prototypes (A) for the validation and they do not necessarily represent individual performance of FlightPlan for Liver.
A)Computed Analysis of Three-Dimensional Cone-Beam Computed Tomography Angiography for Determination of Tumor-Feeding Vessels During Chemoembolization of Liver Tumor: A Pilot Study Deschamps et al. Cardiovasc Intervent Radiol. 2010.
B)Tracking Navigation Imaging of Transcatheter Arterial Chemoembolization for Hepatocellular Carcinoma Using Three-Dimensional Cone-Beam CT Angiography – Minami et al. Liver Cancer. 2014.
C)Clinical utility and limitations of tumor-feeder detection software for liver cancer embolization. Iwazawa et al. European Journal of Radiology. 2013.
8. Liver ASSIST V.I, through a previous version of FlightPlan for Liver, has demonstrated ~68% complete tumor response rate (36% with DSA alone). Hepatic Arterial Embolization Using Cone Beam CT with Tumor Feeding Vessel Detection Software: Impact on Hepatocellular Carcinoma Response. Cornelis et al. Cardiovasc. Intervent. Radiol. 2017
9. Liver ASSIST V.I. solution includes Hepatic VCAR and FlightPlan for Liver that can be used independently. It also requires an AW workstation with Volume Viewer and Volume Viewer Innova. These applications are sold separately
10. Based on quantitative assessment of 65 patients.
11. INTERACT Active Tracker is not available in all markets. INTERACT Active Tracker is an optional feature of 3DXR (part of GE interventional systems Innova IGS 5, Innova IGS 6 and Discovery IGS 7 or Discovery IGS 7OR). This feature supports only one 'Active Tracker' type: OmniTRAX™ Active Patient Tracker (sold separately by CIVCO). 3DXR is not available in all markets. Requires availability of a Logiq E9 XDclear 2.0 or Logiq S8 XDclear 2.0 or Logiq E10 (where commercially available) system into the GE angio suite.
12. Based on the dose of the procedure step needed for needle visualization using a CBCT acquisition vs. a Stereo 3D process. Full 3D anatomic information is provided with the CBCT acquisition, while the Stereo 3D process provides specific information for 3D needle visualization. In both cases, the needle visualization is next used to assess its location. The stated dose reduction does not reflect the entire interventional procedure, but rather to a specific step in the procedure.
The dose for the CBCT acquisition is from typical exposure settings (Innova CT 40°/s, 30fps, IQ Standard, Normal, Nominal FOV). The dose from the Stereo 3D process is from three spatially separated, 2-seconds fluoroscopic acquisitions, with typical exposure settings (3.75 fps, IQ Standard, Normal, Max Dose Reduction, Nominal FOV). The dose data for all acquisitions are from the Air Kerma per IEC 60601-2-43 conditions, provided in the interventional X-Ray user manual.
In clinical practice, the use of Stereo3D may reduce patient radiation dose depending on the clinical task, patient size, anatomical location and clinical practice.
13. Measurement conditions: system with Innova-IQ table or Omega V table, rigid geometric phantom, CBCT data, frontal plane, Region of interest of 10cm
14. Needle ASSIST solution includes TrackVision 2, stereo 3D and requires AW workstation with Volume Viewer, Volume Viewer Innova. These applications are sold separately. Not available in all markets

GE Healthcare

GE Healthcare provides medical technologies and services to help solve the challenges facing healthcare providers around the world. From medical imaging, software, patient monitoring and diagnostics, to biopharmaceutical manufacturing technologies, GE Healthcare solutions are designed to help healthcare professionals deliver better, more efficient and more effective outcomes for more patients.
GE Healthcare is betting big on digital; not just connecting hospital departments and physicians more effectively, but utilizing the masses of data from its equipment and the collaboration between hardware and software –"digital industrial" – to help clinicians make better care decisions. Sensors, software and smart data analytics are converging to enhance GE Healthcare's offerings not just in diagnostics, but also pathology, gene sequencing and even hospital asset tracking.

GE interventional imaging systems help you plan, guide and assess your wide range of interventional procedures precisely and efficiently. The new generation of ASSIST advanced applications allow you to extend your clinical capabilities and help simplify and streamline your procedural workflow.

Gehealthcare.com/ASSIST

The statements by GE's customers reported here are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist, i.e., hospital size, case mix, etc., there can be no guarantee that other customers will achieve the same results.
JB62131XXb