

Detecting coronary artery disease in its asymptomatic stage is one of the greatest challenges a cardiologist faces. The flight surgeons of the German Air Force have had tremendous success in this area, as they have developed a method using computed tomography for early diagnosis of the disease in pilots. This unique method has gained increasing recognition in aeromedicine worldwide.

By Sonja Fischer





Cardiac CT Takes Off



Thanks to its high sensitivity and specificity, MSCT has become increasingly recognized in international aviation medicine when diagnosing CAD in asymptomatic pilots.

“In terms of accelerated temporal resolution, SOMATOM Definition sets groundbreaking standards.”

Stefan Martinoff, MD,
Director, Institute for Radiology and Nuclear Medicine,
German Heart Center, Munich, Germany

Just as the captain of the Boeing 757 has safely taken off, he feels a sharp pain in his chest. He is panting for air. In his field of vision, the controls blur with the decreasing landscape below, and before he has a chance to set up radio communication with the control tower operators,

he collapses and is not able to continue navigating the aircraft. What sounds like a real horror-scenario actually took place in February of this year in a Continental Airlines aircraft. Fortunately, the copilot was able to safely land the aircraft and none of the passengers was harmed. The

captain, however, died from the consequences of his heart attack. Coronary artery disease (CAD) is still the most frequent cause of death in the industrialized world, and can cause what in aviation is feared as ‘sudden incapacitation in flight’. Now, a specialized strategy should prevent these events in both military and civil aviation. This is what Christoph Wonhas, MD, an internal specialist and cardiologist at the German Air Force Institute of Aviation Medicine in Fürstenfeldbruck, Germany, sees as his most important task. “The prevention of fatal occurrences or sudden incapacitation is critical to ensuring flight safety,” he stresses. “For this reason, diagnosing CAD at an early, asymptomatic stage is important for us as flight surgeons so that we can prevent any acute coronary syndrome that could have immediate consequences for the pilot and aircraft.”

Extraordinary Exposure for Jet Pilots

For jet pilots, a sudden incapacitation in flight can be particularly dangerous. They often fly alone and, in case of a heart attack, there would be no one to safely land the aircraft. In addition, specific conditions in the cockpit further cause physical stress: extreme heat, hypoxia, and high accelerating forces that push blood from the head into the legs and can shift internal organs up to 15 centimeters. These conditions increase the danger of an acute coronary event in persons with arteriosclerosis.

However, within the clinical aeromedicine department in Fürstenfeldbruck, Wonhas is responsible for more than just the aeromedical assessment of military pilots. As Assistant Director of the German Air Force’s Aeromedical Center, which has been accredited for civil aviation, he also assesses pilots from major German airlines on behalf of the German Federal Office for Civil Aeronautics. He is currently stationed at the US Air Force School of Aerospace Medicine in Texas, taking part in continuing aeromedical education. There, the significance of CAD for aeromedicine has been confirmed for Wonhas. Statistics from the Federal Aviation

Administration (FAA), the civil aviation authority in the USA, indicate that pilot autopsies have shown a higher-than-average percentage of coronary heart disease. From 1980 to 1982, the agency examined 710 deceased pilots. Of those, three percent showed severe, and 66 percent showed minimal to moderate coronary heart disease. Only 31 percent had no indications of arteriosclerosis of the coronary arteries. "In Germany, we do not have such large sets of statistics, because fewer people are actively flying. Therefore, there are far fewer fatalities," says Wonhas. "However, forensic doctors at the German Air Force Institute of Aviation Medicine have observed a similar situation, and several autopsies have

found more or less severe CAD or stenosis." As a result, the flight surgeons began to search for a reliable method of detecting the disease early to help prevent sudden incapacitation in flight.

Cardiac Health: Strict Guidelines for Pilots

In aeromedicine, bicycle ergometrics is recognized as the essential stress test for the health and fitness of pilots. With respect to CAD, however, ergometrics do not enable diagnosis until a stage that shows changes in the electrocardiogram (ECG) due to ischemia. Yet before the coronary blood flow becomes insufficient, the stenosis diameter has to reach 50 per-

cent. This means that ergometrics are of significant value for assessing patients at risk.

However, during routine screening of young, asymptomatic patients with a low coronary risk score like Framingham or PROCAM Score, as is the case of most pilots, this method has a coronary heart disease hit rate of only 21 percent. In addition, the European JAR-FCL3 guidelines (Joint Aviation Requirements for Flight Crew Licensing) can disqualify pilots with a lumen occlusion of 30 percent. As



German Air Force Institute of Aviation Medicine

The German Air Force Institute of Aviation Medicine in Fürstentfeldbruck is the central aeromedical facility for the German Army, Air Force, and Navy. Its job encompasses the selection, examination, and aerophysiological instruction of aircraft crews for the German Armed Forces. It is also responsible for investigating aviation accidents, ergonomics, aerophysiology, and dealing scientifically with aeromedical problems. The primary tasks are performed in the following departments:

- Research, Science and Education, Air and Space Medicine
- Clinical Aeromedicine
- Forensic Medicine and Aviation Accident Medicine
- Flight Psychology
- Ergonomics
- Aerophysiology

The Clinical Aeromedicine Department, where MSCT diagnostics are used as a noninvasive cardiac examination procedure under the direction of Dr. Wonhas, is the largest department. It is an interdisciplinary, polyclinical diagnostic center with eight specialist groups: Internal Medicine, Orthopedics, Neurology and Psychiatry, Ophthalmology, Ear-Nose-Throat, Dentistry, Diagnostic Radiology, and Central Lab.

Their task is to examine and assess the medical suitability of all candidates for military flight service. This includes follow-up examinations on approximately 3,300 army, navy, and air force pilots and weapon systems officers for deployment on military aircraft. The institute uses equipment of the highest standard. Since 2003, the German Air Force Institute of Aviation Medicine has also served as the Aeromedical Center for civil aviation on the order of the German Federal Office for Civil Aeronautics. As a result, frequent fliers such as Lufthansa captains, hobby pilots, and flight attendants now round off the patient spectrum.

Source: German Air Force



“MSCT is a fast, secure, and cost-effective method for displaying the coronary arteries of asymptomatic pilots in suspicious cases, without having to risk an invasive catheter examination.”

Christoph Wonhas, MD, Internal Specialist and Cardiologist,
German Air Force Institute of Aviation Medicine, Fürstenfeldbruck, Germany

such, for aviation it is very important to be able to determine CAD in asymptomatic subjects without high-degree stenosis. Until now, invasive coronary angiography has been the gold standard. However, physicians do not want to subject asymptomatic patients to the risks associated with this examination every time there is a new but insignificant conspicuity in a stress ECG. “Furthermore, we have found myocardial scintigraphy, which is used regularly in American aeromedicine, for example, to be unsuitable for detecting CAD in our pilots because it does not enable display of the coronary arteries,” says Wonhas. “However, with multislice computed tomography (MSCT), we found a fast, secure, and cost-effective method for displaying the coronary arteries of asymptomatic pilots in suspicious cases without having to risk an invasive catheter examination. This was a method we wanted to use,” he remembers.

Effective Cooperation in Cardiac CT

For this reason, the German Air Force Institute of Aviation Medicine looked for a suitable cooperation partner in diagnostic cardiology and high-resolution cardiac CT, and found that partner in the German Heart Center in Munich (DHM).

The DHM is one of the leading cardiac centers in Europe, and was one of the first facilities to use MSCT technology on the heart. The center has been equipped with state-of-the-art CT scanners from Siemens since 2002. The first MSCT system that the center used was SOMATOM® Sensation 16, which was later upgraded to a 64-slice system. This was then replaced by the latest high-end CT system from Siemens in the summer of 2006: SOMATOM Definition.

Stefan Martinoff, MD, Director of the Institute for Radiology and Nuclear Medicine at DHM, and Jörg Hausleiter, MD, cardiologist at the Department of Cardiovascular Diseases, both helped to develop this innovative method for using MSCT in aeromedical assessments. Martinoff is impressed by the new SOMATOM Definition scanner. “With this system, we took the opportunity to accelerate cardiac imaging in terms of temporal resolution. In this area, the new Dual Source CT sets a groundbreaking standard. The system is much easier on the patient, and it is easier for us to perform significant, high-quality coronary CT examinations,” states the radiologist. “In addition to the resolution, which at 82 milliseconds is twice as fast, there is a whole range of high-tech features that make SOMATOM Definition an excellent system for vascular and cardiac

examinations.” For Wonhas, computed tomography angiography (CTA) using SOMATOM Definition is the method of choice for aeromedical assessments: “The primary advantage is the high negative predictive value of almost 100 percent. With respect to flight safety, we can now rule out whether an asymptomatic pilot is suffering from coronary heart disease with greater certainty.”

Reliable Diagnosis in Asymptomatic Pilots

From a cardiological perspective, Hausleiter particularly stresses the advantages of CTA as a noninvasive method to identify plaque-accumulation in the coronary arteries. “Due to the high spatial and temporal resolution of CTA imaging, we can show calcified as well as noncalcified plaque.” In case of a rupture of these plaques, blood clots occur which can consequently cause a heart attack. Therefore, Hausleiter assumes that these deposits – especially the noncalcified – will, in the future, be increasingly considered for the diagnosis of arteriosclerosis in asymptomatic patients with intermediate risk to suffer from CAD, like the pilots. Since 2003, Wonhas and his colleagues have been using MSCT in aeromedical assessments with the support of DHM. As



Routine investigations at the Institute of Aviation Medicine include bicycle ergometrics as an indispensable stress test.

If irregularities occur in the resulting electrocardiogram, CTA is performed on the same day at the German Heart Center. Exemplary findings (above) from Dr. Wohnas' CTA test in 2003, which ruled out CAD for him.

in the past, they routinely perform ergometrics at the Institute of Aviation Medicine once annually as a screening method. Now, however, if changes are noted in the ECGs and ergometrics when compared to those from the previous year – for example, a new, higher-grade arrhythmia or new ST segment changes – the physicians authorize additional, noninvasive examinations. This means that a transthoracic echocardiogram (TTE) is performed after ergometrics to rule out structural heart diseases such as cardiomyopathy or cardiac valve disease. On the same day, the colleagues at DHM perform the MSCT examination on the affected pilot. This procedure has proven to be extremely effective. From 2003 to 2004, exactly 3,409 flight crew members were examined and retrospectively evaluated in a study. In 1.73 percent of cases (59 pilots), results proved to be suspicious and required further examination. "Fortunately, we were able to rule out coronary heart disease in 85 percent of them. However, we did find coronary artery disease in nine persons, with stenoses up to 90 percent, and these were all asymptomatic pilots with a PROCAM Score of about only five percent," says Wonhas. He has 20 years of clinical experience as an internal specialist in an intensive care unit. In 2003, during his flight certifica-

tion (flight surgeons in the German Air Force are required to fly on a case-by-case basis), Wonhas, too, had suspicious ergometrics while being asymptomatic. CTA was performed, and the findings were normal. "Therefore, I have a different perspective. I understand the problem as an invasive cardiologist, but also as a patient," says Wonhas. Martinoff of DHM can confirm that Wonhas makes sensible patient selections for the examination based on his experience: "Given the hundreds of pilots in the German Air Force, the small number that Wonhas sent to us to be examined in 2003 and 2004 had a relatively high hit rate. The subsequent procedure confirmed that the approach we are using makes sense."

International Recognition in Aeromedicine

Based on the results presented by Wonhas and colleagues, the German Armed Forces have since recognized CTA with MSCT as the diagnostic procedure for their flying service, and use it as routine. The Federal Office for Civil Aeronautics, the highest monitoring agency for aviation in Germany, has also accepted this method because of its high negative predictive value. Internationally, NATO (North Atlantic Treaty

Organization) has begun working with MSCT to diagnose CAD.

Wonhas is convinced of the value of MSCT in aeromedical assessments, and hopes it will be quickly implemented in aviation internationally to prevent harm. "To date, in 85 percent of asymptomatic patients with a newly occurring higher-grade ventricular arrhythmia or nonconclusive new ST depression, our examination has clearly demonstrated that their hearts are healthy. On the other hand, in 15 percent of cases, we discovered coronary artery disease at an early stage. All of these patients were able to receive special approval to fly once they began treatment. For the pilot, this means minimizing the risk of a heart attack before it happens. He can be there for his family, and the Armed Forces or civilian airline will continue to benefit from his expertise. As a result, our method makes a lot of sense."

Sonja Fischer currently studies English and Communications in Bamberg, Germany. She is a member of the Medical Solutions editorial staff, and previously served as voluntary editor-in-chief for local online and print magazines.