

PERFORMING IMAGE REGISTRATION AT LOYOLA UNIVERSITY MEDICAL CENTER WITH THE CARTOMERGE™ IMAGE INTEGRATION SOFTWARE MODULE

As more electrophysiologists use the CARTOMERGE™ Image Integration Software Module, they are refining the registration process to suit their particular techniques. This is one in a series of White Papers that have been prepared to share the experts' methods.

Dr. David Wilber, Professor of Cardiovascular Sciences, Department of Medicine, Loyola University Chicago Stritch School of Medicine, and Director of Cardiology, Loyola University Health System, Maywood, IL, and Neil Brysiewicz, BSE EP Lab Bioengineer have refined their registration technique in the course of performing approximately 150 procedures using the CARTOMERGE™ Image Integration Module. Their experience has led them to focus on surface alignment of the left atrium as the key to a successful registration.

Dr. Wilber usually starts by segmenting the CT image, removing the atrial appendage and tubular portions of the pulmonary veins to simplify the image for registration. Then, in the left atrium, Dr. Wilber acquires approximately 75 CARTO™ XP System points. He then manually superimposes the CARTO™ XP System map of the left atrium over the CT scan image, visually aligning the two images in three planes, typically the superior, right anterior oblique (RAO) and posterior-anterior (PA). After doing this "eyeball" alignment, he'll create one landmark pair, usually just outside the left superior pulmonary vein, using intracardiac echocardiography (ICE) to confirm the location. After creating the landmark pair, he typically adds more CARTO™ XP System points, often in the anterior area of the left atrium and in the mitral annulus. "It's common to take too few anterior CARTO™ XP System points, because you concentrate on the posterior wall," Dr. Wilber noted. "That's one of the things that can cause problems in the alignment." Looking at a superior view of the CARTO™ XP System map helps to ensure a fully filled-in map, Dr. Wilber said. "If the superior view CARTO™ XP System map looks kind of 'pancaked,' you haven't filled in enough anterior points." Using the single landmark pair he has created, Dr. Wilber performs Visual Alignment. He then clicks

Surface Registration to complete the registration process.

Before determining that the left atrium provided them with the best registration results, Dr. Wilber's team also tried registrations using the coronary sinus and aorta, but did not find those approaches helpful.

When Dr. Wilber's team started working with the CARTOMERGE™ Module, they tried using multiple landmarks, Dr. Wilber said. Using ICE to validate their registrations, they determined that their results were better when they used the display to visually align the CARTO™ XP System map and the CT image, followed by surface registration of the left atrium. They use the system's statistics to check the closeness of the match. "Our average tip-to-wall surface distance is 2 mm using this registration technique," he added. While he still uses ICE during procedures, Dr. Wilber no longer needs it for validation of registration. "If you align the images manually in three planes," he said, "the program gives you a reasonable final result." But the system is not perfect. "Our worst registration is likely to be in a patient with a small atrium," he noted.

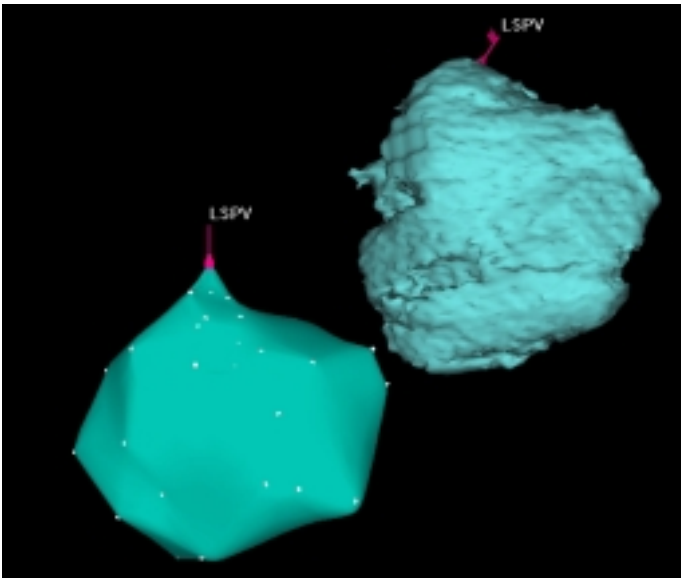
The diversity of angles in the veins and antrum that can be viewed with the CARTOMERGE™ Module has improved Dr. Wilber's ability to perform wide-area circumferential procedures compared with fluoroscopy and other technologies, he said.

Using the CARTOMERGE™ Module, Dr. Wilber's use of fluoroscopy has been reduced by approximately one-half. "We average approximately 15 to 20 minutes of fluoroscopy during a procedure now, and it used to be twice that," he said. "That's an important advantage."

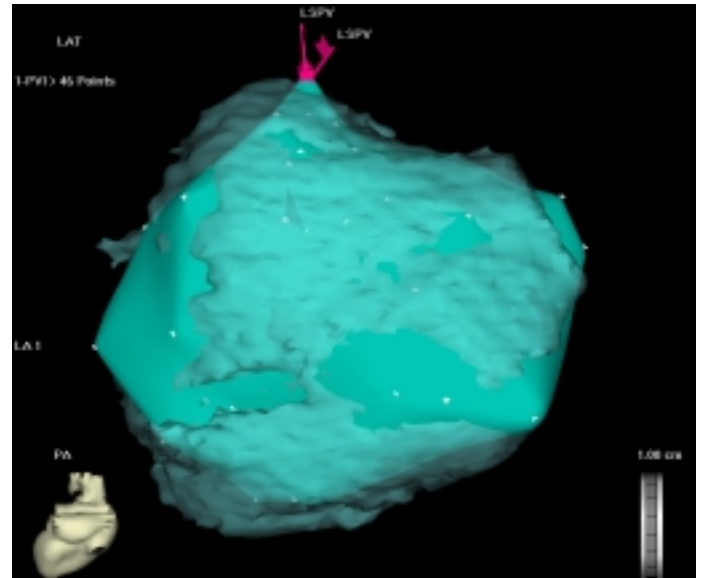
The CARTOMERGE™ Module has also changed Dr. Wilber's approach to the use of electrical measurements in locating anatomical structures. Voltage is not necessarily a good guide for avoiding a vein, he said; while the voltage is small in the distal portion of the vein, the voltage in the proximal vein and antrum may be quite large. "By looking at where you are posteriorly on the CARTOMERGE™ Module image," he said, "you'll see that even though the

voltage was good, in fact the catheter may still be in the proximal portion of the vein or antrum rather than in the atrium.

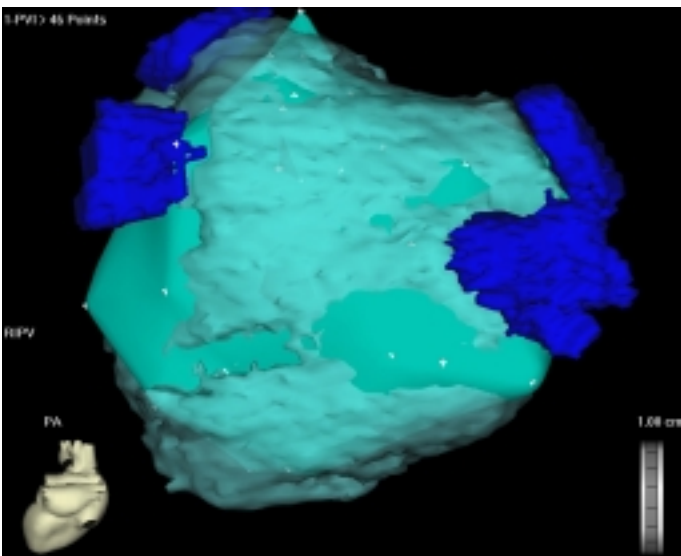
"The CARTOMERGE™ Module is logical and simple," Dr. Wilber concluded. "It allows us to visualize the heart more completely than we were doing before, imaging some areas that we might have overlooked in the past. It works very well."



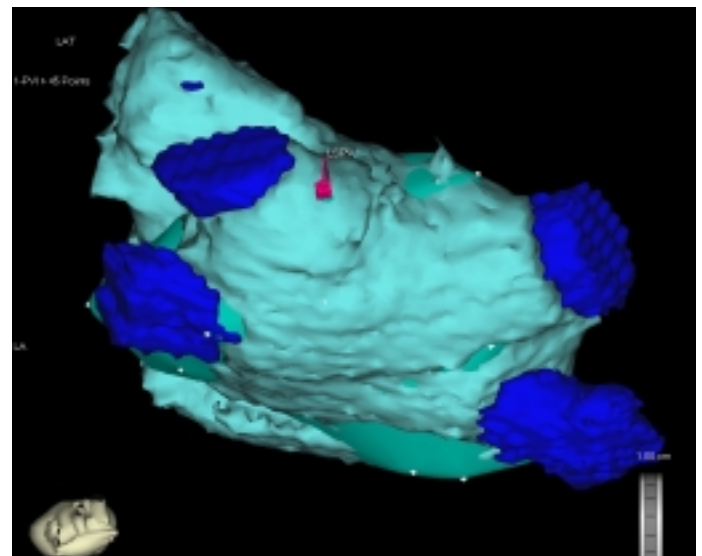
Posterior, comparative view of segmented CT scan and CARTO™ XP System map.



Posterior view of surface registered CT scan and CARTO™ XP System map.



Posterior view of surface registered CT scan and CARTO™ XP System map depicting the positions of the pulmonary veins.



Cranially tilted posterior view of surface registered CT scan and CARTO™ XP System map depicting the positions of the pulmonary veins and appendage.