Enhancement of intracardiac navigation by new GPS-guided location system (MediGuide Technologies)

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Introduction of the technology

The MediGuide-System consists of three components: a miniaturized single coil sensor assembled within an intracardiac device such as a conventional EP catheter; an electromagnetic field reference sensor attached to the patient’s chest; and a transmitter generating a 3-D electromagnetic field. The transmitter is mounted on the fluoroscopy detector of a conventional X-ray system aligning the fluoroscopy space with the 3-D magnetic sensor field. As a result, the sensor equipped EP catheter can be tracked real-time, non-fluoroscopically by the electromagnetic sensor field in pre-recorded fluoroscopy cine loops and visualized within the X-ray environment. Within this cineloops points/region of interest can be marked and visualized with landmark icons, which will be adapted to the 3-D-electromagnetic field. To adjust for cardiac cycle-dependent changes in catheter position the speed of the cine loop is matched to the real-time ECG signal. The magnetic field reference sensor allows the MediGuide-System to accurately display the intracardiac catheter position and to compensate for respiration and patient movement. In addition, all this information (e.g. position in the 3-D-electromagnetic sensor field) can be implemented in a 3-D-electroanatomic mapping system and contributes to geometry creation and can be used as a stable positional reference.

Implementation on ventricular tachycardia ablation procedures

Ablation of ventricular tachycardia is one of the most challenging ablation procedures in the field of cardiac electrophysiology. Procedures are often associated with significant procedure duration and significant radiation exposure for both, patient and physician. Stevenson and colleagues report for instance in a large multicenter series a median procedure duration of 315 min (254–395) with fluoroscopy time of 45 (30–71) min. By visualization of the EP-catheter within dynamic pre-recorded cine loops, the MediGuide-Technology can contribute to decreasing the fluoroscopy times. In addition, by acquisition of these cine-loops as a ventriculography,
specific finding for example aneurysms of the ventricle or location of the papillary muscles as a substrate for ventricular arrhythmia can be visualized and displayed continuously and used as background for catheter navigation and mapping (Figure 1).

The real-time non-fluoroscopy cineloops could be an auxiliary tool at the challenging scenario of epicardial VT ablation especially at patients with dilatative cardiomyopathy. In such circumstances the anatomical proximity of the coronary arteries to the origin of arrhythmia can be an obstacle for successful and safe ablation. Therefore, a peri-interventional coronary angiography is mandatory. Performance of this angiography as an underlying cine-loop for the MediGuide-System enables a continuous visualization of the coronaries during catheter movement and ablation energy delivery and can support the operator to avoid complications.

Activation mapping of tachycardia supported by 3-D electro anatomic mapping system allows significant information for successful treatment. However, current available 3-D electro anatomic mapping systems are partially restricted for cardiac cycle compensation and may lead to only limited accurate catheter visualization and map acquisition. By matching the cine loops and sensor movement to real-time ECG signal, the MediGuide-Systems allows a real-time tracing of the sensor equipped catheters.

As mentioned before, the transmitter of the 3-D electromagnetic field of the MediGuide-System is mounted on the fluoroscopy detector. This means that the field stability and accuracy is autarkical from patient movement. Furthermore, an electromagnetic field reference sensor attached on the chest detects respiratory movement of the patient and can employ this information for online adaptation of catheter visualization and image alignment. Implementation of all this information can facilitate the accuracy and stability of 3-D electro anatomic mapping systems.

Further developments of this GPS-guided location system may lead to safe and effective ablation procedures with no or minimum fluoroscopy even in such complex arrhythmias-like ventricular tachycardia.

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References