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Real Time Monitoring of Tip Electrode-Tissue Orientation and Contact Force: Optimizing Accuracy and Safety of Mapping and Ablation Procedures

Luigi Di Biase, Mauricio Arruda, Luciana Armaganijan, Moataz El Hallage, Dimpi Patel, Mohamed Kanj, Oussama M. Wazni, Thomas Dresing, Jennifer E. Cummings, Mandeep Bhargava, J. David Burkhardt, David O. Martin, Walid I. Saliba, Robert A. Schweikert, Andrea Natale
Department of Cardiovascular Medicine, Cleveland Clinic, Cleveland, OH, USA

Introduction: The accuracy and safety of mapping and ablation procedures depend on tip electrode contact which can be improved by applying force against the tissue. Force sensors have been incorporated to ablation catheters showing a linear correlation between tissue contact force and RF lesion size. We assessed real time monitoring of these parameters.

Methods and Results: An "in vivo" closed chest canine model was used to assess electrode tip-tissue contact and to correlate real time applied force with electrograms amplitude and RF lesion size. The system (Endosense) consists of 1) a customized 7Fr, 3.5mm open irrigation tip electrode incorporating optical sensors, 2) a workstation for continuous display of electrode tip-tissue interface force (axial and lateral) and tip orientation (variable degrees between perpendicular and parallel). A 3-D mapping system (NavX, St. Jude Medical) was used for atrial and ventricular geometry reconstruction. Continuous force feedback allows the operator to optimize force maintain adequate catheter tip-tissue interface contact. When blinded to the force display, the operator consistently applies higher forces in the ventricles (>30gr) compared to the atria (>20 gr). There were no significant atrial electrograms amplitude changes while applying 5-20 gr and no perforation occurred up to 50 gr in the atrium and 80 gr in the ventricle. Whereas a strong correlation between contact force and RF lesion size at smooth myocardium has been shown, this relationship was not confirmed at trabeculated ventricular sites where large lesions, associated with "pops" (80%) were created despite low force (5gr) at 45W (15 ml/min irrigation). A non-audible pop was detected by the force sensor and confirmed on gross and microscopic examination. Esophageal thermal injury occurred with 20gr pressure delivered at 35W for 30 secs to the LA directly opposite to an esophageal probe.

Conclusions: This novel technology allows real time force and tip orientation monitoring. The sensor feedback optimizes electrode tip contact and may favorably impact the accuracy and safety of mapping and ablation procedures using conventional catheter manipulation and more importantly for remote navigation systems.

ENDOSENSE
Chemin du Grand-Puits 42
1217 Meyrin, Switzerland

phone +41 22 306 19 60
fax +41 22 306 19 79
email: info@endosense.com

www.endosense.com