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Transeptal Epicardial Puncture Haptic System

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Background:
Transeptal and Epicardial Puncture (TEP) are necessary for ablation of cardiac arrhythmia, left atrial appendage occlusion, and valve repair. TEP can cause perforation, especially in inexperienced hands. Catheters do not reliably enable palpation of biophysical events. Tactile feedback is advantageous when auditory and visual channels are heavily loaded, providing faster reaction times than visual feedback and alerting operators to unexpected high priority events. Work by our group demonstrated that physicians were able to identify time of contact with and puncture of the septum using digitized pressure waveforms as input into a novel haptic system (HS), and react to palpation of tissue contact in less time than cardiac systole. We also demonstrated the HS enables real-time tactile appreciation of contact force amplitude during ablation in live swine.

Methods:
We hypothesized physicians (P) familiar with TEP, as well as, non physicians (NP) blinded to any visual feedback will be able to palpate sensations due to catheter manipulation (M) and transeptal puncture (TP), differentiate a single attempt TP from one that required M, and identify tactile signals indicative of entry into the pericardial space. We prospectively tested the HS by storing and processing real time pressure signals (data) acquired during 13 consecutive TPs performed for atrial fibrillation ablation and a successful attempt at epicardial access (EP) and input the data into the HS. The HS delivered a TP haptic response to 6 P and 4 NP and EP haptic response to 8 P holding a Haptic Handle. Subjects were asked if they could palpate tangible sensations due to signals generated by M and TEP, differentiate a single pass TP from one that required M, and palpate needle localization within the pericardial space during EP. Results during TP were compared between P and NP subgroups to assess if the HS is intuitive.

Results:
A total of 138 tests were performed. Tangible sensations of M and TP were palpated in 52 of 52 NP and 77 of 78 P tests (p = NS). All 10 subjects were able to differentiate a single attempt TP from one requiring M and all 8 subjects correctly identified time of access within the pericardial space.

Conclusion:
The HS provides P and NP subjects with a means to palpate and identify biophysical signals during M and TEP in the absence of visual cues and can be utilized as a tool to train inexperienced physicians. The HS may reduce complications associated with TEP. More work is required to evaluate the benefits of multi-sensory feedback inclusive of both visual and tactile feedback.