Zero-fluoroscopy transseptal puncture guided by right atrial high dense precision mapping: First in human experience

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Abstract

Zero-fluoroscopy procedures have recently become feasible in catheter ablations, and transseptal puncture (TSP) is the key step of this procedure. With use of the TSP method, zero-fluoroscopy method can be performed in three ways, with transesophageal echocardiography, intracardiac echocardiography or total 3-dimensional technique. However, each method has its own shortcomings. Here, we documented, for the first time to the best of our knowledge, that carried out zero-fluoroscopy TSP guided by right atrial high dense precision mapping using a PentaRay multipolar mapping catheter combined with ConfiDense intelligent high-precision mapping technology, which avoid the shortness of previous method.

Atrial fibrillation (AF) ablation requires access to the left atrium (LA) via transseptal puncture (TSP). Although zero-fluoroscopy procedures have received increased attention from electrophysiologists over the last decade, few studies have investigated the safety and efficacy of TSP using the zero-fluoroscopy technique. Here, we report a zero-fluoroscopy TSP guided by right atrial high dense precision mapping in a patient with AF using electroanatomical mapping system (EAM).
Case
A 65-year-old patient presented with AF. His 12-lead electrocardiogram showed fast atrial fibrillation. The echocardiogram documented a normal atrioventricular diameter and cardiac function. Atrial thrombosis was excluded with transesophageal echocardiography (TEE). After discussion with the patient, we decided to take radiofrequency ablation as the treatment method, and zero-fluoroscopy technique was performed during the whole procedure, including TSP.

Preparation
Right femoral venous accesses were obtained. A 6F and 8.5F introducer sheaths (NaviEase, Synaptic Medical, Peking) were inserted in the femoral vein separately. In order to perform TSP with the EAM as guidance, two clip-pin cables were used to connect the J-type guide-wire and TSP needle (AKS, Synaptic Medical, Peking) to the EAM system for navigation. One side of each connector was clipped onto the guide-wire (Figure 1A) or TSP needle (Figure 1B), while the other side was connected to the pin-box (Figure 1C). The tip of the guide-wire or TSP needle could thus be visualized on the EAM system as a bipolar electrode.

Mapping the Right Atrium and Fossa Ovalis
A multipolar catheter (PentaRay NAV, Biosense Webster, California) was inserted into the right atrium (RA) via the 8.5F introducer sheath, and was used to create the 3D shell of the RA, coronary sinus (CS), superior vena cava (SVC), inferior vena cava (IVC) and tricuspid valve (TA) by using the fast anatomical mapping module integrated in the EAM system (CARTO3 V7, Biosense Webster, California). Meanwhile, combined with confiDense electrical mapping module, the high dense precision voltage of RA was mapped. A decapolar catheter was subsequently inserted from the right femoral vein and placed in the coronary sinus via 6F introducer sheath. The point where the biggest HIS potential was recorded and used as a landmark. As fossa ovalis (FO) is the thinnest part of RA, the point of atrial voltage <0.5mv was tagged as the central FO. (Figure 2)

TSP procedure guided by EAM system
The multipolar catheter was advanced to SVC with the 8.5F sheath, then the catheter was withdrawn and exchanged to the J-type guide-wire and the dilator. As the extracardiac end of the guide-wire was connected to the EAM system, we were able to visualize the tip of guide-wire until it reached the SVC (Figure 3A). Subsequently, the guide-wire was exchanged to the TSP needle. Once the needle tip was advanced to the level just at or slightly (<2 mm) out of the dilator tip, it became visible in the EAM system (Figure 3B). Under the direction of the EAM system, the sheath-dilator-needle assembly was slowly pulled down until the jump sign is present, which indicated that the tip of TSP needle had slipped into the FO (Figure 3C). The position of TSP needle tip was adjusted to point to the FO central, then gentle forward pressure was applied to cross the FO (Figure 3D). As the TSP needle tip was visible in the 3D EAM system and its relative position to RA structures was displayed and tracked on the geometry, the entire TSP process was visualized on a real-time basis. Successful access to the LA was confirmed by the tactile feedback of breakthrough and the oxygenated blood drawn from the needle. The TSP process completed.

Discussion
Zero-fluoroscopy procedures have recently become feasible in catheter ablations due to the development of contact force-sensing catheters, EAM, TEE and intracardiac echocardiography (ICE). TSP is the key step of this procedure. With use of the TSP method, zero-fluoroscopy method can be performed in three ways, with TEE, ICE or total 3-dimensional technique (T3D). However, patients have to be sedated with the use of TEE, this increase the risk of hypotension, prolonged periods of weaning from mechanical ventilation, and postinterventional delirium. Secondly, the procedure is expensive because of the additional cost of anesthesia. In addition, TEE can cause damage to the esophageal mucous membrane, which aggravate esophageal lesions by ablation energy, increasing the incidence of atrial esophageal fistula and risk for life-threatening complications. Studies have also shown that TSP can be performed under the direction of ICE. However, ICE does not allow a panoramic view of the right atrium and continuous chasing of the needle.
tip throughout the entire TSP process. The information ICE provides is insufficient for operators, and use of ICE decreases the safety of associated procedures. Besides, ICE also increases the additional costs. Recently, we reported T3D technique guided TSP, which avoid the shortness of TEE and ICE. However, ablation catheter was used to create the 3D shell of the RA which spent a long time to map the FO by such point-by-point mapping. Moreover, the low-voltage for FO obtained may be inaccurate due to the tissue contact problem by ablation catheter. Here, we documented, for the first time to the best of our knowledge, that carried out zero-fluoroscopy TSP guided by right atrial high dense precision mapping. In our setting, a PentaRay multipolar fluoroscopy mapping catheter combined with ConfiDense intelligent high-precision mapping technology was used to create the 3D shell and voltage of RA, CS, SVC, IVC, TA, HIS potential and FO, which spent less time and was more accurate for anatomic and voltage mapping compared with the previous method. With this technique, we could have a 3D view of the entire RA and neighbor structures, while electrographic information helps in identifying the central FO and other landmarks. The left atrium “landing zone” on the other side of the FO can be estimated through the FO, HIS maker and CS boundary. The distance to advance the TSP needle after breaking through can be justified by real-time, continuous visualization of the TSP needle tip on the 3D image. All these can ensure the safety during puncture procedure. Whereas, future effort should focus the validation of electrographically mapping FO by ICE.

Reference:

Figure Legend

Figure 1
Connecting the guide-wire or the transseptal puncture needle to the electroanatomic mapping system. The connection between the (A) guidewire or (B) transseptal needle with the (C) pin-box.

Figure 2
3D shell of right atrium and electrographical FO. The blue and green labeled low voltage area in the white circle is the electrographical FO. The orange dots represents the HIS potential location. (A) LAO 45° projection; (B) LAO 135° projection.

FO: fossa ovalis; CS: coronary sinus; SVC: superior vena cava; IVC: inferior vena cava; TA: tricuspid annulus; LAO: left anterior oblique.

Figure 3
Transseptal puncture procedure guided by electroanatomical mapping system. (A) The tip of guide-wire (yellow circle) was placed into the SVC. The long sheath was placed into the SVC through the guidewire, which was then replaced with the transseptal needle. (B) The tip of the needle was inserted into the SVC (yellow circle). (C) The sheath-dilator-needle assembly was withdrawal slowly until the jump sign was present, which presented that the tip of the transseptal needle (yellow circle) had slipped into the FO. (D) The position of transseptal needle tip (yellow circle) was adjusted to point to the FO central, then gentle forward pressure was applied to cross the FO.

FO: fossa ovalis; SVC: superior vena cava.