Available online at www.sciencedirect.com

ScienceDirect

Journal of Electrocardiology 50 (2017) 358 – 367

JOURNAL OF
Electrocardiology

www.jecgonline.com

Wire- and needle potentials facilitating transseptal puncture

Konstantin M. Heinroth, MD,[a,*] Thomas Hartkopf, MD,[a] Alexander Plehn, MD,[a]
Joachim Wilhelm, MD,[a] Susanne Unverzagt, PhD,[b] Stefan Frantz, MD,[a]
Alexander Schirdewan, MD[c]

[a] *Martin-Luther-University Halle-Wittenberg, Department of Medicine III*
[b] *Martin-Luther-University Halle-Wittenberg, Institute of Medical Epidemiology, Biostatistics and Informatics*
[c] *Sana Klinikum Lichtenberg, Department of Medicine II, Berlin*

Abstract

Background: Transseptal puncture for left heart interventions became a routine procedure guided by fluoroscopy and echocardiography. The use of intracardiac potentials derived from the sheath-transseptal-needle/guidewire-combination may provide helpful information to increase safety of this procedure.

Methods and results: We recorded the intracardiac potentials from the sheath-transseptal-needle/guidewire-combination during the transseptal puncture procedure in 31 consecutive patients (mean age 67.2 ± 8.2 years; 21 in sinus rhythm, 10 in atrial fibrillation) designated for ablation of atrial fibrillation by the Cryo-balloon ® technique (Medtronic, Minnesota, USA). The EP-Navigator ® 3-D-image integration tool (Philips Healthcare, Hamburg, Germany) was used for visualization of the device position in relation to the cardiac structures.

Typical and reproducible potentials could be derived in all patients for the different device localizations at transseptal puncture procedure. Especially the transition from the muscular interatrial septum into the fossa ovalis could be easily depicted by the changes of both morphology and magnitude of the atrial signal (6.1 ± 2.3 mV in sinus rhythm [SR]/3.5 ± 0.9 mV in atrial fibrillation [AF] at the muscular interatrial septum and 0.5 ± 0.2 mV in SR/0.5 ± 0.1 mV in AF in the fossa ovalis).

Conclusions: The crucial steps of a transseptal procedure can be verified by typical changes (morphology and amplitude) of the intracardiac signals derived from the sheath-transseptal-needle/guidewire-combination in patients with sinus rhythm as well as in atrial fibrillation.

Keywords: Transseptal puncture; Far field potential; Unipolar intracardiac recording

---

Introduction

Transseptal catheterization has become a familiar technique to electrophysiologists and once again to invasive cardiologists because of an increasing volume of various left heart procedures.

Even if the transseptal puncture technique has been performed for decades, severe and potentially life-threatening complications can still occur, including cardiac tamponade and/or death, so that increasing the safety of this procedure is still an issue not only for electrophysiologists [1].

In the EP-lab, transseptal puncture is performed for catheter ablation of atrial fibrillation, left sided accessory pathways, left atrial and left ventricular tachycardias. Most procedures including the transseptal puncture itself are performed without echo-guidance relying on fluoroscopy alone [2]. Misdirected transseptal puncture leading to cardiac tamponade is one of the most common causes for life-threatening emergencies associated with ablation of atrial fibrillation, also in experienced high volume centers [3].

Echo guidance for transseptal puncture is frequently used for non-EP left sided procedures [4,5] as implantation of LAA-closure-Systems [6], transvenous mitral commissurotomy [7,8] and Mitraclip ® procedures [9,10].

As far as the transesophageal echocardiography (TEE) is not well tolerated in an awake patient for longer times and bears a substantial risk of aspiration when performed in supine position, intracardiac echocardiography (ICE) [11] seems to be the most sensitive and safe technique for verification of the optimal positioning of the system to conduct transseptal puncture in the region of interatrial septum (IAS) in comparison to transesophageal

---

* Corresponding author at: Department of Medicine III, Martin-Luther-University Halle-Wittenberg, Ernst-Grube-Straße 40, 06120 Halle, Germany.

E-mail addresses: konstantin.heinroth@uk-halle.de, kmheinroth@googlemail.com

http://dx.doi.org/10.1016/j.jelectrocard.2017.01.004
0022-0736/

echocardiography [12]. However, this technique is relatively expensive and requires special expertise [13], but can avoid complications of the procedure [14].

Integration of intraprocedural rotational X-ray angiography into real time fluoroscopy is a new alternative approach to guide transseptal puncture with increased safety [15]. Recently, the overlay of a segmented 3-D-anatomy onto fluoroscopy was presented for the guidance of transseptal procedures [16] — a technique comparable to the EP-Navigator ® technique (Philips, Hamburg, Germany) used in our EP-lab for several years in ablation procedures for atrial fibrillation by the Cryo-balloon ® technique.

In the present study the feasibility of the recording of intracardiac potentials derived from the tip of the sheath-transseptal-needle-combination and the sheath-guidewire-combination was evaluated with regard to changes of the magnitude and the morphology of these potentials at the different steps of transseptal puncture procedures. The recording of intracardiac signals derived from right atrial catheters [17,18] and guidewires [19] has been used by anesthesiologists for decades in central venous access procedures.

Furthermore we wanted to prove if these signals are specific at the different steps of transseptal puncture procedures in patients in sinus rhythm as well as in atrial fibrillation and thereby provide helpful information to guide this procedures.

Methods

The intracardiac potentials from the sheath-transseptal-needle-combination and the sheath-guidewire-combination during the transseptal puncture procedure for ablation of atrial fibrillation by the Cryo-balloon ® technique (Medtronic, Minnesota, USA) were investigated in 31 consecutive patients with paroxysmal or persistent atrial fibrillation scheduled for pulmonary vein isolation.

Before starting the transseptal puncture, a 5-F quadpolar catheter (Cournand-Curve) was positioned into the right ventricular apex and another steerable 6-F quadpolar catheter was advanced into the coronary sinus. A dedicated temperature probe has been introduced into the esophagus for temperature monitoring during the Cryo-ablation.

At the different steps of the transseptal puncture procedure we derived the unipolar endocardial signals from the superior caval vein, the right atrium, the muscular interatrial septum, the fossa ovalis, the left atrium, the left superior pulmonary vein and in some cases, when the guidewire was unintendedly advanced into the left atrial appendage also from this location.

The signals from the superior caval vein and the pulmonary vein or the left atrial appendage respectively were derived by direct tissue contact of a 0.032 inch guidewire isolated by the transseptal puncture sheath (Fast Cath ® SL0, 63 cm, St. Jude Medical, St. Paul, USA).

Whereas the distal tip of the guidewire was positioned in the structures mentioned above, the proximal end of the guidewire outside the body was connected to the CIM (catheter input module) of a GE Cardiolab CLAB II+ Amplifier ® (GE Healthcare, Chalfont St. Giles, UK) by a sterile alligator clamp (Alphacard ®, B. Braun Melsungen AG, Germany). The WCT (Wilson central terminal, calculated zero reference from the surface ECG) was used to get a unipolar signal. The sampling rate of the GE Cardiolab CLAB II+ Amplifier ® was set at 1 kHz with a band pass filter range from 0.5 to 100 Hz. The signal derived from the transseptal puncture equipment was displayed continuously in combination with selected intracardiac and surface ECG-recordings and designated as "wire potential" (WP).

After advancement of the 0.032 inch guidewire into the superior caval vein, the transseptal puncture sheath-dilator-complex (Fast Cath ® SL0, 63 cm, St. Jude Medical, St. Paul, USA) was carefully positioned over the wire into the superior caval vein, so that the tip of the guidewire was still outside the sheath, and the first unipolar ECG-recording was acquired. The magnitude of the far field signal at the superior caval vein is quite low as compared to the signals recorded at the different atrial positions so that a direct recording from the guidewire could produce a slightly better signal-to-noise ratio.

The guidewire was replaced by the transseptal needle (BRK-1 transseptal needle 71 cm ®, St. Jude Medical, St. Paul, USA). Care was taken that the needle including the introducer wire never walked out of the sheath.

The proximal part of the needle was then connected to the CIM of the GE Cardiolab Amplifier by an alligator clamp as described above, so that the signals were derived from the needle inside the transseptal puncture sheath. Of note, the tip of the needle was at least 1–2 cm inside the sheath without direct contact between the steel needle and the tissue. The sheath has been flashed with saline not only to avoid air embolism at transseptal puncture but also to serve as a conductor for recording of electrocardiograms from the sheath [20].

After rotation of the sheath-dilator-needle-complex in a 5–6 o'clock position, the device was slowly withdrawn during continuous fluoroscopy with a first drop or jump of the tip of the sheath when crossing from the superior caval vein into the right atrium, and a second drop or jump when passing from the muscular interatrial septum into the fossa ovalis. At this position a small amount of contrast medium was injected to create a "septum tattoo". The position of the sheath was checked in both fluoroscopic views (LAO and RAO) and the needle was carefully advanced to carry out the transseptal puncture. After crossing the fossa ovalis the needle was retrieved immediately into the sheath and the pressure of the left atrium was recorded. Then the needle was replaced by a stiff 0.032 inch guidewire, which was carefully advanced into the left superior pulmonary vein.

While performing the transseptal puncture, consecutive screenshots of the multi-panel display were stored at the different steps of the procedure. These screenshots documented simultaneously the biplane fluoroscopic images in LAO 50° without and in RAO 40° including the integrated 3-D-image of the left atrium and the aorta (Fig. 1). Additionally, the recording of the intracardiac electrocardiograms from the coronary sinus, the right ventricle, the electrogram derived from guidewire-sheath-combination or the transseptal-needle-sheath-combination respectively, some selected surface-ECG recordings, and finally the pressure recording from the tip of the transseptal puncture