Short Communication

The impulse origin of converted sinus rhythm in patients with chronic atrial fibrillation

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Chronic atrial fibrillation is the most common supraventricular arrhythmia and is associated with a variety of heart diseases. Direct current (DC) countershock has been an effective method for converting atrial fibrillation to sinus rhythm. This converted sinus rhythm has been assumed to originate in the histological sinoatrial node. However, there has been no proof that this assumption is correct. The purpose of this study is to determine the site of impulse origin of converted sinus rhythm in patients with chronic atrial fibrillation.

Two patients with chronic atrial fibrillation associated with mitral and/or aortic valve disease undergoing surgery were studied. Fentanyl citrate was used for the induction and maintenance of anesthesia, and median sternotomy followed by pericardiotomy was performed. Before instituting cardiopulmonary bypass, atrial fibrillation was converted to sinus rhythm with DC countershock at a strength of 10–20 joule. In order to obviate thromboembolic complications resulting from DC shock, the patients with left atrial thrombus were excluded from this study. After stabilization of converted sinus rhythm, atrial mapping was performed. Using a bipolar electrode (interelectrode distance: 2 mm), local atrial electrograms were recorded from 49 points on the right atrial epicardium (Fig. 1). Surface electrocardiogram leads I and aVF, and a bipolar reference electrogram from the right atrial appendage were simultaneously recorded with each local atrial electrogram. All bipolar electrograms from the right atrial epicardium were connected to differential amplifiers with a frequency response between 50 and 500 Hz. The local activation time was measured as max (dv/dt) in each bipolar atrial electrogram. The isochronous lines (activation map) of the right atrial epicardium were then drawn by hand.

Case 1. The patient was a 52-year-old male who had been diagnosed as aortic regurgitation (grade II) and mitral stenosis with regurgitation (grade II) due to rheumatic fever. The preoperative mitral valve pressure gradient was 8 mmHg. He developed atrial fibrillation 8 months before his elective surgery (aortic and mitral valve replacements). At the time of surgery, atrial fibrillation was converted to sinus rhythm by DC shock. The cycle length of converted sinus rhythm was 920 ms. Fig. 2A illustrates the activation maps of the right atrium during converted sinus rhythm in which a unifocal impulse origin was located in the lower posterior site of the sulcus terminalis. The site of the impulse origin was just inferior to the histological sinoatrial node. The activation spread radially from the site of the impulse origin and terminated in the right atrial appendage.
Case 2. The patient was a 54-year-old male who had been diagnosed as mitral regurgitation (grade IV) due to posterior leaflet prolapse. He developed atrial fibrillation 5 months before his elective surgery (mitral valve replacement). The cycle length of converted sinus rhythm during atrial mapping study was 570 ms. The maps shown in Fig. 2B demonstrate two impulse origins of converted sinus rhythm. A dominant impulse origin corresponded to the sinoatrial node, but the other impulse origin was located in the upper anterior site of the right atrium, just adjacent to the atrio-cavo junction. Therefore, multi centric impulse origins during converted sinus rhythm were demonstrated in this patient. In addition, functional block of activation sequence was found in the upper posterior site of the right atrium, parallel to the crista terminalis.

Since the introduction of DC countershock\textsuperscript{11} for the conversion of atrial fibrillation to sinus rhythm, the term “converted sinus rhythm” has been used to mean that the principal atrial
Fig. 2 Right atrial activation maps during converted sinus rhythm
(A): Maps in the patient I. The impulse origin is located in the lower posterior site of the right atrium. (B): Maps in the patient II. Two impulse origins are located in the anterior atrio-cavo junction and sinoatrial node.

Impulse originates in the histological sinoatrial node. All electrophysiologic interpretation has started with this basic assumption. However, recent studies have demonstrated that normal sinus control of the heart rate during sinus rhythm results from a complex interplay between the upper right atrium, including the sinoatrial node, and the sulcus terminalis\textsuperscript{2-4}. In the present study, the impulse origin of sinus rhythm did not correspond to the sinoatrial node in the first patient. Therefore, our study suggests that the impulse origin of converted sinus rhythm might not be limited to the sinoatrial node. In the second patient, although the dominant impulse origin corresponded to the sinoatrial node, the other impulse origin was found in the extra sinoatrial node lesion. Likewise, the study of Boineau et al.\textsuperscript{4} showed that a widely distributed atrial complex might have controlled the heart rate during converted sinus rhythm in the second patient. Since the extra sinoatrial node tissue contributes to the control of the heart rate during sinus rhythm, the use of the term “sinus rhythm” should be reconsidered.

Previous studies have demonstrated the detrimental hemodynamic effects and thromboembolic complications of chronic atrial fibrillation associated with acquired heart disease. If atrial fibrillation could be ablated at the time of valvular surgery, it would represent a major advance in the treatment of valvular heart disease. Recently, atrial isolation procedures have been experimentally developed to ablate atrial fibrillation; namely, left atrial isolation\textsuperscript{5}, right atrial isolation\textsuperscript{6} and biatrial isolation\textsuperscript{7}. These procedures isolate either the right or left atrium in which
atrial fibrillation arises, while maintaining sinus rhythm in the remainder of the heart. As a result, atrial fibrillation is confined in the isolated atrium and can not affect the restored sinus rhythm in the remainder of the heart. Knowledge of the location of the impulse origin of converted sinus rhythm is pertinent to the successful restoration of sinus rhythm following these procedures. The present study demonstrated that the impulse origin of converted sinus rhythm might not be limited to the sinoatrial node. Therefore, the upper right atrium, including the sinoatrial node and the sulcus terminalis should be preserved in the remainder of the heart at the time of surgery for the restoration of sinus rhythm in patients with chronic atrial fibrillation.

References


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