A Less Invasive Examination for Atrial Tachycardias After Surgery for Congenital Heart Disease

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The clinical results of corrective surgery for congenital heart disease have dramatically improved during the past quarter of a century. As a result, many children who have undergone cardiac surgery in their childhood have now grown up to adults. These patients often have morbidities related to the congenital disease and surgeries they received (adult congenital heart disease). Atrial tachyarrhythmias are the most common among the adult congenital heart diseases and frequently impair the quality of life (QOL) of the patients and even result in sudden cardiac death in patients with a rapid ventricular response or impaired ventricular function.1-2

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There are 2 common electro-physiopathologies associated with atrial tachyarrhythmias: atrial flutter; and incisional reentry. Atrial flutter is characterized as a cavotricuspid isthmus-dependent reentry. Surgical injuries or inflammation may cause scarring or fibrosis in the atrium around the tricuspid annulus and result in slow conduction, particularly at the isthmus between the inferior vena cava and tricuspid annulus. The slow conduction at the isthmus along with a dilated tricuspid annulus provides a perfect substrate for stable reentrant activations around the annulus.

The surgical incision and surrounding scar tissue may act as an obstacle and slow conduction at the isthmus between the incision and adjacent anatomical barriers, such as another atriotomy or cannulation site for the cardiopulmonary bypass, and creates conditions for an incisional reentry around the obstacle. The wave-front curvature and propagation around the edges of incisions also play another important role in maintaining the incisional reentry3-5. The activation pivots around the edge of an anatomical barrier during reentrant activation. The slow conduction at the isthmus or pivot point allows ample time for the refractory period of the atrial myocardium to recover, resulting in stable reentrant activations.

Both forms of atrial tachycardia are frequently medically refractory. Catheter ablation is indicated in order to free patients from symptomatic tachycardias and prevent heart failure and potential sudden cardiac death. Electro-anatomical mapping is usually used to differentiate atrial flutter and incisinal reentry at the time of catheter ablation. The mapping requires the tachycardia to be sustained for a certain period of time, which can impair the patient’s hemodynamics. More importantly, there has been no definitive method of examination to characterize the atrial tachycardias without inserting catheter electrodes.

Dr. Aiba and colleagues used body surface mapping (BSM) to differentiate these tachycardias before doing a catheter ablation6. They demonstrated that BSM combined with the signal-averaged ECG could characterize atrial reentrant tachycardias and differentiate between cavotricuspid isthmus dependent atrial flutter, incisional reentrant tachycardia and double-loop reentry. The determination of the type of atrial tachycardia before the catheter ablation would be beneficial for patients and helpful for physicians. The isopotential map obtained from the BSM can define the primary minimum potential. The activations in the slow conduction area are confined to a small amount of atrial myocardium (isthmus) and thus may not affect the potential distribution. The activation from the isthmus spreads out and activates a large amount of myocardium, making a primary minimum potential in the BSM.

Potential limitations of the isopotential map of the BSM include use with tachycardias with no significant slow conduction in the reentrant circuit and those with slow conduction also located in the area outside the reentrant circuit. Those would affect the definition of the type of tachycardia and it would be difficult to determine the reentrant circuit.

Since the BSM is a less invasive measurement, patients who have undergone a surgery for congenital heart disease in their childhood could be serially examined using BSM during sinus rhythm to examine whether, how and where the delayed conduction occurs in the atria. The data may be helpful for understanding the development of the substrate for atrial reentrant tachycardias after cardiac surgery and for developing a preventive procedure during cardiac surgery.

References