Chapter 15
Intracardiac Echocardiography: Procedural Steps and Clinical Application

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ABSTRACT
Intracardiac echocardiography (ICE) represents one of the major recent advancements in cardiovascular imaging that has directly widened the scope of structural heart disease intervention. It has replaced trans-esophageal echocardiography in many of the structural heart disease interventional procedures and hence, precluded the need for general anaesthetic and its associated clinical and logistic issues. Although ICE has been available for more than two decades, it is still not widely used, and many interventional cardiologists remain unfamiliar to this technology. It is the aim of this chapter to provide a comprehensive overview of the commercially available devices with specific reference to the AcuNav™ catheter (Biosense Webster, California, USA), the procedural steps, and clinical applications of this imaging technique.

INTRODUCTION
Over the last decade, advancements in imaging modalities have widened the scope of structural heart disease intervention. What was once performed predominantly for diagnostic work up for congenital heart disease is now done with a therapeutic purpose. This way non-coronary intervention is rapidly evolving to a sub-speciality of its own. Many of the percutaneous approaches require interventional cardiologists to understand various imaging modalities other than conventional fluoroscopy. Echocardiography gains particular importance as it gives intra-operative structural and functional assessment of cardiac structures in real time. One major advance that has revolutionized structural heart disease intervention is intracardiac echocardiography (ICE). In this...
chapter, the clinical use of the ICE with specific reference to AcuNav™ ICE catheter (Siemens, Mountain View, CA) will be discussed in detail.

BACKGROUND

Intra-cardiac echocardiography (ICE) refers to ultrasonographic imaging from within the cardiac chambers and the major blood vessels. ICE was first introduced in the early 1980s to visualize vascular lumen using mechanical higher frequency transducers (20–40 MHz). (Pandian, 1989) (Foster & Picard, 2001) With time advancements in catheter technology have made ICE catheters smaller, more maneuverable and thus more user friendly. The invasive cardiologist is often able to use simultaneous ICE and fluoroscopy guidance during the manipulation of devices or catheters inside confined cardiac chambers. Dependence on fluoroscopy and consequent exposure to X-rays for patients and laboratory personnel is thereby reduced.

The 3 commercially available ICE catheters at present are the AcuNav™ catheter (Biosense Webster, California, USA), the ViewFlex™ catheter (EP Medsystems, New Jersey, USA) and the Ultra ICE™ catheter (EP technologies, Boston Scientific, Boston, USA). The Ultra ICE™ catheter is a 8F sheath based catheter that houses a 9MHz beveled, single-element mechanical transducer which rotates at 1800 rpm. The distal 1 cm long sono-lucent sheath shields the mechanical transducer from direct contact with the endocardium. Providing a depth of field of approximately 5cm, the catheter acquires crosssectional images perpendicular to its long axis, ideal for 3 dimensional reconstruction. This catheter is used primarily for electrophysiological studies. The other 2 available catheter systems (AcuNav™ and ViewFlex™) have multiple electronically directed piezoelectric crystals with lower frequency ranges. They provide improved depth of imaging, deeper sonar penetration and better visualization of cardiac anatomy. (Packer et al., 2002)

MAIN FOCUS OF THE CHAPTER

Parts of the Equipment and Procedure

The AcuNav™ catheter incorporates 64-element vector phased-array transducer (5.5-10MHz) with full spectral, colour and tissue Doppler capabilities. (Bartel, Caspari, Mueller, & Erbel, 2002) The transducer scans in a longitudinal plane with respect to the catheter providing a 90° sector image. The AcuNav™ catheter is for single use and can be attached to a standard ultrasound machines using adaptors. The catheter is available at 10F and 8F sizes, which are introduced via 11F and 9F sheaths respectively. The depth of ultrasound tissue penetration is up to 12cm for the 10F catheter and 16cm for the 8F catheter. This allows effective visualization of left sided heart structures from the right heart chambers. As there are no guide wires, the catheters should be carefully manipulated under fluoroscopy using 2 proximal rings. (Figure 1) Bi-plane fluoroscopy complements maneuvering of ICE catheter through tortuous iliac vessels or in complex cardiac anatomy with the radio-opaque transducer at the catheter tip as guide. Once inside the vascular system, the distal catheter tip may be articulated to 4 directions (anterior, posterior, left and right) using 2 proximal rings for optimal imaging. (Figure 1) The handle also has a ‘locking knob’ allowing the tip of the catheter to be ‘locked’ in order to maintain a desired plane and to provide ‘hands-free’ imaging. With experience, the catheter can be advanced with tip deflectability without fluoroscopy within the RA, through the tricuspid valve or even through a patent foramen ovale into LA. Different imaging planes are described below for optimal imaging of various cardiac structures with ICE.

“Home View”: Tricuspid Valve

The ‘home view’ may be regarded as a good starting point for systematic ICE examination for the novice as this needs very little in way of catheter