GUEST EDITORIAL

Intracardiac Echocardiography Guiding Successful Ablation

Please see page 17 for the article by Szili-Torok et al. (doi:10.1053/euje.2002.0169) to which this article pertains.

Echocardiography is being utilized more frequently in interventional electrophysiologic procedures particularly since the introduction of lower frequency ultrasound transducer tipped catheters capable of intra-cardiac imaging. These tools are capable of not only providing detailed anatomic information during the procedure but also, with the recent availability of colour flow and spectral Doppler, haemodynamic information as well[1,2]. Coincident with these advances in ultrasound/catheter technology is an increased need for precise, expeditious and safe percutaneous interventional guidance and a better understanding of the relationship of cardiac anatomy and arrhythmogenesis.

Several practical uses for ICE have emerged in the setting of electrophysiology procedures, potentially enhancing procedural safety and success. These include guiding transeptal puncture[3,4], assessment of complex anatomic structures (and their variation from normal)[5], guidance of ablation lesion creation[6,7], and prompt assessment of procedural complications[8]. Also, by providing a means for non-fluoroscopic catheter navigation, ancillary ICE guidance may minimize radiation exposure[9].

The major determinants of successful radiofrequency ablation are (1) the accurate targeting of arrhythmogenic substrate and (2) good lesion formation. Traditionally, fluoroscopy and electrograms have guided ablation catheter positioning in relation to pertinent cardiovascular structures and arrhythmogenic substrate. However, targeting anatomical structures by fluoroscopy alone is challenging and may be limited. In contrast, ICE enables accurate placement of an ablation catheter at anatomic structures not seen fluoroscopically by continuous direct visualization of endocardial anatomy[10,11].

Regarding good ablation lesion formation, ICE can potentially facilitate this in three ways. First, it ensures optimal electrode-tissue contact by identifying electrode migration and also confirms proper electrode–endocardial surface orientation[6,7]. Second, presence of ‘bubbles’ during ablation guides energy delivery. Early investigations using ICE suggested that microcavitation or ‘bubble’ formation seen during ablation was a manifestation of poor electrode–tissue contact (antecedent to a rise in impedance) increasing the risk of coagulum formation[6]. More recently however, using newer ICE catheters, fine microbubble generation has been observed with good electrode contact and lesion formation[12]. These bubbles are distinct from the coarse, larger bubbles that are generated prior to an impending impedance rise with subsequent coagulum formation. Lastly, echocardiographic tissue changes during ablation, manifest as an increase in echogenicity, have been described. These changes have been used to confirm that an ablation lesion has been created despite apparently ‘low’ temperatures and to guide creation of linear ablation lesions without gaps — critical for successful arrhythmia control[13,14].

In this issue of the European Journal of Echocardiography, Szili-Torok and colleagues tackle aspects of these determinants of successful radiofrequency ablation. They describe their experience using a non-steerable ICE catheter to visualize intra-cardiac structures and ablation lesions in patients having already undergone RF atrial flutter ablation. They sought to determine whether a femoral vs subclavian vein entry and pullback approach resulted in better visualization of pertinent anatomical landmarks. The fossa ovalis, tricuspid valve and crista terminalis were always visible regardless of the route of ICE catheter insertion. However, rather than introducing the catheter from the femoral vein and imaging by withdrawing the catheter inferiorly, they found that a pullback from a superior, subclavian vein approach yielded better images of the cavo-tricuspid isthmus. The limitation of lack of steerability (using a less expensive, mechanical, rotating element, 9 MHz ICE catheter) was overcome by using an alternate-imaging route. Whether presence of interventional hardware will hamper visualization and whether this approach will in turn result in improved procedural outcomes were not tested.

Interestingly, they also observe that the ablation lesions, although apparently successful in terminating
atrial flutter, were not identifiable 20 min after lesion creation. Unfortunately, no baseline description of tissue or acute post-ablation changes (if any) was possible because ICE imaging was only performed 20 min after lesion creation. It is possible that immediate tissue changes were present and evolved or diminished with time. Certainly, from previous reports, it appears that ablation lesions are not always seen even immediately after energy delivery. In one study changes were identified in only 30% of lesions created[15]. Another limitation of this study was that assessment of tissue changes (or lack thereof) was subjective. However, tissue texture analysis itself has limitations resulting from numerous factors including variability in gain settings and imaging angle. Also, the capability of detecting changes may vary with varying imaging transducer frequencies. Thus, identification of tissue changes alone to confirm successful lesion creation may be unreliable. Fine bubble generation during energy delivery, endocardial thickening and altered strain-rate patterns in ablated tissue, rather than tissue texture changes per se, may be more reliable indicators of successful lesion creation. These findings warrant further investigation in controlled animal and human experiments.

In conclusion, ICE is a relatively new technology that is maturing as a clinical tool to guide electrophysiologic procedures. It is able to not only provide detailed real-time high-resolution images of cardiac structures and interventional hardware but also haemodynamic information, both of which are not afforded by fluoroscopy. The article by Szil-Torok provides additional insight into alternative imaging strategies using the mechanical ICE transducers. However, their findings regarding the lack of tissue changes following radiofrequency ablation mandate further careful study. A better understanding of the tissue changes with time and their interaction with ultrasound are needed. It is possible that by including the use of expanded imaging techniques, such as strain-rate imaging and tissue characterization, ICE imaging may more reliably detect ablation lesions so that we may most effectively apply this new technology in managing our patients.

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References