Chapter 1

Introduction to cardiac electrophysiology – a brief historical perspective
CHAPTER 1 Introduction

Within a few decades, clinical cardiac electrophysiology has evolved from an esoteric off-shoot, largely of theoretical interest to a few academic cardiologists, into one of the major sub-specialties of modern cardiology, threatening to eclipse coronary intervention in many tertiary centres in terms of workload and budgetary/resource allocation. The complexity, scope and technology of cardiac electrophysiology continue to change at a breathtaking pace and new trainees may benefit from a brief historical perspective on how the discipline has reached the current ‘state of the art’ and might evolve.

Early years

Following the first description of His bundle recording in the 1960s, invasive cardiac catheterization methods were rapidly adapted for routine intracardiac recording and programmed stimulation and the electrophysiological study (EPS) was born. Within a few years, these techniques had been used to unravel the mechanisms of all the common forms of supraventricular and ventricular tachycardia, and the key role of re-entry in arrhythmogenesis had been established. An early therapeutic application was surgical cure of Wolff-Parkinson-White Syndrome. During the 1970s arrhythmia surgery was extended to treat other forms of SVT refractory to medical therapy, as well as subsequently map-guided endocardial resection for VT. In addition, the insights gained from EPS provided the basis for anti-tachycardia pacing, which has been incorporated into the modern tiered-therapy ICD (it was also tried as a treatment for SVT).

The advent of catheter ablation

Despite these many important contributions, cardiac electrophysiology remained a marginal sub-specialty until the end of the 1980s – EPS was just required for the few patients undergoing surgery or receiving anti-tachycardia devices and only a small minority of tertiary centres considered it worth investing in the necessary medical expertise and facilities.

The situation was transformed by the emergence of catheter ablation. Closed chest ablation of the AV junction with standard diagnostic electrophysiology catheters and Lown defibrillators (under GA) was practised from the start of the decade but was very limited in its scope. The crucial advances were:

- Introduction of radiofrequency (RF) current as the standard power source for ablation, which was much safer and more controllable than DC shocks and obviated the need for GA in most cases.
- Commercial release of steerable ablation catheters to facilitate positioning within the heart.
- Development of detailed electrophysiological mapping techniques for identifying target sites, for example for ablation of accessory pathways.

By the early 1990s, catheter ablation of the common forms of SVT had become so straightforward and successful that arrhythmia surgery was largely supplanted; the threshold for referral of patients with this condition dropped, and almost all tertiary centres were prompted to develop their own cardiac electrophysiology services for the first time.
Era of consolidation

After an initial phase of rapid expansion, the 1990s were characterized by steady incremental progress in cardiac electrophysiology and ablation rather than further sea changes. Developments included:

- Extension of catheter ablation to common atrial flutter (cavo-tricuspid isthmus ablation) and scar-related VT.
- Replacement of traditional paper-based EPS recorders with modern digital, split-screen, multi-channel recorders offering superior performance.
- Greater customization of mapping and ablation catheters, support sheaths etc.
- Introduction of new power sources, especially saline-irrigated RF and cryoablation.

Emergence of catheter ablation for AF and VT

Although the surgical Cox-Maze procedures were developed and successfully used to treat AF by the early 1990s, palliative AV junction ablation and pacing remained the mainstay of non-surgical treatment until recently. Nevertheless, catheter ablation for AF, the commonest arrhythmia, has always been a holy grail for electrophysiologists and the emergence of effective techniques within the past decade prompted a second phase of exponential expansion in arrhythmia services. Some of the key advances have been:

- Identification of the major role of the pulmonary veins in arrhythmogenesis and development of techniques for PV isolation and wide area circumferential ablation, and more recently linear ablation.
- Development of 3-D electroanatomic mapping techniques, more recently with image integration modalities.
- Remote navigation systems.

Over the same timeframe, ablation therapy has become increasingly important for VT associated with structural heart disease, particularly due to the inexorable growth of ICD populations, a significant proportion of who develop intractable ventricular arrhythmias, often resulting in multiple shock therapies. Many of the developments in 3-D mapping and power sources described above have also facilitated VT ablation but two other crucial developments have been:

- The concept of VT substrate mapping and ablation.
- The use of the epicardial route for VT mapping and ablation.
Conclusions

Current techniques for ablation of AF and VT are reasonably effective but still cumbersome and there are likely to be further technological and methodological advances over the coming years to address these shortcomings. While awareness of newer developments is important, the priority for new trainees in cardiac electrophysiology is always to pick up (i) the basic principles underlying diagnostic EPS; (ii) how these techniques are applied to common presentations such as narrow complex tachycardia; (iii) a working knowledge of the electrophysiological features of the common cardiac arrhythmias; and (iv) the standard techniques for ablation of these arrhythmias. These four closely interlinked subjects constitute the major sections of this textbook.