PRACTICE REVIEWED

Electrophysiology in a district general hospital

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Abstract

Objective—To investigate the feasibility of performing electrophysiological studies at a district general hospital and to evaluate the importance of such studies in the management of patients with suspected arrhythmias.

Design—Retrospective study of patients having had electrophysiological studies during a three year period.

Setting—District general hospital.

Subjects—93 patients (50 men, 43 women, mean age 45.9 years) with suspected arrhythmias.

Results—The patients were divided into two groups according to symptoms. Group 1 (34 patients) presented with syncope. Group 2 (59 patients) presented with palpitation. All had previously undergone non-invasive investigations. All had had multiple hospital admissions and outpatient attendances. In group 1 nine patients with no documented arrhythmias had inducible ventricular tachycardia and three of six with suspected bradyarrhythmias had ventricular tachycardia. Fourteen patients had suspected ventricular arrhythmias before electrophysiological studies, which were confirmed in all, four receiving automatic implantable cardioverter defibrillators. Electrophysiological studies were used to guide drug treatment in all patients. Group 2 consisted of 32 patients with re-entrant supraventricular tachycardia and 15 with ventricular tachycardia; 12 had no documented arrhythmias. In those with supraventricular tachycardia, accessory pathways were identified in all. In 23 patients drug treatment (guided by electrophysiological studies) was successful. In nine, drug treatment guided by electrophysiological studies were ineffective and radiofrequency ablation was successful. In 15 patients with ventricular tachycardia and palpitations, 10 had their drugs changed after electrophysiological studies and their ventricular tachycardia was suppressed. In five patients electrophysiological studies showed that ventricular tachycardia was unsuppressed and they were referred for an operation or implantation of an automatic cardioverter defibrillator. In 12 patients with no documented arrhythmias electrophysiological studies identified significant

arrhythmias in six. There were no complications.

Conclusions—Diagnostic electrophysiological studies can safely and effectively be performed in a district general hospital. These studies are especially effective in investigating patients with syncope, and also provide a strategy for future arrhythmia management.

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Keywords: electrophysiology, district general hospital.

Clinical electrophysiology is important in the diagnosis of patients with arrhythmias, and vital in providing a management strategy for them. The success of radiofrequency ablation in patients with accessory pathways¹⁻³ and the identification of patients at high risk with ventricular arrhythmias^{4,5} increases the need for electrophysiological studies still further.

At present such studies are performed almost exclusively at regional centres. Their medical, technical, and laboratory resources will be increasingly taken by the time consuming therapeutic ablation procedures, thereby further extending waiting list times for those in need of routine diagnostic studies.

Our objectives were twofold. Firstly, to show that diagnostic electrophysiological studies can be performed safely and effectively at a district general hospital and, secondly, that such studies significantly modified and improved the future management of those patients. We hope that this will add weight to the thesis that electrophysiological studies are not a "last resort" in the management of patients with proved or suspected arrhythmias,^{6,7} but are, in fact, an important tool whose early use leads to considerable clinical and financial benefits.

Patients and methods

In total, 93 patients underwent electrophysiological studies at Maidstone District General Hospital during a three year period from May 1990 to April 1993. There were 50 men and 43 women aged 15 to 80 years (mean 45.9 years). Eighty patients were referred from Maidstone district and 13 from neighbouring districts for investigation of suspected or proved arrhythmias. Therefore in the three years of the study 80 patients had

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electrophysiological studies from Maidstone district (population 200 000)—that is, 120/10⁶ each year. Demographically, Maidstone district has an age distribution and an incidence of ischaemic heart disease comparable with the national average.

All patients had previously undergone non-invasive investigations, including 12 lead electrocardiography, echocardiography, Holter monitoring, and exercise testing. All patients had had two to five outpatient visits (mean 3.5 visits) and most had had previous emergency admissions (none to three; mean 0.92 admissions). Electrophysiological studies were undertaken for the following reasons: (a) in patients with symptoms of palpitation or syncope strongly suspected to be secondary to arrhythmia, which had not been proved non-invasively; (b) to optimise medical treatment in patients with arrhythmias previously refractory to empirical drug treatment; and (c) to clarify future arrhythmia management strategy and facilitate interventions (for example, radiofrequency ablation or automatic implantable cardioverter defibrillator implantation at a tertiary centre).

In group 1, 25 patients were subsequently documented to have underlying cardiac disease, 20 with ischaemic heart disease and five with congestive cardiomyopathy. In group 2, 19 patients had underlying heart disease, 16 with ischaemic heart disease and three with congestive cardiomyopathy. Underlying cardiac disease was found predominantly in the patients with known ventricular tachycardia (10 with ischaemic heart disease, three with congestive cardiomyopathy) and the group with atrial fibrillation (four with ischaemic heart disease).

METHODS

Most patients were studied as day cases. Those with ventricular tachyarrhythmias required a longer period of hospital admission. The patients were fasted, premedicated, and bipolar 6 French USCI leads were inserted via the right femoral vein after local anaesthesia with 1% lignocaine. Three leads were inserted and positioned initially at the high right atrium, bundle of His, and right ventricular apex. Leads were subsequently manipulated to other sites—for example, coronary sinus or right ventricular outflow or inflow as required during the studies. Signals were recorded on a six channel Picker KD 6000 machine with three simultaneous electrocardiogram leads and three simultaneous intracardiac signals displayed. Filtering was between 50 and 500 Hz. Intracardiac stimulation was performed using a Biotronik VH 10 electrophysiological stimulator.

To establish electropharmacological efficacy, intravenous antiarrhythmic drugs were administered according to a set protocol⁸ and repeat stimulation studies undertaken. The response to intravenous antiarrhythmic drugs was used to indicate long term drug treatment by mouth.

In patients with ventricular tachycardias the drugs tested were disopyramide, mexiletene,

sotalol (where left ventricular function allowed), and amiodarone. In those in whom the ventricular tachycardia was stable and well tolerated, the response was assessed by intravenous administration of the drug chosen during the tachycardia. No more than one drug was administered intravenously in each study. Where the arrhythmia was unstable or not well tolerated, and also for pre-discharge assessment, the effectiveness of the antiarrhythmic drug given by mouth was assessed when adequate plasma concentrations were achieved. In patients with syncope or known ventricular arrhythmias, all 12 electrocardiogram leads were attached during the electrophysiological studies. For all studies full facilities for cardiopulmonary resuscitation were available.

The studies were performed by a single cardiologist (PH) with previous electrophysiology training, or a cardiac registrar (AP) under supervision. An average of one to two electrophysiological studies were performed each week.

Patients requiring therapeutic intervention were referred to a regional centre with a full report and copies of the relevant results.

Results

Ninety three patients were studied (50 men, 43 women, mean age 45.9 years). The procedure times ranged from 45 to 90 minutes (mean 65 minutes) with a screening time of five to 15 minutes (mean 13 minutes). No complications were encountered. Follow up ranged from three to 36 months.

Outpatient follow up was undertaken at two, six, and 12 months after the electrophysiological studies. Patients with recurrent arrhythmias were reviewed more often, as necessary.

The results are considered in two sections on the basis of presenting symptoms.

GROUP 1: PATIENTS PRESENTING WITH SYNCOPE

There were 34 patients (mean age 49.8 years), 14 with no arrhythmias on non-invasive investigation, and six with bradycardias as the presumed aetiology for their syncope (two with bifascicular block on 12 lead electrocardiology and four with non-diagnostic episodes of sinus bradycardia on Holter monitoring). The remaining 14 patients in group 1 had presumed ventricular arrhythmias and evidence of sustained or non-sustained ventricular tachycardia on Holter monitoring, which was not associated with syncope, their presenting symptom.

Electrophysiological testing significantly influenced the diagnosis in those patients with syncope and no documented arrhythmia, and in those with presumed bradyarrhythmias. Nine of the 14 patients with no previously documented arrhythmias had sustained ventricular tachycardia induced and three of six patients with presumed bradycardia had in fact ventricular tachycardia as the basis of their syncope (figs 1 and 2). Table 1 summarises the results for group 1 patients.

Figure 1 Patient with right bundle branch block and inducible sustained monomorphic ventricular tachycardia on programmed stimulation. RA = Right atrial electrogram; HB = His bundle electrogram; and RVA = electrogram from right ventricular apex.

Figure 2 Same patient as in fig 1. Repeat programmed stimulation after six weeks of amiodarone treatment shows ventricular tachycardia can no longer be induced (abbreviations as in fig 1).

Table 1 Group 1: Patients with recurrent syncope

Pre-EPS	EPS	Outcome after EPS	Long term follow up and management
14 patients. No arrhythmia documented	VT (n = 9) Non-sustained VT (n = 1) Normal study (n = 4)	Guided drugs successful (n = 7) Guided drugs unsuccessful (n = 2) Abnormal EEG (n = 2)	Well. No hospital admissions AICD, alive Well. Receiving anticonvulsant drugs
Six patients presumed bradycardia	VT (n = 3) Confirmed SSS (n = 3)	Guided drugs successful Atrial pacemakers	Well. Receiving drugs Well
14 patients presumed VT	Inducible VF (n = 2) Inducible VT (n = 12)	AICD Guided drugs successful (n = 9) VT inducible despite drugs (n = 3)	Alive and well Alive and well Alive with AICD

EPS = Electrophysiological studies; VT = ventricular tachycardia; AICD = automatic implantable cardioverter defibrillators; EEG = electroencephalogram; SSS = sick sinus syndrome; and VF = ventricular fibrillation.

Figure 3 Patient with Wolff-Parkinson-White syndrome with re-entrant supraventricular tachycardia. The earliest retrograde atrial activation is seen in the electrogram recorded from the distal coronary sinus. Dcs = Electrogram recorded from the distal coronary sinus. a, atrial electrogram; b, His bundle electrogram; v, ventricular electrogram. Other abbreviations as in fig 1.

GROUP 2: PATIENTS PRESENTING WITH PALPITATIONS

There were 59 patients presenting with palpitations; 32 patients had narrow complex re-entrant supraventricular tachycardias documented on Holter monitoring and 15 patients with palpitations had non-sustained ventricular tachycardia diagnosed on Holter monitoring (their arrhythmia on Holter monitoring did not coincide with their symptoms). All had previously been treated empirically and unsuccessfully and required multiple hospital admissions. Twelve patients with a history of palpitations were investigated with no documented arrhythmias on non-invasive investigation.

Electrophysiological study allowed pharma-

cological investigation of antiarrhythmic treatment and (in those with re-entrant supraventricular tachycardia, documented the anatomical substrate for the arrhythmia (fig 3). Table 2 summarises the results of electrophysiological study in group 2 patients.

Intravenous antiarrhythmic drugs apparently successful at the time of electrophysiological studies were not necessarily successful long term when given by mouth. This was either because of patient intolerance or because of breakthrough arrhythmias. These patients were subsequently referred to the tertiary centre for the appropriate intervention already identified as the next option in the management strategy at the time of electrophysiological study.

Table 2 Group 2: Patients presenting with palpitations

Pre-EPS	EPS	Outcome after EPS	Long term follow up and management
32 patients. Known re-entrant SVT	13 DAVNP 19 accessory AV pathway	Guided drugs successful (n = 8) Guided drugs not successful (n = 5) Guided drugs successful (n = 15) Guided drugs ineffective (n = 4)	Remain well on drugs RF ablation Well. Receiving drugs (n = 13) RF ablation (n = 2) RF ablation
15 patients. Non-sustained VT on Holter monitoring	Monomorphic VT	VT non-inducible after guided treatment (n = 10) VT inducible despite drugs (n = 5)	All alive AICD (n = 1) VT RF ablation (n = 1) Well receiving same drugs (n = 1) CABG (n = 1) Died awaiting AICD (n = 1)
12 patients. No arrhythmias documented	Normal study (n = 6) AF (n = 2) Re-entrant SVT (n = 3) AF and VT	Reassured Drugs Drugs Drugs	Well

EPS = Electrophysiological studies; DAVNP = Dual atrial ventricular (AV) nodal pathway; CABG = coronary artery bypass grafting; RF = Radiofrequency ablation; AICD = automatic implantable cardioverter defibrillators; AF = atrial fibrillation; VT = ventricular tachycardia; and SVT = supraventricular tachycardia.

In those 12 patients with palpitations and no arrhythmias documented, atrial fibrillation was induced in two, re-entrant supraventricular tachycardias in three, and sustained ventricular tachycardia and atrial fibrillation in a fourth patient. The remaining six patients with no arrhythmias on electrophysiological studies were reassured, and to date have not required further hospital admission.

Discussion

We have shown that diagnostic clinical electrophysiological investigations can be safely and effectively performed at a district general hospital.

In our 93 patients there were no complications. This compares extremely well with the 0.7% reported in other larger studies.^{9,10} The diagnostic ability of the study compares well with those undertaken in larger centres and previously reported. In the group of patients with recurrent syncope, 57% had abnormal electrophysiological results. This is similar to the results collated from several studies from larger centres where abnormal electrophysiological results were seen in 55% of patients with syncope; the most common abnormality observed was ventricular tachycardia.¹¹ Ventricular tachycardia has also been shown as the most often provoked abnormality in patients with syncope and bundle branch block.¹² Fifty per cent of our patients with suspected bradyarrhythmia had inducible ventricular tachycardia.

Our results confirm that electrophysiological testing in patients with syncope or in patients with presumed bradycardias provides a high yield of previously unsuspected ventricular tachyarrhythmias. This is particularly so in patients with underlying heart disease, as in our study population.

Drug treatment chosen as a result of the electrophysiological study resulted in significantly better control of the patient's arrhythmias. Where further intervention was required, the results were utilised by the regional centre for radiofrequency ablation, or implantation of automatic implantable cardioverter defibrillators where appropriate. Full diagnostic studies were not repeated at the regional centre. Regional centre acceptance of electrophysiological studies performed at a district general hospital would depend on the links between the two hospitals and also on the quality of the studies. Electrophysiological testing at our centre was performed by a cardiologist trained in electrophysiology or by a registrar in training, under the supervision of the consultant cardiologist. Widespread devolution of electrophysiology studies from regional centres to district general hospitals would be restricted if no staff with adequate experience and training was available. The "boundaries" between district hospital and regional centre cardiologists are becoming increasingly blurred, however. Many cardiologists have appointments at district and tertiary centres and are able to bring

invasive training and expertise to their district general hospital practice.

Electrophysiological studies are now arguably essential in patients with recurrent arrhythmias because of the significant increase in treatment options available to such patients. In our view all junior doctors wishing to achieve consultant cardiologist status should receive some formal training in arrhythmia management and electrophysiological studies in addition to conventional training in ischaemic heart disease intervention. Our work confirms that satisfactory information can be obtained from electrophysiological studies using relatively less sophisticated equipment than that encountered in tertiary centres. With three simultaneous intracardiac recordings and using bipolar catheter electrodes, adequate anatomical mapping was performed by repositioning the catheter electrodes.

Based on the Maidstone district population (200 000), we have shown that about 120 studies per million population may be required each year. With the greater success of therapeutic electrophysiology—that is, radiofrequency ablation—the need for diagnostic electrophysiology will probably increase.

In addition to the obvious clinical benefits of performing electrophysiological studies at a district general hospital, there could also be a financial benefit. The cost/benefit ratio of electrophysiologically guided drug treatment compared with an empirical approach has been shown to be 10:1 for patients with recurrent supraventricular arrhythmias and 18:1 for patients with recurrent ventricular arrhythmias.^{13,14} An emergency admission in our hospital costs £300 for each 24 hours, compared with a day case electrophysiological procedure at £250. Before electrophysiological studies the mean number of inpatient admissions in this group of patients was 0.92. After electrophysiological study in a follow up period ranging from three months to three years, the number of emergency admissions was 0.46 for each patient.

These results confirm that electrophysiological studies should be undertaken early in the investigation of patients with syncope or palpitations, and that they can safely and successfully be performed at a district general hospital with adequately trained staff. This would reduce the pressure on electrophysiological laboratories in regional centres and free them to perform the more time consuming therapeutic interventions such as radiofrequency ablation.

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