Cryoablation of the accessory pathway in Wolff-Parkinson-White syndrome: initial results and long term follow up

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SUMMARY Cryoablation of the accessory pathway was used in the management of 20 patients with pre-excitation syndromes. All patients had presented with paroxysmal atrioventricular reentrant tachycardia; in addition, six had experienced atrial fibrillation. In 16 patients pre-excitation was overt and in four the accessory pathway was concealed. Intraoperative epicardial and endocardial mapping showed 10 left free wall pathways, seven septal pathways, and four right free wall pathways. One patient had two right free wall accessory pathways. There was one postoperative death (from a ruptured cerebral haemangioma) and one patient had transient hemiparesis. There was early recurrence of arrhythmia or pre-excitation in six patients and five of these were among the first ten in the series. Four of the six underwent successful reoperation; 17 patients remain symptom free of all antiarrhythmic treatment. Two patients did not undergo reoperation—one became symptom free on drugs that had previously been ineffective and the other received an antitachycardia pacemaker. The mean period of follow up was six years.

Accessory pathway function was not restored and atrioventricular nodal function was preserved in all patients, demonstrating the feasibility of this technique in the long term management of patients with the pre-excitation syndrome.

Since surgical operation in patients with Wolff-Parkinson-White syndrome was first attempted in 1967¹ and described definitively in 1968² various techniques of dissection or cryoablation have been used to ablate the accessory pathway.^{3,4} Ablation by endocardial dissection must be performed under induced cardiac arrest in the open heart. Cryosurgery may obviate the need for extensive endocardial dissection⁴ and may, combined with dissection, be applied to the epicardium without necessarily opening the heart.^{5,6}

We have used cryosurgery as the primary mode of ablation of accessory atrioventricular pathways since 1977 and report our long term follow up as well as the immediate results.

Patients and methods

Between 1977 and 1985 238 patients undergoing electrophysiological study were shown to have accessory atrioventricular pathways. Of these, 186 were successfully treated medically, 13 had anti-tachycardia pacemakers implanted, and 19 required no treatment. Twenty patients (11 female, 9 male), aged 21—58 (mean 39) years had an operation (table). All had presented with paroxysmal orthodromic atrioventricular reentrant tachycardia. Six had also experienced paroxysmal atrial fibrillation with anterograde conduction across the accessory pathway and three of them had been resuscitated from ventricular fibrillation. In 16 pre-excitation was overt whereas in four it was concealed. Sustained orthodromic atrioventricular reentry tachycardia was inducible in all patients; one also had antidromic tachycardia. The indications for operation were failure of medical management in 13 patients with paroxysmal reentrant atrioventricular tachycardia, refusal of medical treatment in another, and atrial

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Table Accessory pathway location and outcome in patients undergoing surgical cryoablation

Patient	Age at operation	Sex	Pathway location	Arrhythmia recurrence	Reoperation	Clinical outcome	Follow up (years)
1	27	F	Right free wall (2)	—	—	1	10.2
2	46	M	Left posteroseptal	—	—	1	10.1
3	21	F	Right posteroseptal	+	+	1	9.5
4	36	M	Right posteroseptal	—	—	1	9.2
5	47	F	Left free wall	—	—	1	8.8
6	40	F	Left free wall	+	—	3	8.7
7	58	F	Left posteroseptal	+	—	2	8.6
8	48	F	Left free wall	+	+	1	8.5
9	49	F	Left free wall	—	—	—	*
10	40	F	Left free wall	+	+	1	6.2
11	49	M	Right posteroseptal	—	—	1	6.1
12	36	M	Left free wall	—	—	1	5.9
13	41	M	Left posteroseptal	—	—	1	4.6
14	41	M	Right free wall	—	—	1	3.9
15	30	M	Left free wall	—	—	1	2.8
16	33	F	Left free wall	+	+	1	2.7
17	42	M	Left free wall	—	—	1	2.3
18	21	F	Right posteroseptal	—	—	1	1.1
19	38	M	Right free wall	—	—	1	1.1
20	29	F	Left free wall	—	—	1	1.0

Clinical response: 1, asymptomatic; 2, asymptomatic on previously ineffective medication; 3, no improvement.

*Died suddenly 24 hours after operation from rupture of a cerebral haemangioma.

fibrillation with rapid ventricular response in six. The 13 patients with atrioventricular tachycardia had received atrioventricular nodal blocking drugs as well as class I agents; the six patients with atrial fibrillation had also received class I agents and five had been given amiodarone, without success.

ELECTROPHYSIOLOGICAL STUDY

Electrophysiological study was carried out before and after surgery in all patients.⁷ Intraoperative electrophysiological mapping was carried out with atrial and ventricular reference electrodes and a hand held exploring electrode.⁸ Detailed and precise atrial and ventricular mapping was performed to determine the pathway location.⁵ Electrophysiological study was repeated 6–10 days after operation.

SURGICAL TECHNIQUE

Cardiopulmonary bypass was started in the standard manner. All applications of the cryoprobe were made during continuous coronary perfusion without aortic cross clamping. Transient suppression of pre-excitation during temporary cryothermia was used to confirm the pathway location⁴ (figs 1 and 2). Cryoablation was first performed epicardially at the site of earliest atrial and/or ventricular activation in the atrioventricular groove⁴ for a maximum of five minutes. If this epicardial approach was unsuccessful the accessory pathway was located by endocardial mapping and the cryoprobe was applied. Right sided pathways were approached by a right atriotomy and those on the left side by opening the atrial septum through a right atriotomy. During this procedure

temporary ventricular fibrillation was induced to prevent air embolism; when the mitral valve was made regurgitant and an aortic vent incision made the heart was defibrillated and endocardial mapping and ablation performed. A similar procedure, in reverse order, was undertaken during closure of the heart.

In patients 1–8 single discrete cryolesions were used until accessory pathway conduction was abolished. From patient 9 onwards at least three contiguous lesions were made even if accessory pathway conduction was abolished by the first.

Septal cryolesions were delivered while atrioventricular conduction was monitored, and cooling was stopped immediately atrioventricular block occurred.

Results

ELECTROPHYSIOLOGICAL MAPPING

Intraoperative mapping confirmed the presence of an accessory atrioventricular connection in each patient and in one patient two right free wall pathways were found.

SURGICAL RESULTS

Two of the 10 left free wall pathways were ablated epicardially; one required additional dissection through the epicardial fat pad in the atrioventricular groove. In seven of the remaining eight, accessory pathway conduction was abolished by endocardial cryoablation. In the eighth, permanent interruption of the accessory pathway could not be achieved at the

Fig 1 During continuous atrial pacing (top) application of the cryoprobe to the site of the accessory pathway resulted in the disappearance of pre-excitation and conduction from atria to ventricles occurred across the atrioventricular node, with type 1 second degree block.

Fig 2 Removal of the cryoprobe and rewarming of the site of pre-excitation was followed by restoration of 1:1 atrioventricular conduction across the accessory pathway.

first operation despite both epicardial and endocardial freezing. At reoperation epicardial dissection and cryoablation did not succeed but repeat endocardial freezing was effective. Of the four right free wall pathways, one was successfully ablated by the epicardial approach and the remainder were ablated endocardially. All seven posteroseptal pathways required endocardial cryoablation. In those with right free wall and posteroseptal accessory pathways, pre-excitation was absent at the end of the operation.

POSTOPERATIVE ACCESSORY PATHWAY FUNCTION

In five patients accessory pathway conduction was present either at the end of the operation (two cases) or recurred within 24 hours. Of the five, arrhythmia recurred early in three and prompt reoperation was successful in all. In the fourth, accessory pathway behaviour was unchanged after the operation although spontaneous arrhythmia did not recur until three months later; reoperation then was successful. In the fifth, electrophysiological testing showed impaired anterograde accessory pathway conduction and reoperation was not performed. Reentrant

tachycardia recurred after three months and has been controlled successfully with an implanted anti-tachycardia pacemaker.

POSTOPERATIVE COMPLICATIONS

One patient died 24 hours after operation. A ruptured cerebral haemangioma was found at necropsy. In another patient there was transient hemiparesis. In a third who had a septal accessory pathway there was transient complete atrioventricular nodal block which resolved within 10 days and has not recurred.

Long term follow up has ranged from 1 to 10 years (mean 6). Tachycardia recurred in a further patient after three months: postoperative electrophysiological study had shown normal anterograde conduction and apparent abolition of the concealed accessory atrioventricular pathway. This patient remains free of arrhythmias on medications that had previously been unsuccessful.

Discussion

In the Wolff-Parkinson-White syndrome, arrhythmia may be troublesome and is sometimes life threatening.⁹ Not all patients respond to medications

and their long term use, even when successful, may be associated with adverse effects. More specifically, in patients with this syndrome a short anterograde effective refractory period of the accessory pathway is associated with a rapid ventricular response to atrial fibrillation which may induce ventricular fibrillation.¹⁰

Surgical operation may offer definitive cure of the pre-excitation syndrome, abolish the incidence of atrial fibrillation,¹¹ and obviate the need for medication. The first definitive surgical interruption of an accessory pathway used atrioventricular disconnection.² This was superseded by the use of cryosurgery⁴ which has undergone considerable modification.^{5,6} Other techniques, notably endocardial dissection with or without cryoablation, are also successful^{3,12} and surgical operation is now used extensively.^{13,14} The well substantiated success rate of the endocardial approach will also determine the method chosen by individual institutions.³

Advantages of the cryosurgical technique include the production of a well demarcated area of damage¹⁵ and the ability to interrupt conduction transiently before permanent ablation is performed (figs 1 and 2). Although an open heart procedure with cardiopulmonary bypass may sometimes be avoided¹⁶ this will not be possible if other procedures, such as valve surgery, are required at the same time.

Septal accessory pathways may present difficulties because of the proximity of the specialised conduction system and, in the case of cryosurgery, the increased thickness of the atrioventricular tissue in this region. In this series, however, cryosurgery, in some cases from both sides of the septum, effectively ablated all seven septal pathways.

In a recent study which included a general review, delta waves recurred in approximately 12% of 388 patients, many of whom had required reoperation.¹³ Antiarrhythmic treatment which had been unsuccessful before operation was often successful thereafter. In six of our patients pre-excitation recurred. In five this was early, within 24 hours of operation; in four reoperation was carried out and was successful. In the fifth patient the presence of excessive adipose tissue on the epicardial and endocardial aspects of the atrioventricular groove made accurate localisation uncertain and effective cryoablation impossible. Limited endocardial dissection was also unsuccessful and reoperation was not advised. The sixth patient had recurrence of arrhythmia after three months despite apparently successful pathway ablation as judged at electrophysiological reinvestigation 10 days after the operation.

This relatively high frequency of recurrence probably reflects early experience with this technique. Intraoperative mapping showed the pattern of

pre-excitation and its participation in arrhythmia to be the same as that during the first operation, suggesting temporary damage to the accessory pathway rather than the presence of widely separated multiple bypass tracts.¹⁷ After the recurrence of arrhythmia in patient 8, in whom a single cryolesion was used at the first operation, at least three adjacent cryolesions were used.

The length of follow up after surgery in these patients confirms the usefulness of this technique in the long term management of the pre-excitation syndrome. Most patients are well, require no treatment, and lead normal lives. Technical improvements have led to better immediate results in the later patients, but should pre-excitation recur early it can be controlled by reoperation with good expectation of the maintenance of normal atrioventricular conduction and abolition of the presenting arrhythmia.

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