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Long-term results of the corridor operation for atrial fibrillation

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Abstract

***Objective*—To investigate the long-term results of the corridor operation in the treatment of symptomatic atrial fibrillation refractory to drug treatment.**

***Background*—The corridor operation is designed to isolate from the left and right atrium a conduit of atrial tissue connecting the sinus node area with the atrioventricular node region in order to preserve physiological ventricular drive. The excluded atria can fibrillate without affecting the ventricular rhythm. This surgical method offers an alternative treatment when atrial fibrillation becomes refractory to drug treatment.**

***Patients*—From 1987 to 1993, 36 patients with drug refractory symptomatic paroxysmal atrial fibrillation underwent surgery. The in hospital rhythm was followed thereafter by continuous rhythm monitoring and with epicardial electrograms. After discharge Holter recording and stress testing were regularly carried out to evaluate the sinus node function and to detect arrhythmias; whereas Doppler echocardiography was used to measure atrial contraction and size.**

***Main outcome measures*—Maintained absence of atrial fibrillation without drug treatment after operation; preservation of normal chronotropic response in the sinus node.**

***Results*—The corridor procedure was successful in 31 (86%) of the 36 patients. After a mean (SD) follow up of 41 (16) months 25 (69%) of the 36 patients were free of arrhythmias without taking drugs (mean (SE) actuarial freedom at four years 72 (9)%)). Paroxysmal atrial fibrillation recurred in three patients; paroxysmal atrial flutter (two patients) and atrial tachycardia (one patient) developed in the corridor in three others. Among the 31 patients in whom the operation was successful sinus node function at rest and during exercise remained undisturbed in 26 and 25 patients respectively (mean (SE) actuarial freedom of sinus node dysfunction at four years (81(7)%)). Pacemakers were needed in five (16%) of the 31 patients for insufficient sinus node rhythm at rest only. Doppler echocardiography showed maintenance of right atrial contribution to right ventricle filling in 26 of the 31 patients after operation in contrast to the left atrium, which never showed such contribution. His bundle ablation was performed and a pacemaker implanted in the five patients in whom the corridor operation was unsuccessful.**

***Conclusion*—These results substantiate the idea of this surgical procedure. Modification of the technique is, however, needed to achieve a reliable isolation between left atrium and corridor, which would make this experimental surgery widely applicable in the treatment of drug refractory atrial fibrillation.**

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Chronic or paroxysmal atrial fibrillation without structural heart disease[1] or pre-excitation syndrome[2] does not affect life expectancy but may strongly alter exercise capacity and the quality of life. This arrhythmia is common, particularly in older people, and its cause is often unknown ("lone atrial fibrillation"). Two electrophysiological interventions are currently available to treat atrial fibrillation that is disabling and refractory to drug treatment: His bundle ablation followed by long-term cardiac pacing,[3 4] and the surgical exclusion of the anatomical substrate of atrial fibrillation.[5–9]

We studied the results of cardiac surgery with the corridor procedure.[5 9] Firstly, the area of sinoatrial and atrioventricular node is insulated to preserve physiological electrical activation of the ventricles. Secondly, the excluded left atrium and a remnant of the right atrium are electrically isolated from an anatomical conduit containing the sinus node-atrioventricular node axis (the corridor). Thirdly, to prevent the development of atrial fibrillation in the corridor the anatomical dimensions of the corridor are surgically reduced below a critical surface area. Thus the size of the corridor does not allow a sufficient number of wavelets of atrial fibrillation to occur, and hence the arrhythmogenic conditions for atrial fibrillation as formulated by Moe[10] and Allessie *et al*[11] cannot be fulfilled.

Short-term results of the corridor procedure have already shown the feasibility of the surgical concept,[5 9] but refinement of the technique, in particular the electrical isolation of the corridor in the area of the coronary sinus,[9] is needed while patient selection has to be further explored. We evaluated the long-term efficacy of the corridor operation with respect to treatment of atrial fibrillation, function of the sinus node, and the haemodynamic capacity of the corridor.

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Table 1 Baseline characteristics of 36 patients having corridor operation. Values are means (SD) or numbers of patients*

Characteristic	
No of men/women	25/11
Age at surgery (years)	55 (11)
No of years of paroxysmal atrial fibrillation	7 (5)
No of preoperative antiarrhythmic drugs	4 (1)
No taking preoperative amiodarone	33
Follow up time (months)	41 (16)
No of patient years after surgery	102

*No patient had organic heart disease or was lost to follow up or died.

Patients and methods

PATIENT SELECTION

From 1987 to 1993, 36 patients with paroxysmal lone atrial fibrillation underwent corridor surgery in St Antonius Hospital. Presence of the sick sinus syndrome or supraventricular or ventricular arrhythmias other than paroxysmal atrial fibrillation was an exclusion criterion for surgery. Only patients without documented structural heart disease and with normal atrial size, as shown by echocardiography and invasive studies, were accepted. Patients had had paroxysmal atrial fibrillation for at least one year before surgery (table 1). The arrhythmia caused disabling symptoms such as dizziness, loss of exercise capacity, and extreme fatigue during attacks, temporarily forcing most patients to stop working. Between the attacks of arrhythmia all patients experienced a normal lifestyle and physical capacity. Table 1 shows the baseline characteristics of 36 patients who were operated on. In all patients consent for surgery was obtained after full information about the investigational character of this surgical intervention.

ARRHYTHMIA STUDIES BEFORE OPERATION

Standard electrocardiography, 24 hour Holter recordings (two channels), and bicycle stress testing were used to document paroxysmal atrial fibrillation and to exclude sinus node disease, abnormal atrioventricular conduction, and accessory atrioventricular nodal pathways. All invasive studies were carried out after antiarrhythmic drugs had been withdrawn for a minimum time of at least 2·5 half lives. In all cases amiodarone was withdrawn at least four months before programmed electrical stimulation and surgery. Sinus node function was considered to be normal when its rate varied at rest from 60 to 120 beats/min during Holter monitoring without drug treatment and when the corrected sinus node recovery time was less than 550 ms, determined by a conventional method.[12] Normal atrioventricular conduction was defined as 1:1 conduction to at least 140 beats/min at spontaneous sinus rhythm or driven atrial rhythm at programmed electrical stimulation. In 12 of the 36 patients electrocardioversion was needed during programmed electrical stimulation to permit the investigation of sinus node function. In five patients atrial fibrillation was incessant, and after electrical cardioversion, sinus rhythm resumed only for a while. Therefore, in this group sinus node function was estimated from Holter recordings and bicycle stress testing.[13] Accessory atrioventricular nodal pathways, atrial flutter, and tachycardia were excluded with programmed electrical stimulation by standard methods.[12]

ECHOCARDIOGRAPHIC AND HAEMODYNAMIC STUDIES BEFORE AND AFTER OPERATION

Routine cross sectional echocardiography and Doppler echocardiographic studies were performed to measure the size of both atria[14] and to exclude the presence of mitral and tricuspid incompetence and other structural heart diseases. The mediolateral diameter of the left and right atrium was measured as the distance from the interatrial septum to the atrial free wall in the apical four chamber view. This examination was repeated in all patients at the end of follow up. For examination of transvalvar flow velocity spectra, cross sectional and pulsed wave Doppler echocardiographic examination was performed in all patients before and after operation with a 2·5 mHz transducer and a Hewlett Packard cardiac ultrasound imaging system (77020 A). The sample volume was placed between the mitral and tricuspid leaflet tips and adjusted until flow velocities were maximal for Doppler assessment of the transvalvar flow spectrum in the apical four chamber view. Doppler recordings and electrocardiograms were recorded at 25 or 50 mm/s. Attention was paid to the presence of the second peak of the velocity curve, which represents an increase in velocity after atrial contraction. In sinus rhythm the second peak is usually present, whereas in atrial fibrillation it is absent.[15] In all cases catheterisation of the left and right heart and coronary angiography were performed to rule out cardiac abnormalities and to assess the arterial supply of the sinus node area.

OPERATION ELECTROPHYSIOLOGICAL STUDIES

The details of the corridor operation have been reported in detail elsewhere.[9] After mediansternotomy, cardiopulmonary bypass, and cold cardioplegic cardiac arrest the operation has two steps. Firstly, a horseshoe incision excludes the left atrial free wall. The incision runs along the attachment of the left atrium on to the atrial septum. The incision starts at the anterior commissure, over the mitral valve annulus, and finishes at the mitral valve annulus at the posterior commissure. Secondly, the corridor is constructed by excluding major portions of the free wall of the right atrium. The incision starts at the tricuspid valve annulus in the anteroseptal region, extends across the right atrial free wall inferior to the sinus node region, cuts through the septum across the fossa ovale, circumscribes the coronary sinus orifice, and finishes at the tricuspid annulus in the posterior septal region. Cryoablation of the four ends of the two horseshoe incisions is carried out to obtain complete exclusion of the atrial segments; finally, all incisions are closed. The atrial muscle fibres touching the left atrium

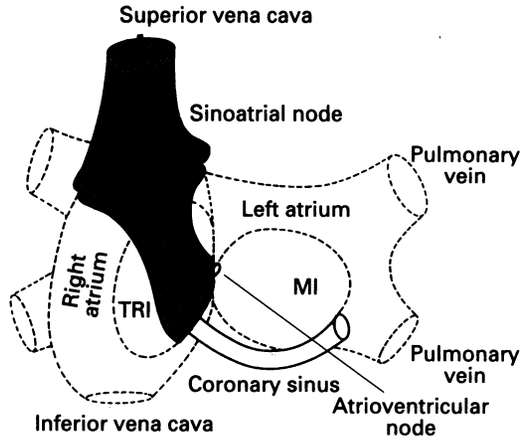

Figure 1 Corridor in an anterior view of the atria after excision of the ventricles. After a conduit of right atrial free wall and septal tissue is constructed the left atrium and residual right atrium are isolated from the corridor. The corridor connects the sinus node with the atrioventricular node. The arrow suggests the tube configuration of the upper part of the corridor. See text for description of atrial incisions. MI = mitral valve circumference; TRI = tricuspid valve circumference.

and corridor and wrapped around the coronary sinus are carefully cryoablated. Special attention is given to the sinus node artery by staying away from the superior vena cava-right atrial junction. Figure 1 shows a schematic view of the corridor.

Electrophysiological studies performed before and after operation have been reported previously.[9] Pairs of temporary epicardial wires were attached to the left atrium, right atrium, corridor and right ventricle. The electrical bipolar signal allowed the evaluation of the isolation of the three atrial compartments after completion of surgery before chest closure, and postoperatively by stimulation of the different compartments. Postoperative induction of atrial fibrillation was attempted in any atrial compartment. The postoperative behaviour of the sinus node and atrioventricular node was evaluated before discharge. In addition to standard postoperative care, all patients received warfarin on the first postoperative day for up to three months after discharge; then aspirin was given.

DEFINITION OF SUCCESS

The primary success of the operation was defined as persistent absence of atrial fibrillation in the corridor without antiarrhythmic drugs after surgery. As this is innovative surgery for arrhythmia the necessity of a second operation to obtain complete success of the original procedure did not exclude primary success. An additional end point was the preservation of a normal chronotropic response in the sinus node.

LONG TERM FOLLOW UP

All patients were followed up in the hospital's outpatients department, initially every three to six months for the first year and then annually. Patients were asked in particular for palpitations and symptoms of cerebrovascular accidents, as well as about daily lifestyle and exercise capacity. Holter recordings and bicycle stress testing were carried out six months after discharge and then every year. The purpose of these examinations was to detect arrhythmias, particularly atrial fibrillation, and to evaluate the behaviour of the sinus and atrioventricular nodes. Chronotropic incompetence of the sinus node after operation was defined as symptomatic sinus bradycardia at rest (< 60 beats/min) requiring pacemaker insertion or as an insufficient rise in sinus rate during stress testing (arbitrarily chosen at < 80% of predicted value according to sex and age criteria[15] in the absence of any antiarrhythmic drug). The data presented reflect the results of the most recent examinations in order to achieve the longest times of follow up.

STATISTICAL ANALYSIS

Data were analysed by using the paired Student's t test or Fisher's exact test when applicable. The occurrence of supraventricular arrhythmias and evidence of abnormal sinus node function after the intervention were estimated using the product limit actuarial method (Kaplan Meier).

Results

SHORT-TERM RESULTS

In all patients complete isolation of the corridor from right and left atrium was present at chest closure. The mean (SD) extracorporeal circulation time was 136 (24) minutes and the mean aortic cross clamp time 82 (8) minutes. In nine of the 36 patients incomplete surgical isolation of the corridor became obvious three days after operation from the spontaneous recurrence of atrial fibrillation. Supplementary surgical exploration showed a residual electrical connection between the corridor and left atrium adjacent to the coronary sinus in all patients; this could be interrupted by additional dissection and cryoablation of the region. This second procedure was always carried out without extracorporeal circulation. Despite the additional intervention a new connection between corridor and left atrium occurred in five of the patients and, finally, paroxysmal atrial fibrillation was indirectly treated with His bundle ablation and cardiac pacing.

Repeated attempts to induce atrial fibrillation with the temporary epicardial wires did not result in atrial fibrillation in the corridor or the residual right atrium. In all cases, however, programmed stimulation with the wires on the left atrium induced paroxysmal atrial fibrillation or flutter. Epicardial recordings of the residual right atrium showed electrical standstill in most patients, whereas very slow rhythms (< 40 beats/min) were recorded in the remaining patients.

SUPRAVENTRICULAR TACHYCARDIA

After a mean follow up of 41 (16) months, 25 of the 36 patients remained free of any supraventricular arrhythmia without taking drugs (table 2). Three to six months after discharge paroxysmal atrial fibrillation reoccurred in three patients in whom the operation had been initially successful. Catheter mapping of the coronary sinus showed a new connection between the left atrium and corridor in sinus rhythm, but the site of electrical leakage could not be localised precisely. Impulses conducted through the

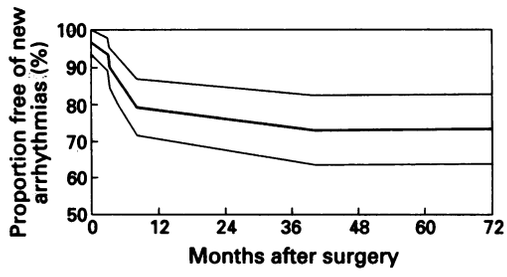

Figure 2 Mean actuarial proportion and SE of 31 patients in whom corridor operation was successful who were free of atrial arrhythmias and not taking antiarrhythmic drugs after surgery. Four years after surgery 10 of the 31 patients were still under study.

leakage from the fibrillating left atrium activated the corridor with various intervals and this atrial compartment behaved like a bystander. In these cases atrial fibrillation could never be induced in the corridor, in contrast to atrial flutter. Drug treatment with flecainide suppressed both the conduction between both atrial compartments and episodes of atrial fibrillation. Paroxysmal atrial flutter (two patients) and paroxysmal atrial tachycardia with a rate of 180 beats/min (one patient) occurred in the corridor after discharge and were easily managed with a single antiarrhythmic drug. These atrial tachycardias were not documented before operation. One year after surgery the actuarial freedom of supraventricular arrhythmias in the 31 operated patients was 79(9)% (figure 2).

FUNCTION OF SINUS NODE

The function of the sinus node after operation was evaluated only in the 31 patients whose operation was successful because the induced atrioventricular block after unsuccessful surgery complicates the examination. After a mean follow up of 32 (14) months 26 patients had a normal sinus node activity at rest (table 3). Twenty one of the 26 patients showed a sufficient increase in sinus rate during exercise; the remaining five showed an incompetent chronotropic response during exercise. Four out of five patients with cardiac pacing for symptomatic insufficient sinus node activity at rest (< 60 beats/min) had a sufficient rise of heart rate during exercise (table 3). Hence

Table 2 Outcome of corridor surgery in 36 patients

Outcome	*No of patients*
Free of arrhythmias and drugs	25
Recurrent paroxysmal atrial fibrillation	3
Treated for other atrial arrhythmias	3
Paroxysmal atrial flutter	2
Paroxysmal atrial tachycardia	1
Paroxysmal atrial fibrillation developed owing to surgical failure	5

Table 3 Evaluation of sinus node and atrioventricular node function in 31 patients in whom corridor operation was successful

	No of patients
Normal sinus node at rest (> 60 beats/min)	26
Stress testing (predicted sinus rate):	
⩾80%	21
< 80%	5
Abnormal sinus node at rest (< 60 beats/min)	
Pacemaker rhythm	5
Stress testing (predicted sinus rate):	
⩾80%	4
< 80%	1
Normal atrioventricular conduction	31

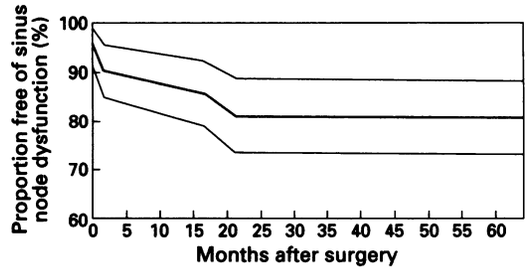

Figure 3 Actuarial proportion and SE of 31 patients in whom corridor operation was successful who had normal sinus node activity after surgery (defined by absence of artificial cardiac pacing and sufficient increase in heart rate during bicycle stress testing). Four years after surgery 10 of the 31 patients were still under study.

at the end of follow up 25 of the 31 patients whose operation had been successful showed sufficient chronotropic response. Figure 3 shows actuarial proportion of patients with normal sinus node activity at rest and during exercise according to our definition. After one year of follow up normal sinus rhythm was observed in 90(5)% and after four years of follow up in 81(7)% of the patients. Impairment in atrioventricular conduction was never recorded.

ECHOCARDIOGRAPHY

Pulsed wave Doppler examination of the mitral valve showed, as could be expected, absence of left atrial contraction (A wave) in all 31 patients whose operation was successful (table 4). The left atrium often showed mechanical standstill or very slow activity. An obvious right atrial contraction (A wave) was, however, observed in 26 patients (table 4, figure 4). A slow rhythm in the corridor with temporary nodal rhythm or a ventricular pacemaker rhythm at rest caused mechanical asynchrony between the right atrium and ventricle in five patients. Consecutive echocardiographic examinations showed an increase in the size of the left atrium in 18 of the patients. In most patients, however, the right atrial dimension remained unchanged and within normal limits (table 4). Colour Doppler flow mapping showed slight mitral and tricuspid

Table 4 Echocardiographic findings in 31 patients in whom corridor operation was successful

	No of patients
Left atrial dimension:	
Unchanged and normal*	13
Increased	18
Right atrial dimension:	
Unchanged and normal†	21
Increased	10
Left atrioventricular synchrony	0
Right atrioventricular synchrony	26
Dissociation due to bradycardia/paced rhythm	5
Mitral incompetence (grade):	
None	18
1/4	8
2/4	5
Tricuspid incompetence (grade):	
None	19
1/4	7
2/4	5

*Normal values of left atrial mediolateral dimension 37 (4)mm (range 25 to 45).[14]

†Normal values of right atrial mediolateral dimension 37 (0·4)mm (range 29 to 46mm) mm.[14]

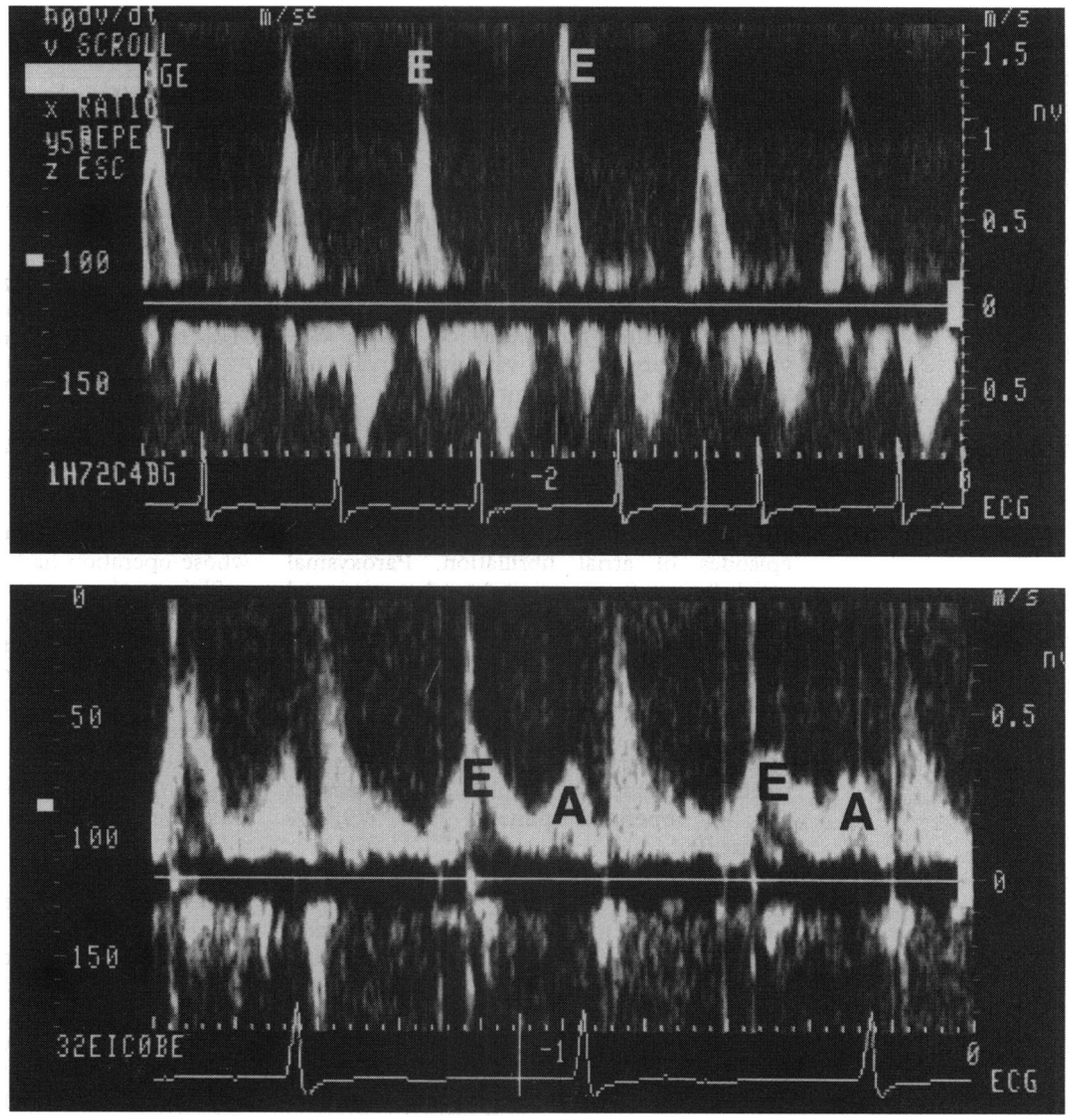

Figure 4 Pulsed Doppler flow velocity spectra across the mitral and tricuspid valve four months after corridor surgery. Top: Mitral inflow velocity curve (recording speed 25 mm/s) showing peak velocity of the early filling wave (E). Note the absence of late filling wave (A) due to left atrial fibrillation. Bottom: Inflow velocity of the tricuspid valve in the same patient (recording speed 50 mm/s) showing the early filling wave (E) and the corresponding late filling wave (A). This pattern shows an obvious contraction of the corridor atrial mass and was seen in most of the patients (table 4).

valve incompetence in 13 and 12 of the patients respectively.

STROKE

Two patients experienced systemic thromboembolic complications: one patient (case 1) had speech disturbances for a couple of days one week after reoperation, and another (case 2) had a stroke manifest by right sided muscular weakness four months after discharge. In case 1 anticoagulant treatment was reduced before reoperation and started again on the first day after reoperation; presumably, the degree of anticoagulant treatment was still insufficient at the time of stroke. In case 2 coumadin was stopped one month before the stroke. Echocardiography performed immediately after the thromboembolic complications showed a normally sized left atrium in case 1 and a slight enlargement in case 2. Both patients recovered neurologically.

Discussion

SURGERY FOR ATRIAL FIBRILLATION

In 1985 Guiraudon and coworkers introduced the corridor procedure for the direct surgical treatment of atrial fibrillation.[5] The corridor is a conduit of atrial tissue connecting the area of the sino atrial and the atrioventricular nodes that is isolated from the left and right atrium. At the right atrium the isolation of the corridor also yields a reduction of its surface area. This reduction is carried out under the assumption that a small conduit cannot contain sufficient number of atrial wavelets to allow atrial fibrillation to occur or be perpetuated.[10 11] This surgical method preserves physiological driving of the ventricles but left atrial contribution to left ventricular filling (atrial kick) is lost.

In 1991 the maze procedure was introduced by Cox and coworkers.[6-8] This is also a direct surgical method for treating atrial fibrillation. Multiple atrial incisions associated with subtotal exclusion of the left atrium prevent the emergence of fibrillation and, permit normal sinus node action in the included atrial tissue as well as in the ventricles, resulting in left and right sided atrial transport. In the latest reported series of 22 patients atrial fibrillation developed in four, and atrial flutter in four others in the immediate postoperative phase.[8] However, no patient had spontaneous atrial fibrillation beyond the three months postoperative period, but atrial flutter reoccurred in three patients at least five months after surgery. This operation claims to pre-

serve normal haemodynamics and have a negligible risk of thromboembolism because both atria contract actively, as suggested by the postoperative Doppler examinations.[8] Until now the maze procedure has been performed for a heterogeneous group of atrial arrhythmias and not exclusively for paroxysmal atrial fibrillation, as in this study.

RESULTS OF CORRIDOR OPERATION

Primary success, defined as absence of paroxysmal atrial fibrillation without drugs, was achieved in 84% of the operated patients; actuarial freedom of any supraventricular arrhythmia after four years was 72(9)%. Comparison with other published series of patients is hardly possible because of differences in selection criteria for surgery—for example, chronic fibrillation, paroxysmal atrial fibrillation, and the sick sinus syndrome. Although a few patients developed new arrhythmias in the corridor after operation, the mass and size of the tissue of the corridor evidently could not harbour atrial fibrillation. When atrial fibrillation recurred the arrhythmia emerged in the left atrium and not the corridor. This observation shows that the concept of the corridor operation in terms of reduction of atrial mass to avoid the onset of atrial fibrillation is valid. Our observations also show that surgical refinement for an immediate definite isolation of the left atrium from the corridor is needed and further understanding is requested for the intriguing problem of late connection between left atrium and corridor.

LONG-TERM FUNCTION OF SINUS NODE

An important concern of the corridor operation is the long-term postoperative behaviour of the sinus node. In our series sinus node activity remained undisturbed in 84% of the patients whose operations were successful, whereas the majority of patients with pacing had a normal chronotropic response at stress testing. The normal chronotropic response in patients with pacing is similar to the behaviour of the sinus node in the sick sinus syndrome, in which firing is slow and incompetent at rest but shows a normal chronotropic response on exercise.[16] The initial results of Guiraudon's group showed a somewhat higher incidence of abnormal sinus node activity postoperatively: in four out of nine patients a long recovery time or sporadic activity was observed in the early phase after surgery.[5] This finding was not specifically related to preoperative chronic or paroxysmal atrial fibrillation.[5] However, their observations cannot precisely be compared with ours because of a difference in the time of observation and in the definition of sinus node failure. Long-term sinus node activity in the 22 patients with the maze procedure remained undisturbed in 13 (59%) patients, whereas pacemaker treatment was needed in the remaining patients (41%).[8] Cox *et al* suggest, however, that the maze operation had damaged sinus node function in only two (9%) patients because the sick sinus syndrome was preoperatively already present in some patients and the pacemaker could be turned off during follow up in the others.

When these initial data are considered it is still unclear whether the maintenance of the sinus node function after cardiac surgery for atrial fibrillation is determined by the direction and extension of atrial incisions,[17] or by an unfavourable selection of patients who had silent sinus node disease at the time of surgery. Much care is spent to spare the circulatory supply of the sinus node during atrial surgery.[8 9] It is clinically well recognised that chronic or paroxysmal atrial fibrillation is sometimes one limb of an ongoing sick sinus syndrome, which initially shows as tachycardia alone. Therefore the selection of surgical candidates with regard to long-term preservation of normal sinus node function seems to be critical. Sinus node function is often examined only superficially before surgery because many patients are taking drugs, which interferes with an appropriate investigation. Moreover, after withdrawal of antiarrhythmic drugs electrical cardioversion is often needed to restore sinus rhythm. After this measure it becomes questionable whether the examination of sinus node function is reliable in view of the immediate non-physiological circumstances.

HAEMODYNAMIC CONSEQUENCES OF CORRIDOR SURGERY

Doppler pulsed wave examination during follow up clearly showed right atrial transport in most patients with the corridor operation, which suggests that the corridor contracts actively (table 4). This can be attributed to the large amount of atrial tissue of the corridor that encompasses a part of the anterior and posterior right atrial free wall and the complete atrial septum. The excluded remnant of the right atrium, however, is only a small part of the right atrial free wall with passive movements, as always observed immediately after completion of the surgical procedure. Absence of an active filling of the right ventricle was observed only in the five patients with pacemaker rhythm.

As expected, left atrial contraction was absent in all cases and therefore the left atrium does not contribute substantially to the maintenance of cardiac output. Experimental haemodynamic studies, however, have shown that absence of left atrial contribution to left ventricular filling does not affect cardiac output adversely.[18] In addition, when left ventricular function is normal the ability to increase heart rate seems to be more important than atrial contraction itself in increasing cardiac output.[19] With respect to valve incompetence, serial echocardiographic examinations are needed to determine the clinical importance of slight mitral and tricuspid valve incompetence seen postoperatively in colour Doppler studies of flow velocity (table 4). These findings were not associated with haemodynamic consequences in terms of medical or surgical treatment.

THROMBOEMBOLISM

The risk of thromboembolism seems to be unaltered after the corridor operation because the left atrium may continue to fibrillate. The echocardiographic studies showed an increase in size of the left atrium in most patients after surgery. This enlargement is probably caused by the paroxysmal or chronic fibrillation.[20] In 32% of the patients the increase in size of the right atrium is difficult to explain. It can be attributed to asystole of the excluded remnant of the right atrium or to the atrial incisions. Asystole was common in the early postoperative phase in epicardial electrocardiographic recordings. Notwithstanding, echocardiography after discharge showed global right atrial contractions in most of the patients (table 4). We recommend long-term anticoagulant treatment after the corridor operation, given the fibrillation in the left atrium and increased atrial size postoperatively.

Conclusions

This study validates the concepts of the corridor operation. Refinement of the surgical technique and more experience are needed to consider the operation a reliable alternative treatment when atrial fibrillation becomes refractory to treatment. Because sinus node function was assumed to be normal before intervention and atrial fibrillation was paroxysmal, the results cannot be immediately extrapolated to patients with chronic atrial fibrillation. Long-term follow up did not disclose adverse sequelae of the operation in terms of deterioration of cardiac function. The right atrial flutter or atrial tachycardia of the sick sinus syndrome is not a suitable candidate for such surgery: a different non-pharmacological approach is needed when it becomes refractory to drug treatment.

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