Effects of Oral Disopyramide Phosphate on Induction and Sustenance of Atrioventricular Reentrant Tachycardia Incorporating Retrograde Accessory Pathway Conduction

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SUMMARY We performed electrophysiologic studies before and after oral administration of disopyramide phosphate, 200 mg every 6 hours, in 20 patients with atrioventricular (AV) reentrant tachycardia using a retrogradely conducting accessory pathway. Disopyramide markedly depressed retrograde accessory pathway conduction by increasing the mean ventricular paced cycle length that produced ventriculo-atrial block (\( \leq 287 \pm 4 \) to \( \geq 392 \pm 22 \) msec, \( p < 0.01 \)); it also depressed antegrade normal pathway AV conduction by increasing the atrial paced cycle length that produced AV block (287 ± 9 to 328 ± 7 msec, \( p < 0.01 \)).

In 14 patients, tachycardia could not be induced or sustained after disopyramide phosphate. In 13 patients, this reflected depression of the retrograde limb with either absence of atrial echoes (nine patients) or induction of nonsustained tachycardia that terminated after the QRS complex (four patients), and in one, it reflected depression of the antegrade limb with induction of a single atrial echo not followed by a QRS response. In six patients, sustained tachycardia could still be induced after disopyramide.

Oral disopyramide phosphate is effective in preventing induction of sustained AV reentrant tachycardia in most patients. This effect is achieved primarily by depression of the retrograde limb of the reentrant circuit.

EFFECTIVE DRUG THERAPY for reentrant tachycardia in patients with the Wolff-Parkinson-White syndrome can be achieved by eliminating atrial or ventricular premature complexes responsible for induction of tachycardia, or by modifying the conduction properties of the reentrant circuit. The former is difficult to achieve and hard to evaluate, while the latter can be evaluated with electrophysiologic studies in the catheterization laboratory. Procaini- 
mandine and quinidine increase the retrograde effective refractory period of the accessory pathway; digitalis, propranolol, and verapamil increase the antegrade effective refractory period of the atrioventricular (AV) node. These agents may prevent the induction or sustain- 
ance of tachycardia. The limited data available suggest that disopyramide increases refractoriness of the retrograde accessory pathway and can suppress reen-
trant tachycardia.

In this study, we evaluated the effects of oral disopyramide on induction and sustenance of AV reentrant tachycardia incorporating a retrogradely conducting accessory pathway in a large group of patients. These effects are examined in terms of the measurable proper-

ts of the components of the reentrant circuit.

Materials and Methods

The study group consisted of 20 patients, six females and 14 males, ages 17–70 years (mean 43 ± 17 years [± sd]). All 20 patients had electrocardiograph-
ic documentation of recurrent paroxysmal supraventricular tachycardia, electrophysiologic demonstration of AV reentrant tachycardia incorporating a retro-
gradely conducting accessory pathway, and induction of sustained tachycardia necessitating termination with electrical stimulation on the day of control study. Patients 1–4 had ventricular preexcitation (three type A and one type B); patients 5 and 6 had intermittent ventricular preexcitation (type A, type B, respectively) and patients 7–20 had concealed accessory pathway (two right and 12 left) (table 1). Patient 6 had a left-sided concealed accessory pathway, and both the right and left accessory pathways were capable of retrograde conduction. Only the left-sided concealed accessory pathway could sustain tachycardia. The tachycardia incorporating the right accessory pathway always termin-
inated spontaneously with a QRS complex not fol-

don by an atrial response (retrograde block in the accessory pathway). Thus, the data on this patient’s latter tachycardia are not presented.

Electrophysiologic Studies

After informed, written consent was obtained, electrophysiologic studies were performed with the patient supine and unsedated. All cardioactive drugs were dis-

continued at least 72 hours before the study. His bundle electrograms were recorded from the proximal two electrodes of a #7 quadripolar electrophatheter intro-
duced percutaneously into the right femoral vein and placed across the tricuspid valve. The distal two electrodes were used for right ventricular pacing. A second 
#7 hexapolar electrophatheter was advanced to the coronary sinus through the right antecubital vein. In this position, the proximal four electrodes were against

the lateral wall of right atrium near the junction of

superior vena cava. The distal two electrodes were
used to record the left atrial electrogram from the coronary sinus, the middle two electrodes to record the high right atrial electrogram and the proximal two electrodes to stimulate the right atrium. Surface leads I, aVF, and V_1 were simultaneously recorded with the intracardiac electrograms on a multichannel oscilloscopic photographic recorder (Electronics for Medicine, VR-16) at paper speeds of 100, 150 and 250 mm/sec, using a filter setting of 30–500 Hz. Stimuli 2 msec long and approximately twice diastolic threshold were delivered by a programmable digital stimulator (Bloom and Associates).

The study protocol included (1) incremental atrial pacing up to the atrial paced cycle length that produced AV block; (2) atrial extrastimulus testing (A_1A_2 testing) at a driven cycle length of 500 msec, and double atrial extrastimulus testing (A_1A_2A_3 testing) in patients in whom A_1A_2 testing failed to produce an echo beat or tachycardia; (3) incremental ventricular pacing up to the ventricular paced cycle length that produced ventriculoatrial (VA) block; and (4) ventricular extrastimulus testing (V_1V_2 testing) at a driven cycle length of 500 msec. AV reentrant tachycardia incorporating a retrogradely conducting accessory pathway was documented by an abnormal atrial activation sequence during induced tachycardia, an increase in VA interval or cycle length of tachycardia when bundle branch block occurred ipsilateral to the accessory pathway, and capture of the atrium by a ventricular extrastimulus during tachycardia when the His bundle was still refractory. At the end of the control study, the tip of the hexapolar electrocatheter was repositioned and secured at the right ventricular apex for subsequent electrophysiologic study; the quadripolar electrocatheter was removed. The patient was then given oral disopyramide phosphate, 200 mg every 6 hours, and the electrophysiologic studies were repeated 2 hours after the last dose 2–4 days after the control study. Three patients had mild urinary retention, but side effects necessitating discontinuation of disopyramide were not observed.

Definitions

HRA_1, CS_1, A_1, H_1 and V_1 represent, respectively, the high right atrial, left atrial (recorded from coronary sinus), low septal right atrial (recorded from His bundle catheter), the His bundle and the ventricular responses of the sinus or the driven beats (S_1). HRA_2, CS_2, A_2, H_2 and V_2 represent, respectively, the high right atrial, left atrial, low septal right atrial, the His bundle and ventricular responses to the extrastimulus (S_2).

Antegrade properties were evaluated by noting the longest atrial paced cycle length that produced second-degree block in the accessory pathway or in the normal pathway, and by measuring the effective refractory period of the accessory pathway and the normal pathway. For comparison before and after disopyramide, antegrade properties were measured from the high right atrial electrograms. The antegrade effective refractory period of the accessory pathway is defined as the longest A_1A_2 at which A_1 fails to conduct via the accessory pathway. The antegrade effective refractory period of the normal pathway (AV conducting system) is the longest A_1A_2 at which A_1 fails to conduct via the normal pathway. The antegrade echo zone is defined as the zone of A_1A_2 at which A_1 provokes atrial echoes with or without tachycardia. The critical AV interval is defined as the shortest AV interval provoking AV reentrant atrial echoes or tachycardia. The maximal AV interval (MAV) is the longest AV interval achieved during incremental atrial pacing or extrastimulus testing.

Retrograde properties were evaluated by noting the longest ventricular paced cycle length that produced VA block and by measuring the effective refractory period of VA conduction. The retrograde effective refractory period of the accessory pathway is the longest V_1V_2 interval at which V_2 fails to conduct to the atria (in patients with relatively fixed VA interval), or the longest V_1V_2 at which V_1 conducted to the atria with a sudden increase in V_1A_2 (in patients in whom the effective refractory period of the accessory pathway is longer than that of the normal pathway). The retrograde echo zone is defined as the zone of V_1V_2 at which V_2 provokes AV reentrant ventricular echoes with or without tachycardia.

Sustained tachycardia is defined as an episode of induced AV reentrant tachycardia lasting longer than 2 minutes and requiring termination with electrical stimulation. Nonsustained tachycardia is defined as an induced episode of AV reentrant tachycardia that terminates spontaneously. The antegrade weak link of the reentrant circuit refers to termination of echoes or tachycardia occurring with an atrial response not followed by a ventricular response. The retrograde weak link of the reentrant circuit refers either to termination of echoes or tachycardia occurring with a ventricular response not followed by an atrial response, or to an AV interval longer than the observed control critical interval, without induction of AV reentrant atrial echoes or tachycardia.

Results

Induction of Tachycardia

Sustained AV reentrant tachycardia was induced in all 20 patients during the control study. In 14 patients, the tachycardia was induced by rapid atrial pacing (patients 3–7, 9, 10, 12, 13 and 15–19), in 16 patients by atrial extrastimulus testing with demonstration of an antegrade echo zone (patients 2, 3, 5–12 and 14–19) (figs. 1A and 2A), in 12 patients by rapid ventricular pacing (patients 2, 3, 6, 8, 10, 12–15 and 17–19), and in two patients by ventricular extrastimulus testing with demonstration of a retrograde echo zone (patients 2 and 10).

Antegrade induction of tachycardia was related to the achievement of a critical AV conduction time (critical AV interval) either with rapid atrial pacing or with atrial extrastimulus testing. In 16 patients, a left-sided accessory pathway was used for retrograde conduction (patients 1, 2, 4, 5, 7–10, 12–15 and 17–20).
while in three patients a right-sided accessory pathway was used for retrograde conduction (patients 3, 11 and 16). Patient 6 had bilateral accessory pathways capable of retrograde conduction, but only the left-sided accessory pathway contributed to sustenance of tachycardia, so further data regarding the right accessory pathway will not be presented.

After oral disopyramide, sustained tachycardia could be induced in only six patients (fig. 1C) (patients 1, 2 and 7–10); nonsustained tachycardia was inducible in patient 3, in whom tachycardia terminated spontaneously with a QRS complex not followed by an atrial response, suggesting a retrograde block in the accessory pathway.

**FIGURE 1.** Recordings from patient 8 showing induction of sustained paroxysmal supraventricular tachycardia (PSVT) before and after disopyramide and the effect of disopyramide on retrograde conduction. Electrocardiographic leads I, aV<sub>1</sub>, and V<sub>1</sub>, the high right atrial electrogram (HRA), the left atrial electrogram recorded from the coronary sinus (CS), and the His bundle electrogram (HBE) are shown. HRA<sub>1</sub>, A<sub>1</sub>, and H<sub>1</sub> represent, respectively, high right atrial, low septal right atrial, and His bundle responses to the basic driven stimulus (S<sub>1</sub>); HRA<sub>2</sub>, A<sub>2</sub>, and H<sub>2</sub> represent, respectively, high right atrial, low septal right atrial, and His bundle responses to the extrastimulus (S<sub>2</sub>); HRA<sub>3</sub> represents high right atrial response to the second extrastimulus (S<sub>3</sub>). HRA<sub>1</sub>, H<sub>1</sub>, and V<sub>1</sub> represent, respectively, high right atrial, His bundle, and ventricular responses during PSVT. HRA represents the high right atrial response to rapid ventricular pacing stimulus (S). The paper speed is 100 mm/sec. (A) Induction of sustained PSVT before disopyramide. The basic atrial driven cycle length was 500 msec and the HRA-HRA<sub>1</sub> coupling interval was 350 msec. The cycle length of PSVT was 390 msec, with a V<sub>HRA</sub> of 145 msec and HRA<sub>2</sub>V<sub>1</sub> of 245 msec. (B) One-to-one ventriculoatrial conduction at a ventricular paced cycle length of 330 msec before disopyramide. (C) Induction of sustained PSVT with a second atrial extrastimulus after disopyramide. The cycle length of PSVT remained 390 msec. V<sub>HRA</sub> increased to 200 msec and HRA<sub>2</sub>V<sub>1</sub> decreased to 190 msec. (D) Second-degree ventriculoatrial block occurring at a ventricular paced cycle length of 330 msec after disopyramide. The asterisk indicates the ventricular paced beat with ventriculoatrial block. The subtle change in high right atrial electrograms before and after disopyramide (HRA<sub>1</sub> in panels A and C or HRA in the last beat in panels B and D) could have reflected a minor change in atrial recording site or the effect of disopyramide on atrial conduction.
In patients 11, 12, 13 and 20, only a single AV reentrant echo beat was induced. In patients 11, 12 and 13, the echo beat terminated with a QRS complex not followed by an atrial response, suggesting a retrograde weak link; in patient 20, the echo beat was terminated with an atrial response not followed by a QRS complex, suggesting an antegrade weak link.

In the remaining nine patients (patients 4, 5, 6 and 14–19), neither tachycardia nor a single echo beat was inducible (fig. 2C). In these nine patients, the maximal AV conduction time (maximal AV interval) during rapid atrial pacing or with atrial extrastimulus testing was longer than the critical AV interval during the control study, which suggests that refractoriness of the retrograde accessory pathway or atria is increased after disopyramide.

Cycle Length of Tachycardia (table 1, figs. 1 and 3)

The cycle lengths of tachycardia before and after disopyramide could be compared only in the patients in whom tachycardia was still inducible after disopyramide (cases 1, 2, 3 and 7–10). In these seven patients, cycle lengths were 260–450 msec (mean 339 ± 24 msec [± SEM]) before disopyramide phosphate (fig. 1A), and 325–440 msec (mean 374 ± 17 msec) after disopyramide (NS) (fig. 1C). The AV interval during tachycardia increased in three patients and decreased in four after disopyramide. The mean AV interval was 214 ± 27 msec (range 98–335 msec) before disopyramide and 216 ± 15 msec (range 165–270 msec) after disopyramide (NS). The VA interval during tachycardia lengthened in all seven patients. The mean VA interval was 125 ± 11 msec (range 70–162 msec) before disopyramide and 157 ± 12 msec (range 110–200 msec) after disopyramide (p < 0.01).

Antegrade Properties (table 1, figs. 1, 2 and 4)

In patients 1–4, who had ventricular preexcitation during the control study, the atrial paced cycle lengths that produced antegrade block in the accessory pathway were 260, 280, 300 and 300 msec, respectively. After disopyramide, ventricular preexcitation was lost in patient 1; the atrial paced cycle length that produced antegrade block in the accessory pathway was increased in patients 2 and 3 (570 and 360 msec, respectively) and unchanged in patient 4. Only in patient 3 could the antegrade effective refractory period of the accessory pathway be compared before and after disopyramide (260 msec before and 330 msec after disopyramide).
### Table 1. Electrophysiologic Findings Before and After Disopyramide

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Abbreviations: PSVT = paroxysmal supraventricular tachycardia; CL = cycle length; CL-APB = longest atrial paced cycle length; CL-AVB = longest atrial paced cycle length producing block in the accessory pathway; CL-ABV = longest atrial paced cycle length producing block in the normal pathway; ERP-AP = effective refractory period of the accessory pathway; ERP-AVCS = effective refractory period of atrioventricular conducting system (normal pathway); ERP-AV = effective refractory period of the accessory pathway; MAV = maximal atrioventricular interval; MAV = maximal atrioventricular interval achieved during the study; ERP-AV = average atrioventricular cycle length producing intraventricular block; ERP-AP = effective refractory period of the accessory pathway; C = control; D = disopyramide; Ret = retrograde; Ant = antegrade.

The atrial paced cycle length that produced block in the normal pathway either remained the same (six patients) or lengthened (14 patients). Cycles lengths were 205-360 msec (mean 288 ± 9 msec) during the control study and 280-400 msec (mean 328 ± 7 msec) after disopyramide (fig. 4). The increase was statistically significant p < 0.01. The site of the antegrade block was proximal to the His bundle recording site in all the 20 patients before disopyramide. His bundle recording was not performed after disopyramide, so the exact site of block could not be ascertained after disopyramide. In each of the seven patients (cases 1–3 and 7–10) in whom tachycardia could be induced after disopyramide, the cycle length of tachycardia was longer than the cycle length that produced block in the normal pathway. In five of the remaining 13 patients in whom tachycardia could not be induced (cases 4, 5, 12, 16 and 19), the cycle length producing block in the normal pathway after disopyramide was shorter than the cycle length of tachycardia during the control
study. In eight patients (cases 6, 11, 13, 14, 15, 17, 18 and 20), the cycle length that produced block in the normal pathway was longer than the cycle length of tachycardia during the control study. The effective refractory period of the AV conducting system could be compared in only three patients before and after disopyramide; it was decreased in patients 7 and 19 and increased in patient 18.

The antegrade echo zone could be defined by a single atrial extrastimulus during the control study in patients 2, 3, 5–12 and 14–19 (figs. 1A and 2A). In the remaining four patients, tachycardia was induced by rapid atrial pacing or double atrial extrastimulus testing (A1A2A3 testing). In two of these 16 patients, the echo zone was demonstrable after disopyramide (cases 3 and 7), and was narrowed in both. In six of the remaining 14 patients (cases 2 and 8–12), echoes or tachycardia could be induced by a second atrial extra-stimulus with a longer critical AV interval (fig. 1B). Echoes or tachycardia could not be induced in eight patients (cases 5, 6 and 14–19) despite a longer AV interval than the critical AV interval during the control study (fig. 2B). These findings suggest that refractoriness in the retrograde limb of the circuit is increased after disopyramide. The effective refractory period of the atrium was measured before and after disopyramide in all 20 patients, and increased from 220 ± 6 msec before to 295 ± 8 msec after disopyramide (p < 0.001).

**Retrograde Properties**

The effects of disopyramide on retrograde conduction of the accessory pathway were evaluated by the longest ventricular paced cycle length that produced VA block and the effective refractory period of the ventriculoatrial conducting system. The ventricular paced cycle length that produced VA block ranged from less than 260 msec to 330 msec (mean ± 287 ± 4 msec) before disopyramide and ranged from 240 msec to more than 600 msec (mean ± 392 ± 22 msec) after disopyramide (figs. 2B, 2D and 4). The increase was statistically significant (p < 0.01). In patients 1, 2
and 7–10, in whom tachycardia could be induced after disopyramide, the cycle length of the tachycardia was longer than the ventricular paced cycle length that produced VA block (figs. 1C and 1D). In the only patient in whom nonsustained tachycardia could be induced after disopyramide (patient 3), the ventricular paced cycle length that produced VA block was identical to the cycle length of tachycardia. In the 13 patients with and without echo beat inducible after disopyramide, the ventricular paced cycle length that produced VA block was longer than the cycle length of tachycardia before disopyramide (cases 4–6 and 11–20) (figs. 2A and 2D).

The retrograde effective refractory periods of the accessory pathway before and after disopyramide could be compared in 14 patients (cases 1–5, 8, 9, 11–13, 15, 16, 18 and 20). The mean retrograde effective refractory period of the accessory pathway was ≤ 266 ± 10 msec range (< 210 to < 320 msec) before disopyramide and increased to 330 ± 12 msec (range 230–390 msec) after disopyramide (p < 0.01). The retrograde echo zone could be defined in only two cases during the control study, but was lost in both after disopyramide (patients 2 and 10). In patient 7, the retrograde echo zone was demonstrable only after disopyramide.

Discussion

Disopyramide phosphate has been used in the management of cardiac arrhythmias since the late 1960s.20–27 Microelectrophysiologic studies have shown that disopyramide decreases the rate of spontaneous phase-4 depolarization, decreases the upstroke slope of phase 0 and lengthens the action potential and the effective refractory period of His-Purkinje fibers.28 Macrocphysiologic studies of disopyramide in animals and man have shown that although its effect on the sinus node and AV node is insignificant, it lengthens His-Purkinje conduction and increases the refractory period of atria, the His-Purkinje system and the ventricles.29–36 Electrophysiologic studies in a limited number of patients with Wolff-Parkinson-White syndrome have shown that disopyramide prolongs both the conduction time and the refractory period of the accessory pathway in both antegrade and retrograde directions.12–14 Disopyramide reportedly prevents sustenance of AV reentrant tachycardia and reduces the ventricular rate during atrial fibrillation.12, 13

Our findings in this study of oral disopyramide in 20 patients with AV reentrant tachycardia are consistent with those in previous studies of i.v. disopyramide.12, 13 Oral disopyramide lengthened the paced cycle length that produced block in the accessory pathway and increased the effective refractory period of the accessory pathway in both antegrade and retrograde directions. The effect of disopyramide on the antegrade normal pathway conduction was less consistent. However, disopyramide lengthens the atrial paced cycle length that produced block in the normal pathway in most patients. Although the exact site of AV block could not be localized after oral disopyramide (the His bundle electrogram was not recorded), block could have occurred in the His-Purkinje system in many patients, as shown previously.29–36 Disopyramide has an indirect vagolytic effect and may enhance AV nodal conduction.27, 29, 36, 37 Thus, block in the AV node would be less likely to occur after disopyramide. Although the high right atrial recording sites were not identical before and after disopyramide in this study, we found a consistent lengthening of the VA interval and an inconsistent change in the AV interval during induced tachycardia after oral disopyramide. As a consequence, the effect of oral disopyramide on cycle length of tachycardia varied. These observations are in accord with studies of i.v. disopyramide.12, 13

Reentrant circuit in patients with the Wolff-Parkinson-White syndrome consist of the atrium, the AV node, the His-Purkinje system, the ventricle and the accessory pathway.1, 6, 38 Sustenance of tachycardia depends on the cycle length of tachycardia being longer than the effective refractory period of all components of the circuit.1, 6, 38 In this study, oral disopyramide prevented induction and sustenance of tachycardia in a majority of patients primarily because of the increased retrograde refractory period of the accessory pathway. This observation is substantiated by (1) inability to induce AV reentrant atrial echo or tachycardia after disopyramide despite an AV interval longer than the critical AV interval during the control study; (2) spontaneous termination of the induced tachycardia after disopyramide with a QRS complex not followed by an atrial response; and (3) the ventricular paced cycle length that produced VA block after disopyramide being longer than the cycle length of the tachycardia. In eight patients, the atrial paced cycle length that produced block in the normal pathway after oral disopyramide was longer than the cycle length of tachycardia during the control study. Since disopyramide did not significantly lengthen the cycle length of tachycardia, sustenance of tachycardia in some of these patients would have not been possible even if the accessory pathway had been capable of retrograde conduction after disopyramide. Theoretically, disopyramide could have prevented induction or sustenance of tachycardia by increasing atrial or ventricular effective refractory period.12, 27, 30, 31, 33–35, 37 An increased atrial effective refractory period after disopyramide may also result in abolition of atrial echo, termination of the tachycardia with a retrograde weak link, and lengthening of ventricular paced cycle length that produced VA block. Our findings are consistent with this possibility. Because initiation of tachycardia requires premature atrial or ventricular complexes, disopyramide could have also prevented induction of tachycardia suppressing premature complexes.1, 5, 6

Other investigators have suggested that reentrant tachycardia could be potentiated by antiarrhythmic agents.2, 3, 39–42 Disopyramide lengthens the retrograde conduction time of the accessory pathway and therefore may lengthen the cycle length of tachycardia. Lengthening the cycle length of tachycardia without appropriate increase in the effective refractory period
of the circuit may facilitate sustenance of tachycardia. In addition, disopyramide increases the antegrade effective refractory period of the accessory pathway and may enhance AV nodal conduction by its indirect vagolytic action; therefore, disopyramide may widen the echo zone. By increasing the retrograde effective refractory period of the normal pathway, disopyramide may facilitate retrograde induction of tachycardia. These potentially hazardous effects were not observed in this study. Last, the clinical relevance of this study may be limited by the fact that the study was performed at the likely peak serum concentration level of disopyramide after oral administration of the drug. It cannot be ascertained whether or not identical electrophysiologic effects of disopyramide on the AV reentrant tachycardia could have been achieved 6 hours after the oral administration of the drug.

In conclusion, oral disopyramide depresses the conduction of the retrograde limb of the reentrant circuit and prevents induction or sustenance of AV reentrant tachycardia in most patients with the Wolff-Parkinson-White syndrome. It can be used as an alternative to other effective antiarrhythmic agents in prophylaxis of symptomatic AV reentrant tachycardia incorporating a retrogradely conducting accessory pathway.

Acknowledgment
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References

Modulation of Parasystolic Activity by Nonparasystolic Beats

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SUMMARY We studied 12 patients with ventricular parasystole in whom pacemaker activity could be modulated by nonparasystolic beats (NPBs). In six patients (group 1) in whom the intrinsic parasystolic cycle length (XX interval) was obtained without interposed NPBs, we found that NPBs falling during the first half of the cycle prolonged the XX interval (containing one NPB) and that NPBs falling during the second half of the cycle abbreviated the XX interval; both effects were maximal when NPBs fell close to the middle of the cycle and were separated by a reversal point. However, because of mutual interference between parasystolic beats and NPBs, only 13.2–43.4% of the parasystolic cycle could be effectively scanned. We also found that the XX and RX intervals were linearly related. This relationship served to establish that in six patients in whom the XX interval was not obtained (group 2), modulation showed a similar behavior, although neither the reversal point nor the sense of the modulation could be determined. In this report, we suggest diagnostic criteria of parasystolic modulation.

IN CLASSIC parasystole, an automatic focus is assumed to be totally independent of the electric activity elsewhere in the heart. Entrance block (a form of unidirectional block) is the barrier that protects the parasystolic center from exogenous influences. However, a mechanism by which nonparasystolic beats (NPBs) can modify the activity of a protected automatic center has been conceived by Jalife and Moe. They reasoned that "if an impulse cannot invade the pacemaker, but the pacemaker impulses can escape, then clearly there must be a viable ionic pathway across the blocked region." Using an in vitro preparation — the sucrose gap model — they established the existence of an electrotonic action exerted, by evoked action potentials or current pulses, on the activity of a protected pacemaker.

Electrotonic modulation of a protected automatic center was demonstrated, and it was assumed that similar events had to occur in clinical cases of ventricular parasystole (VP). Although isolated reports indicate that this may be the case,2-4 the extent to which and the mechanism by which NPBs modulate parasystolic activity in man are still unknown.

In this report, we present 12 patients with VP in whom the activity of the parasystolic center was predictably enhanced or depressed by the effect of NPBs, depending on their timing within the ectopic cycle. These cases are a clinical counterpart of the experimental findings and serve to delineate the diagnostic criteria of parasystolic modulation, underline the differences from the experimental results, and show the limitations of extrapolating the latter to the clinical situation.

Material and Methods

The ECGs of 50 patients with VP were carefully examined for the presence of ectopic cycle lengths that varied because of the presence of interposed NPBs, as described by Jalife and Moe. Fifty such patients (30%) were found, but two were excluded because the
Effects of oral disopyramide phosphate on induction and sustenance of atrioventricular reentrant tachycardia incorporating retrograde accessory pathway conduction.
H C Kou, J S Hung, Y S Lee and D Wu

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