Intracardiac conduction defects in dystrophia myotonica

Electrophysiological study of 12 cases

MICHEL KOMAJDA, ROBERT FRANK, JACQUES VEDEL, GUY FONTAINE, JEAN-CLAUDE PETITOT, YVES GROSGOGEAT

From the Service de Cardiologie du Professeur Y. Grosogeat, Hôpital de la Salpêtrière, 47 Boulevard de l'Hôpital, Paris, France

SUMMARY Twelve patients with dystrophia myotonica had cardiac electrophysiological study for conduction disturbances (five cases) or for syncope (seven cases).

Conduction disturbances were found in each case, being intranodal in two cases, intra-Hisian in three cases, or diffuse in seven cases. These findings are in agreement with those previously reported, and may be related to the high incidence of sudden death in these patients.

Pacemakers are advocated in symptomatic patients, and in some asymptomatic patients with severe and diffuse lesions.

Myotonic muscular dystrophy is a progressive autosomal dominant disorder¹ characterised by amyotrophy, especially obvious in the neck, face, and distal limb muscles, and widespread dystrophic change (cataracts, diabetes, hypogonadism, premature balding) which may be the result of an abnormality of the cell membrane² and myotonia.

The possibility of cardiac involvement was reported by Griffith³ soon after Steinert⁴ had defined the disease which sometimes bears his name. Many reports of electrocardiographic abnormalities followed and large series of patients studied by DeWind and Jones,⁵ Fisch,⁶ and Church⁷ indicated the frequency of atrioventricular and intraventricular conduction defects. Independently, syncope from complete heart block, and sudden death were observed.^{5, 8, 9} Complete heart block therefore seems to be the ultimate expression of a progressive conduction defect.^{10, 11}

The development of electrophysiological methods has allowed a more precise definition of the site of these abnormalities. The results obtained with these techniques in 12 patients with dystrophia myotonica are compared with those previously reported.

Subjects and methods

Twelve patients with dystrophia myotonica were referred by the Departments of Neurology of La

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Pitié-Salpêtrière Hospital for electrophysiological investigation between April 1973 and March 1978.

The indications for this investigation were either typical syncope or faintness associated with electrocardiographic abnormalities (seven cases), or asymptomatic conduction defects (five cases). The 12 patients comprised nine men and three women aged 18 to 69 years (average age 47 years).

The electrophysiological investigation was carried out using Scherlag *et al.*'s technique¹² with three bipolar USCI No 6 electrode wires introduced percutaneously via the femoral vein under local anaesthesia and without premedication. They were positioned in the upper right atrium, at the superior border of the tricuspid ring, and at the apex of the right ventricle. The recording was performed with a 6-channel Siemens ink-jet recorder at speeds of 50 and 100 mm/s.

The following intervals were measured in the basal state:

(a) PA: from the start of the P wave on the surface electrocardiogram to the intrinsic deflection of the atrial wave recorded on the atrioventricular lead (normal values (N): 40 ± 15 ms).

(b) AH: from the intrinsic atrial deflection to the intrinsic deflection of the His potential (N: 70 ± 20 ms).

(c) H duration: (N: 15 to 20 ms).

(d) HV: from the intrinsic deflection of the His potential to the beginning of the ventricular depolarisation taken as the earliest ventricular event

on either the V wave of the His bundle lead or the QRS on a surface electrocardiogram (N: 45 ± 10 ms).

Sinus function was tested by the extrastimulus technique¹³ with measurement of the estimated sinuatrial conduction time (N: 200 ms) and by the corrected sinus node recovery time¹⁴ (N: 500 ms).

Atrioventricular nodal conduction was assessed by measurement of the Wenckebach point, defined as the rate of right atrial pacing at which atrioventricular block is noted (N: 170 ± 20 /min), and by measurement of the refractory periods by the extrastimulus technique.¹⁵ The latter was performed in all patients except cases 2 and 6, for whom it was rendered impossible by supraventricular arrhythmias. The normal values¹⁶ for pacing rate close to that of the sinus rhythm (600 to 750 ms) are given in Table 1.

Table 1

	Effective refractory period	Functional refractory period
A	235 ± 25	227 ± 33
AV	297 ± 20	388 ± 39
V	241 ± 21	265 ± 27

The sensitivity of the study of distal conduction was increased by the ajmaline test. This was performed in cases 1 to 6 using an intravenous injection of 50 mg ajmaline over 1 minute followed by a second injection of 50 mg 5 minutes later; in cases 7 to 12 ajmaline 1 mg/kg body weight was injected at a rate of 1 mg/s. The test was considered positive if the HV interval exceeded 100 per cent of its initial value or exceeded 90 ms.¹⁷

The investigation was performed after withdrawal of all treatment (quinidine, procainamide, phenytoin) which might have modified the values being measured. In case 8 the His potential was also recorded externally during follow-up by signal averaging¹⁸ and summation after suitable amplification, using a PDP 11/20 mini-computer (Fig. 1). In cases 2 and 6 conduction was assessed by RR interval histogram because of atrial arrhythmias (Fig. 2).

Results

These are shown in Table 2. On the surface electrocardiogram, abnormalities were found in all subjects except case 11. First-degree heart block was very frequent, being seen in 9, either as an isolated finding in three or associated with intra-ventricular conduction defects in six. In the presence of supraventricular arrhythmias (cases 2

and 6) atrioventricular conduction was delayed: atrial flutter was conducted either 4:1 or 6:1, and in atrial fibrillation the ventricular cycle length ranged from 600 to 1600 ms. Intraventricular conduction disturbance was more commonly left-sided (four with left bundle-branch block, one with pronounced left axis deviation), than right-sided (three with right bundle-branch block). These abnormalities may become more severe with time; with observations made over a period of six months

Fig. 1 Case 8. Display of analogue signals on the computer terminal. Scale is 50 ms between each vertical dotted line.

Top tracing: A, H, and V recordings by normal bipolar endocardial catheter. Middle tracing: A, H, and V recordings by bipolar catheter with widely separated electrodes (right atrium, right ventricular apex). Bottom tracing: external recordings with digital signal averaging. Each trace is averaged from 100 cycles. The first wave is the amplified and averaged P wave. The arrow points out a wave synchronous to the His bundle recording, between the P and the averaged QRS. The same pattern is found for each averaged series.

to 10 years, the PR interval was seen to lengthen in four cases (cases 1, 7, 8, and 10) and the QRS complexes to widen in four (cases 2, 7, 8, and 10).

Electrophysiological investigation showed sinus node function to be normal in all eight patients in whom it was studied (cases 3, 4, 5, 8, 9, 10, 11, and 12). The intra-atrial conduction as measured by the PA interval was normal in the 10 cases in which it could be measured, but the intra-atrial conduction refractory period was increased in cases 1, 5, 9, 10, 11, and 12. The intranodal conduction time (AH interval) was recorded in 10 cases and increased by 80 to 285 per cent in cases 1, 3, 4, 5, 7, 9, and 12, thus demonstrating block proximal to the bundle of His. The Wenckebach point produced by intra-

nodal block was observed at pacing rates of 100/minute or less in cases 1, 3, 7, and 9. The effective atrioventricular conduction refractory period was increased in cases 1, 3, 5, 7, 9, and 11 (Fig. 3). The functional atrioventricular conduction refractory period was increased in cases 3, 4, 7, and 9. A supraventricular arrhythmia prevented the recording of the refractory periods in two patients but the slow ventricular rhythm in these cases suggested an intranodal conduction defect. Conduction delays at the atrioventricular node were thus observed in nine of 12 patients.

Conduction within the bundle of His was abnormal in cases 5 and 11. First degree bundle-branch block was recorded with widening of the

Table 2 Results in 12 patients

Case no. sex, age (y)	Symptoms	ECG	Intervals (ms)			Wenckebach phenomenon (rate/min)	ERP (ms)	FRP (ms)	Ajmaline test	Conduction defects	Necropsy	
			AH	H	HV							
1 M 50		PR =260	150	15	55	90	A AV V	300 400 160	240 380 200	+	Nodal + distal	-
2 M 69	Faintness	AF, LAD		10	50	—	A AV V	— — —	— — —	+	Nodal + distal	+
3 M 33	Faintness	PR =240	150	15	35	90	A AV V	220 580 260	200 440 240	-	Nodal	-
4 M 23		PR =240, RBBB	125	15	70	140	A AV V	220 520 320	200 300 240	+	Nodal + distal	+
5 M 56		PR =220, LBBB	130	40	60	130	A AV V	320 380 240	360 440 300	+	Nodal + intra- Hisian + distal	+
6 F 52	Faintness	Flutter, LBBB	—	10	40	—	A AV V	— — 320	— — 360	+	Nodal + distal	+
7 F 58	Syncope	PR =380, RBBB	270	10	60	95	A AV V	— 590 300	— 670 280		Nodal + distal	+
8 M 54		PR =200, LBBB	95	10	60	160	A AV V	260 420 —	240 260 —	+	Distal	-
9 M 52	Syncope	PR =240	140	15	55	100	A AV V	280 440 280	260 760 225	+	Nodal + distal	+
10 F 48		PR =220, LBBB	80	10	55	160	A AV V	305 380 300	220 205 250	+	Distal	-
11 M 18	Syncope	Normal	40	20	50	150	A AV V	278 396 300	294 358 260	-	Intra- Hisian	+
12 M 53	Faintness	PR =240, RBBB	190	15	40	160	A AV V	280 360 260	260 300 240	-	Nodal	-

LAD, Left axis deviation; LBBB, left bundle-branch block; RBBB, right bundle-branch block; AF, atrial fibrillation; ERP, effective refractory period; FRP, functional refractory period.

His potential, which was split after an extra-stimulus in case 11. A distal conduction defect with lengthening of the HV interval was observed in 9 of 12 cases, either without drugs (cases 4, 5, 7, and 8) (60 to 70 ms) or after ajmaline (cases 1, 2, 6, 9, and 10) when it increased by more than 100 per cent. Refractory period of intraventricular conduction was increased in cases 6 and 7.

Fig. 2 RR interval histogram of case 2. Periods range from 600 to 2000 ms.

There was little correlation between electrophysiological findings and the symptomatology as severe intra- and infra-Hisian conduction defects were observed both in patients with typical syncopal attacks (cases 7, 9, and 11), in patients with atypical symptoms (cases 1 and 6), and in asymptomatic patients with electrocardiographical abnormalities (cases 2, 4, 5, 8, and 10).

Discussion

Electrocardiographic abnormalities are very frequent in myotonia dystrophica. DeWind and Jones⁵ reported an incidence of 62 per cent in a series of 98 cases, and Church⁷ 85 per cent in 236 cases. In some cases, low voltage P waves or supra-ventricular arrhythmias are observed, atrial flutter more often than atrial fibrillation, associated with slow ventricular rhythms.^{19 20} However, atrio-ventricular and intraventricular conduction defects predominate and are the object of this study: first

Table 3 Incidence of first degree atrioventricular block

Authors	No.	Abnormal	Per cent
Church ⁷	236	89	38
DeWind and Jones ⁵	98	42	43
Fisch ⁴	85	41	48

Fig. 3 Effective refractory periods (A) and functional refractory periods (B) of atrioventricular conduction in 10 patients. Mean values (normal): ERP: 297 ± 20 ms; FRP: 388 ± 39 ms.

degree atrioventricular block is reported in approximately 40 per cent of cases already published (Table 3) and in nine of 12 cases in our series. Higher degrees of atrioventricular block^{5 21 22} or complete heart block^{5 10 23} have also been reported but were not observed in our series. Intraventricular conduction defects have been seen nearly as often (Table 4) associated with long PR intervals in half the cases.

Table 4 Incidence of intraventricular conduction defects

Authors	No.	RBBB	—	LBBB	LAHB
Church ⁷	236		32 (14%)		45 (19%)
Fearrington <i>et al.</i> ¹⁹	17	1 (6%)		3 (18%)	
Laurent ²⁰	138	13 (9%)		18 (13%)	22 (16%)
Schmitt <i>et al.</i> ²⁵	13	2 (15%)		2 (15%)	3 (23%)
Welsh <i>et al.</i> ²⁷	34	5 (14%)		6 (18%)	8 (24%)

LAHB, left anterior hemiblock.

In a review of the existing literature, 33 cases of dystrophia myotonica were found with documented electrophysiological investigations comprising basal AH and HV intervals (Table 5), sometimes with mention of the Wenckebach point,^{22 24 25} and in one case with the ajmaline test.²² This series included 20 instances of atrioventricular block and 15 of intraventricular conduction defects, associated with atrioventricular block in 13 cases.

The indications for electrophysiological investigation were given in only 18 cases; five were for symptoms and 13 were systematic investigation. The authors reported six isolated nodal blocks, seven isolated distal blocks, and 12 multilevel blocks.

Table 5 *Electrophysiological studies in dystrophia myotonica*

Authors	No. of cases
Griggs <i>et al.</i> ¹⁴	11
Josephson <i>et al.</i> ¹¹	2
Leprat ²²	3
Meihac <i>et al.</i> ³⁰	1
Montoyo <i>et al.</i> ³¹	4
Schmitt <i>et al.</i> ³²	8
Thery <i>et al.</i> ³³	1
Uemura <i>et al.</i> ³⁴	3

This is in keeping with our results where conduction defects were sometimes isolated (two nodal blocks, one bundle-branch block, two infra-Hisian blocks), and in general diffuse, multilevel (seven cases) involving the atrioventricular node, the His bundle, and the bundle-branches. It confirms the predominance of widespread involvement of the atrioventricular conduction pathways in dystrophia myotonica; combined experience is reflected in Fig. 4.

Fig. 4 Atrioventricular conduction defects in 37 patients with dystrophia myotonica, according to the site of conduction disturbances (nodal, His bundle, distal).

Severe conduction defects are observed in two out of three investigations, but this reflects a group of patients who were either symptomatic or had abnormal electrocardiograms; the incidence is therefore higher than it would be in an unselected

series. With this reservation, certain conclusions can be drawn as to the management of conduction defects in these patients.

The symptomatology may be unreliable for, though typical syncopal attacks are always associated with high-degree distal blocks, two asymptomatic patients were found to have multilevel block (surface electrocardiogram: first degree block) and a distal block (electrocardiogram normal). The surface electrocardiogram does not always provide full information: 36 abnormal electrocardiograms showed distal (in nine cases) or multilevel (in 18 cases) bundle-blocks in 75% instances. Among these cases distal conduction defects were observed in six of 10 patients with first degree block but narrow QRS complexes, and thus surface electrocardiograms which were more suggestive of simple delay of nodal conduction. Bundle-block and distal block were each discovered once among the nine remaining cases with normal electrocardiograms.

The evolution of these lesions is variable. The progressive deterioration of the conduction defects observed in our series is in accord with previous reports of the appearance¹¹ or aggravation of atrioventricular block,^{8 10 21} or bundle-branch block, usually left-sided.^{10 11}

Sudden death may result from complete heart block^{8 9}; this may cause death in perhaps 10 per cent of cases.²⁶ Conversely, the stability of lesions as observed on the surface electrocardiogram has been the subject of other reports.^{11 27}

The management of these patients is difficult in view of the unknown natural history of the conduction defects in the absence of repeated electrophysiological investigation on a large series of patients, and in view of the rarity of histological studies of the conduction pathways which may be affected at all levels^{28 29} In previous publications permanent pacing was reserved for all patients with a history typical or suggestive of Adams-Stokes syncope.^{10 21 23} Our attitude is slightly different. pacemakers are implanted in all patients with a typical or suggestive history of syncope with multilevel or distal conduction defects. On the other hand, a wait-and-see attitude is adopted for asymptomatic patients despite the presence of distal or multilevel conduction defects. Non-invasive His bundle recording, when possible, may be used for the follow-up of such patients, as in one of our cases. The implantation of a pacemaker is, however, recommended to prevent iatrogenic aggravation of conduction defects in patients on drugs known to depress the conduction distal to the bundle of His, such as quinidine and procainamide.

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Requests for reprints to Dr Robert Frank, Service de Cardiologie, Hôpital de la Salpêtrière, 47 Boulevard de l' Hôpital, 75013 Paris, France.