THE DIAGNOSTIC SIGNIFICANCE OF AN INCREASED Q-T INTERVAL IN THE ELECTROCARDIOGRAM

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The principal factor which influences the duration of electrical systole as indicated by the Q-T interval of the electrocardiogram is the heart rate.[1] In studies of the effect of other factors upon the length of electrical systole, corrections, therefore, must be made for the influence of variations in the heart rate. This can be done either by the use of the chart constructed by White and Mudd[1] or by employing Bazett's[2] formula: systole $= K\sqrt{\text{cycle}}$. For purposes of clinical application the use of the chart of White and Mudd appears to be more practical than the use of the formula.

Prolongation of the period of electrical systole often is observed in association with such electrocardiographic abnormalities as bundle branch block, ventricular paroxysmal tachycardia, ventricular premature beats and auricular paroxysmal tachycardia.[1] It also has been known for many years that a low serum calcium value may be accompanied by a prolonged Q-T interval,[1,3,4,5] and more recently[6] attention has been directed to the fact that a reduction in the concentration of the serum potassium may be responsible for lengthening of electrical systole. In two patients who had tetany, White and Mudd[1] observed a prolongation of the Q-T interval beyond the normal when the serum calcium content was extremely low (4 to 6 mg. per 100 cc.). When the serum calcium value rose above 6 mg. per 100 cc., however, the duration of the Q-T interval usually fell within the limits of normal. It would seem, therefore, that although a reduction in the concentration of serum calcium may fail to reflect itself in significant changes in the duration of electrical systole, the presence of a prolonged Q-T interval in an electrocardiogram showing none of the disturbances of conduction or rhythm mentioned above should suggest the possibility of a reduced concentration of serum calcium or serum potassium. The results of the present study confirm this opinion.

MATERIAL AND RESULTS

Electrocardiograms and measurements of the concentration of serum calcium and phosphorus were made in fifteen patients (Table 1). Twelve individuals were suffering from acute or chronic parathyroid tetany but in none were the symptoms of more than moderate severity. The lowest serum calcium content recorded was 6.4 mg. per 100 cc. Two patients had hypocalcemia due to chronic glomerulonephritis; the lowest serum calcium value in one of these was 6.1 mg. per 100 cc. and in

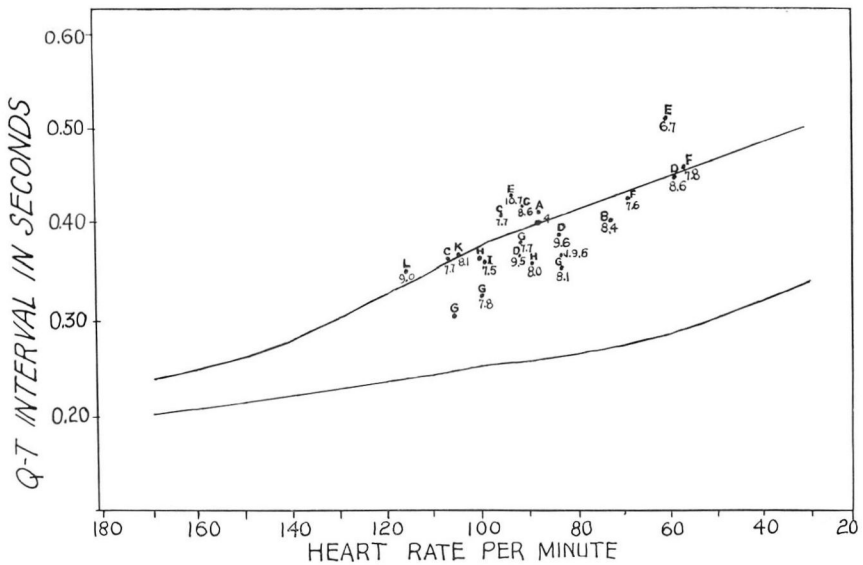

FIGURE 1: The Q-T Interval of Twelve Patients with Hypocalcemia Due to Postoperative Tetany.

The lines indicating the limits of normal for the Q-T interval are from the chart of White and Mudd[1]. The serum calcium content (in milligrams per 100 cc.) is indicated by the figure below each dot representing a Q-T interval.

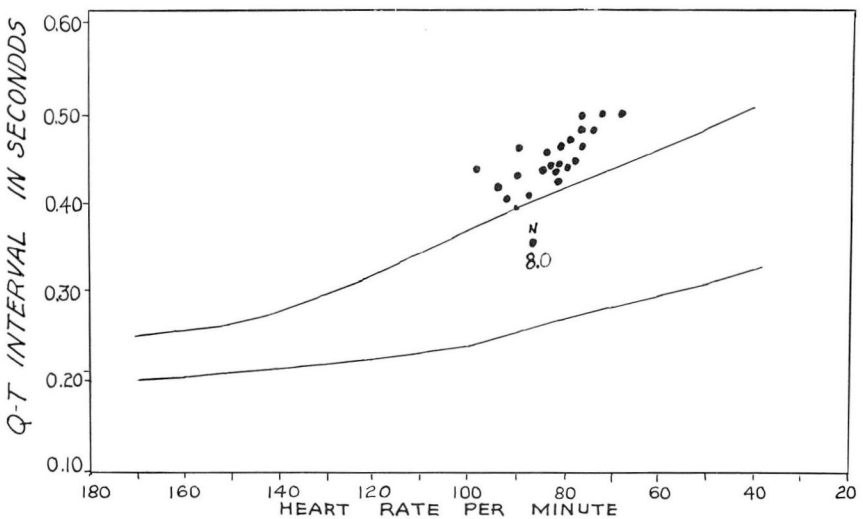

FIGURE 2: The Q-T Interval of Two Patients with Hypocalcemia Due to Chronic Glomerulonephritis.

The lines indicating the limits of normal for the Q-T interval are from the chart of White and Mudd[1]. The measurement on patient N is indicated by the letter above the dot and the serum calcium content by the figure below the dot.

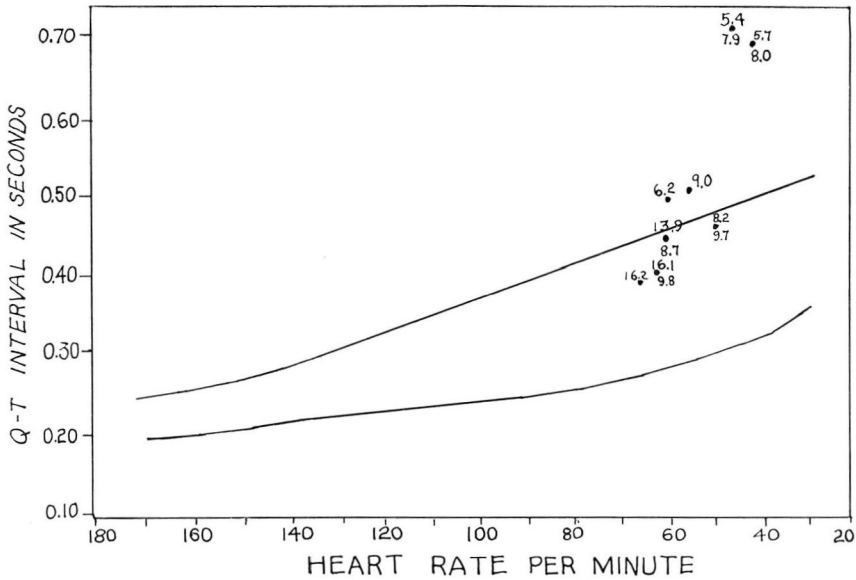

FIGURE 3: The Q-T Interval in a Patient with Addison's Disease Under Treatment with Desoxycorticosterone Acetate.

The lines indicating the limits of normal for the Q-T interval are from the chart of White and Mudd[1]. The serum calcium content is indicated by the figures below each dot representing a Q-T interval and the serum potassium content by the figures above the dot.

the other, 7.9 mg. per 100 cc. One person had Addison's disease and was being treated with desoxycorticosterone acetate. In this case the serum calcium concentration ranged from 7.9 mg. to 9.8 mg. per 100 cc.

The observations on the Q-T interval in the patients who had tetany are presented in Figure 1. In five of the twelve individuals the Q-T interval was found to be prolonged beyond the limits of normal on one or more occasions. Values at the upper limit of normal were recorded in two of the remaining patients, while in all of the others the duration always was perfectly normal. No suggestion of a mathematical relationship between the level of the serum calcium and the duration of the Q-T interval was observed.

In one patient with chronic glomerulonephritis and hypocalcemia, the Q-T interval was invariably prolonged (22 observations), while in the second individual the Q-T interval was normal in the one electrocardiogram which was made (Fig. 2).

The greatest prolongation of the Q-T interval was observed in the patient who had Addison's disease and who was being treated with desoxycorticosterone acetate (Fig. 3). The serum calcium concentration was higher in this individual than in many of the other patients studied. The serum potassium content, however, was greatly reduced

TABLE 1

THE DURATION OF ELECTRICAL SYSTOLE IN HYPOCALCEMIA

Case	*Sex*	*Age*	*Date*	*Q-T Interval*	*Heart Rate*	*Serum Ca.*	*Serum P.*	*Remarks*
A	F	39	8/12/39	.40	87	6.4	4.4	Resection of recurrent thyroid adenoma 8/10/39. Mild tetany.
B	F	56	9/15/39	.40	72	8.4	4.8	Chronic postoperative tetany. Thyroidectomy, 1929.
C	F	29	9/12/39 9/15/39	.36 .41	107 93	7.7 7.7	4.2 5.5	Thyroidectomy 9/9/39. Mild tetany.
D	F	55	1/17/36 1/20/37 2/17/40	.38 .36 .46	80 90 58	9.6 9.5 8.6	5.9 5.7 4.4	Chronic postoperative tetany. Thyroidectomy, 1928.
E	F	42	4/17/40 4/20/40	.52 .40	60 92	6.7 10.7	5.9 2.6	Chronic postoperative tetany. Thyroidectomy 7/14/39.
F	F	51	5/13/40 5/14/40 5/16/40	.41 .43 .47	83 66 57	 7.6 7.8	 6.4 5.3	Resection of recurrent adenoma 5/10/40. Mild tetany.
G	F	58	5/16/40 5/22/40 5/24/40 5/27/40 5/31/40	.30 .42 .36 .36 .32	108 90 80 90 100	 8.6 8.1 7.7 7.8	 3.4 4.3 5.7 3.6	Thyroidectomy 5/20/40. Mild tetany. Parathormone (100 units) daily from 5/27 to 5/30 and 30 gm. Ca. lactate orally.
H	F	49	7/25/39 7/28/39	.36 .36	100 88	 8.0		Thyroidectomy 7/22/39. Moderately severe tetany.
I	F	26	7/29/39	.36	100	7.5	5.0	Thyroidectomy 4/24/39. Mild tetany.
J	F	29	8/28/39	.36	80	9.5	5.5	Thyroidectomy 11/20/23. Chronic mild postoperative tetany.
K	F	40	9/18/39	.36	105	8.1	4.3	Thyroidectomy 9/16/39. Mild tetany.
L	F	40	3/27/40	.34	116	9.0	4.0	Thyroidectomy 3/25/40. Mild tetany.
M	M	46	8/26/39 8/28/39 8/29/39 8/30/39 8/31/39 9/1/39 9/5/39 9/6/39 9/9/39 9/11/39 9/12/39 9/15/39 9/16/39 9/18/39 9/19/39 9/20/39 9/22/39 9/23/39 9/25/39 9/26/39 9/28/39 10/18/39	.50 .46 .44 .48 .44 .46 .50 .48 .50 .46 .44 .40 .40 .41 .45 .46 .44 .42 .42 .42 .42 .41	72 80 78 76 98 76 68 74 77 78 78 87 92 93 84 89 83 90 83 82 82 80	6.2 6.1 7.6 5.4 6.4 6.2 5.9 6.3 7.5 6.7 8.0 8.4 8.9 8.7 9.3 8.9 8.8 8.5 8.3 8.0 6.9	 8.3 10.6 10.0 11.4 11.0 11.0 9.1 9.8 10.0 11.8 11.8 11.3 10.0 11.2 11.8 11.3 11.3 11.3 11.3 10.1	Chronic *glomerulonephritis*. Given A.T. 10 from 9/1/39 to 9/22/39. Blood urea 162-243 mg. per 100 cc. Died 10/28/39.
N	M	38	10/2/39 10/4/39 10/5/39	.34	86	8.0 7.9	9.1 10.4	Chronic glomerulonephritis. Blood urea 330 mg. per 100 cc.
O	F	37	3/2/40 3/11/40 3/20/40 4/5/40 4/17/40 4/25/40 5/2/40 11/2/40	.68 .48 .50 .70 .46 .44 .40 .38	48 62 56 54 52 62 64 66	8.0 9.0 7.9 9.7 8.7 9.8	2.5 2.6 2.9	Addison's disease, receiving desoxycorticosterone acetate.

below normal during the earlier observations and later returned to normal. With this change the duration of the Q-T interval likewise became normal. Although the lowest serum calcium values were obtained when the Q-T interval was longest, the subnormal serum potassium concentration appeared to be of greater importance than the hypocalcemia in prolonging the Q-T interval.

Summary and Conclusions

Electrocardiograms and measurements of the serum calcium concentration were made in twelve patients who had acute or chronic parathyroid tetany, in two individuals with hypocalcemia due to chronic glomerulonephritis, and in one patient with Addison's disease who was being treated with desoxycorticosterone acetate. The Q-T interval of the electrocardiogram was abnormally prolonged on one or more occasions in five of the twelve individuals with tetany, in the patient with Addison's disease, and in one of the two individuals with chronic glomerulonephritis. There was no apparent mathematical relationship between the level of the serum calcium and the duration of the Q-T interval. The greatest prolongation of the Q-T interval was observed in the patient who had Addison's disease and who was being treated with desoxycorticosterone acetate. In this patient the subnormal serum potassium concentration appeared to be of greater importance than the hypocalcemia in prolonging the Q-T interval.

The observations indicate that although hypocalcemia does not always increase the duration of electrical systole, the presence of a prolonged Q-T interval should lead one to consider the possibility of a subnormal concentration of either calcium or potassium in the blood serum.

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