THE INFLUENCE OF EXPERIMENTAL THYROID INTOXICATION ON THE POTASSIUM, SODIUM, AND WATER CONTENT OF THE MYOCARDIUM

By EATON M. MacKAY and H. C. BERGMAN

(From the Scripps Metabolic Clinic, La Jolla, Calif.)

(Received for publication December 21, 1931)

Harrison et al. (1) analyzed samples of cardiac and skeletal muscle obtained from patients who had died of congestive heart failure and found them to be abnormally poor in potassium. It is their belief (2, 3) that this diminution in the potassium content is related to overwork and the attendant fatigue. The heart in experimental thyrotoxicosis seemed to offer a possible opportunity of examining the hypothesis in question under controlled conditions. In addition, the effect of thyroid intoxication on the potassium content of the greatly enlarged heart has an interest of its own.

Thirty-six male albino rats 140 days old and 14 rats 100 days old were divided into two groups on the basis of body weight. For two weeks they all received a special diet described elsewhere (4). In addition the diet of one group had 0.2 per cent of desiccated thyroid (Wilson Laboratories) intimately mixed with it. At the end of the period the rats were etherized and the heart removed, freed of adherent blood by blotting on filter paper, weighed on an analytical balance, and preserved for analysis. The water content of the tissue was determined by drying to constant weight at 80° C. in vacuo. The residue was then ashed with the aid of nitric acid and heat. Either sodium or potassium was determined on the ash, the small quantity of sample precluding both determinations upon a single heart. For sodium the modification of the uranyl zinc acetate method described by Butler and Tuthill (5) was used and for potassium the volumetric modification of the chloroplatinate method described by Shohl and Bennett (6). The potassium content was determined in the hearts of 15 animals of each group and the sodium content measured in those of the remainder.

The results have been tabulated in Table I. The administration of thyroid substance, although producing the usual marked increase in the weight of the heart, was without demonstrable effect upon the water, potassium or sodium content of the myocardium.

The data tabulated here give no support to the idea that overwork or fatigue causes a diminution in the potassium content of cardiac muscle insofar as the effect of thyroid substance is concerned. They

TABLE I

The influence in the albino rat of experimental thyroid intoxication upon the potassium, sodium and water content of the myocardium

Number	Controls						Thyroid fed					
	Body weight		Heart weight	Heart H_2O	K Per cent wet heart	Na Per cent of wet heart	Body weight		Heart weight	Heart H_2O	K Per cent wet heart	Na Per cent of wet heart
	Initial	After death					Initial	After death				
	grams	*grams*	*mgm.*	*per cent*	*per cent of fresh tissue*	*per cent of fresh tissue*	*grams*	*grams*	*mgm.*	*per cent*	*per cent of fresh tissue*	*per cent of fresh tissue*
1.....	186	213	598	75.8	0.378		229	228	1053	77.1	0.349	
2.....	238	258	677	75.8	0.370		*158	176	806	75.2	0.375	
3.....	220	248	694	75.2	0.358		238	220	1024	75.8	0.347	
4.....	216	239	691	76.0	0.326		*163	182	879	75.3	0.341	
5.....	213	223	681	75.9	0.320		*156	164	755	75.4	0.327	
6.....	261	297	769	75.4	0.322		270	270	1116	77.0	0.296	
7.....	252	295	754	76.1	0.304		*182	194	945	75.1	0.322	
8.....	210	228	600	76.0	0.300		185	184	842	75.3	0.317	
9.....	*194	239	660	75.6	0.302		170	168	844	76.6	0.297	
10.....	*165	200	626	74.7	0.312		245	226	1044	76.5	0.297	
11.....	*153	180	526	74.5	0.304		191	197	875	75.2	0.310	
12.....	*148	176	540	74.6	0.300		214	207	856	75.5	0.304	
13.....	171	200	624	75.3	0.292		213	194	940	75.5	0.275	
14.....	*166	208	592	75.0	0.289		213	224	903	75.7	0.256	
15.....	234	273	772	75.4	0.258		220	210	1118	75.3	0.259	
16.....	*142	181	527	75.2		0.096	197	213	933	77.9		0.087
17.....	*140	178	520	74.8		0.088	200	193	915	77.4		0.085
18.....	220	254	624	75.1		0.086	*128	148	756	76.2		0.086
19.....	*132	160	540	75.1		0.076	216	210	955	77.0		0.082
20.....	227	264	698	76.6		0.074	*145	162	846	74.5		0.087
21.....	225	289	762	75.9		0.068	228	232	1079	76.6		0.078
22.....	236	294	803	75.7		0.068	200	199	866	77.0		0.076
23.....	208	222	582	75.2		0.064	235	236	1021	75.6		0.080
24.....	220	227	715	76.3		0.064	222	221	860	76.3		0.077
25.....	200	245	656	75.6		0.054	*142	154	680	75.3		0.074
Average...	199	234	649	75.6	0.316	0.074	199	200	917	76.1	0.311	0.081

* 100 days old.

cannot, however, be interpreted as directly opposing this hypothesis proposed by Harrison (2,3), for there is some doubt (7) that heart failure ever occurs in goiter with hyperthyroidism as its sole cause. If this is true our assumption that thyroid intoxication produces overwork and fatigue of the myocardium may be incorrect.

The constancy in the potassium content of the heart muscle before and following thyroxinization is very interesting. It would appear to indicate that the increase in heart weight is a simple hypertrophy, the tissue having essentially the same composition after the remarkable weight increase as before the administration of thyroid material.

SUMMARY

The increase in heart weight which ensues when active thyroid material is administered to the albino rat is without demonstrable effect upon the potassium, sodium or water content of the myocardium.

BIBLIOGRAPHY

1. Harrison, T. R., Pilcher, C., and Ewing, G., J. Clin. Invest., 1930, viii, 325. Studies in Congestive Heart Failure. IV. The Potassium Content of Skeletal and Cardiac Muscle.
2. Calhoun, J. A., Cullen, G. E., Clarke, G., and Harrison, T. R., J. Clin. Invest., 1930, ix, 393. Studies in Congestive Heart Failure. VI. The Effect of Overwork and Other Factors on the Potassium Content of the Cardiac Muscle.
3. Calhoun, J. A., and Harrison, T. R., J. Clin. Invest., 1931, x, 139. Studies in Congestive Heart Failure. IX. The Effect of Digitalis on the Potassium Content of the Cardiac Muscle of Dogs.
4. MacKay, E. M., and MacKay, L. L., J. Exp. Med., 1926, xliii, 395. Compensatory Hypertrophy of the Adrenal Cortex.
5. Butler, A. M., and Tuthill, E., J. Biol. Chem., 1931, xciii, 171. An Application of the Uranyl Zinc Acetate Method for Determination of Sodium in Biological Material.
6. Shohl, A. T., and Bennett, H. B., J. Biol. Chem., 1928, lxxviii, 643. A Micro Method for the Determination of Potassium as Iodoplatinate.
7. McEachern, D., and Rake, G., Johns Hopkins Hosp. Bull., 1931, xlviii, 273. A Study of the Morbid Anatomy of Hearts from Patients Dying with Hyperthyroidism.