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Birefringence and Contractile Power of Muscles During Atrophy Due to Upper Neurone Lesions or Tenotomy.

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In a recent paper Solandt and Magladery[1] reported that rat muscles deprived of the upper motor neurone control, atrophy to about half of their original weight during the first 2 weeks, but that thereafter the spastic muscles regain weight to a considerable extent. About 1½ years ago, I made similar observations when trying to determine during muscular atrophy due to section of the upper neurones or to tenotomy, the relation between birefringence and contractile power (direct stimulation with currents of optimal frequency and duration). The cumbersome method of the determination of birefringence restricted my experience to a very limited number of rats, and, since the secondary gain in weight of the spastic muscles threw some doubt upon the completeness of the elimination of the upper neurone control, I did not publish my results. Since the correctness of this secondary weight gain has been confirmed now on much more material with sufficient controls, my results concerning the contractile power during atrophy due to upper neurone lesions have gained in significance. The methods employed were those reported for the investigation of the atrophy of denervated rat gastrocnemius-soleus muscles.[2] The elimination of the upper motor neurone control was accomplished either by semisection of the spinal cord in the region of the fifth or sixth vertebra or by total section of the cord at this level. In the latter case, the sciatic nerve of the opposite side was resected simultaneously in order to enable a direct comparison between upper neurone and final neurone atrophy. In the experiments with atrophy due to tenotomy, the *os calcis* was clipped off and sutured to the skin.[3] The tables of this paper contain for comparison purposes some of the data found for denervation atrophy and previously published.[2] Table I gives the data for atrophies of 9 to 10 days' duration. For all 3 types of atrophy, there exists no diminution in contractile power per weight unit and no diminution in birefringence, despite the fact that the

[1] Solandt, D. Y., and Magladery, J. W., *Proc. Am. Physiol. Soc.*, 1941, p. 268.

[2] Fischer, E., *Am. J. Physiol.*, 1940, **131**, 156.

[3] Hines, H. N., and Knowlton, G. C., *Am. J. Physiol.*, 1940, **128**, 97.

TABLE I.
Comparison of Left Muscle with Right Muscle of the Same Rat.

Exper. procedure	Days after operation	Wet wt		Tension		Gram tension per g wet wt	Total birefringence	
		Right g	Left g	Right g	Left g	Left in % of right	Right 10^{-3}	Left in % of right
Left hemisection spinal cord	9	1.465	1.058	1550	1100	98.6	2.37	102.7
	10	2.466	1.803	2250	1700	103.6	2.54	101.3
Total section spinal cord and left sciatic nerve	10	1.877	1.656	1850	1600	98.3	2.58	97.3
	10	2.080	1.635	2050	1650	100.6	2.23	99.6
Tenotomy of left Achilles tendon	9	2.661	2.132	2300	1850	100.7	2.35	98.5
	10	2.055	1.403	2150	1550	105.2	2.43	101.3
Section of left sciatic nerve	9	2.929	2.060	2350	1800	109.1	2.26	101.8
	10	1.971	1.109	2350	1350	104.2	2.61	97.6

atrophy as manifested by weight loss is distinct. This weight diminution is larger for denervation atrophy than for upper neurone atrophy, while tenotomy results in a weight loss as considerable as that by denervation. The results obtained 21 to 35 days after operation are given in Table II. The weight losses have become more distinct for denervation and tenotomy atrophy, while in the experiments with upper neurone lesions there is apparently a regain of

TABLE II.
Comparison of Left Muscle with Right Muscle of the Same Rat.

Exper. procedure	Days after operation	Wet wt		Tension		Gram tension per g wet wt	Total birefringence	
		Right g	Left g	Right g	Left g	Left in % of right	Right 10^{-3}	Left in % of right
Left hemisection spinal cord	21	2.432	1.882	2300	1750	98.4	2.33	98.3
	28	1.769	1.385	2150	1650	98.3	2.41	100.2
	35	2.226	1.913	1950	1700	101.5	2.38	97.0
Total section spinal cord and left sciatic nerve	27	1.922	1.198	1950	850	70.1	2.35	62.3
	32	2.045	0.868	2050	600	68.8	2.61	58.7
	34	1.783	0.675	1950	500	67.7	2.46	68.4
Tenotomy of left Achilles tendon	23	1.933	1.035	1850	1000	96.5	2.21	96.5
	28	2.567	1.223	2350	1150	102.8	2.38	98.3
	32	2.278	1.185	2250	1100	98.7	2.45	98.7
Section of left sciatic nerve	23	2.056	0.804	2100	550	67.0	2.43	71.3
	29	1.906	0.621	2150	500	70.5	2.47	67.0
	33	1.793	0.561	1850	350	59.9	2.34	63.3

weight. Only in the case of denervation atrophy, the contractile power per weight unit shows a diminution, and this loss in power corresponds roughly to the simultaneously observed diminution in birefringence. This parallelism between contractile power per weight unit and birefringence can serve as a further indication that the submicroscopic crystalline structure of the muscle is essential for the contractile mechanism.

Summary. Although in muscular atrophy, either due to final or upper neurone lesions, or due to tenotomy, there is a distinct weight loss after 9 to 10 days, the muscles have at that time still the same contractile power per weight unit and the same birefringence as normal muscles. But 3 to 5 weeks after onset of the atrophy, only muscles atrophying due to upper neurone lesions or to tenotomy have still the contractile power per weight unit and the birefringence of normal muscle. However, for denervated muscle, contractile power and birefringence are distinctly diminished at that time. Only in the latter type of atrophy does the submicroscopic crystalline structure, so essential for the contraction process, become seriously impaired.

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Excretion of Pregnandiol in Women with Virilism.

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Butler and Marrian[1] in reporting the isolation of a steroid compound pregnane-3-17-20-triol, from the urine of 2 women with virilism caused by "enlarged adrenals," also noted the presence of "appreciable amounts of pregnandiol." Venning, Weil and Browne[2] later reported the finding of considerable amounts of sodium pregnandiol glucuronidate (12 mg to 30 mg per day) in 2 cases of virilism, one of which was subsequently found to have an adrenal cortex carcinoma and, the other, adrenal cortex hyperplasia.

During the past 2 years, we have been performing pregnandiol excretion studies in women with the arrhenomimetic (virilism) syndrome. In the present communication, we wish to report the results of these studies.

[1] Butler, G. C., and Marrian, G. F., *J. Biol. Chem.*, 1937, **119**, 565; *Nature*, 1938, **142**, 400.

[2] Venning, E. H., Weil, P. G., and Browne, J. S. L., *J. Biol. Chem.*, Scien. Proc., 1939, **128**, CVII.