Summary. A technic for the study of gastric absorption is presented by which the pyloric opening can be completely blocked without operation or disturbance of blood supply in human subjects that are in every way normal. Methods of detecting immediately failure of the blocking device insure against false surmise in the interpretation of results.

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Histological Changes in Skeletal Musculature of Paralyzed Suckling Young of E-Low Rats.*

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Evans and Burr[1] first described the partial or complete paralysis affecting a high percentage of suckling young of vitamin E-deficient rats. Olcott[2] found that a degeneration of the cross striated musculature occurs in such paralyzed rats not unlike the nutritional muscular dystrophy earlier observed in herbivores by Goettsch and Pappenheimer,[3] Woodward and McCay,[4] Madsen, McCay and Maynard,[5] Victor,[6] and Morgulis and Spencer.[7] Lipschutz,[8] although not studying the musculature, reported that suckling E-deficient rats had definite lesions in the vestibular nuclei and their connections, and in the extra pyramidal tracts, proprioceptive tracts, and ventral horn cells of the cord. Olcott[2] observed "no abnormalities in the nerves,

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1 Evans, H. M., and Burr, G. O., *J. Biol. Chem.*, 1928, **76**, 273.

2 Olcott, H. S., *J. Nutrition*, 1938, **15**, 221.

3 Goettsch, M., and Pappenheimer, A. M., *J. Exp. Med.*, 1931, **54**, 145.

4 Woodward, J. C., and McCay, C. M., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 241.

5 Madsen, L. T., McCay, C. M., and Maynard, L. A., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 1434.

6 Victor, J., *Am. J. Physiol.*, 1934, **108**, 229.

7 Morgulis, S., and Spencer, H. C., *J. Nutrition*, 1936, **11**, 573.

8 Lipschutz, D., *Revue Neurologique*, 1936, **65**, 221.

cord, or brain." An investigation of all neurological lesions in vitamin E-deficiency is in progress in this laboratory.

Materials and Procedure: A total of 151 suckling rats were used in this study. All were born of young E-deficient mothers of proved sterility which had received, on the day of the second positive mating, one gram of a standardized wheat germ oil, a quantity little more than sufficient to insure a single normal gestation. Each litter was divided into experimental and control groups. The 81 experimental E-low rats were kept with their mothers held on E-free diet 808.†

Seventy control littermates were treated by 2 methods, both with equal success. Wheat germ oil was administered to one control group 6 times weekly by dropper or stomach tube after day 5 or day 10 until weaning. The second control group was placed with foster E-free mothers which were given a dose of 2 g of wheat germ oil immediately following parturition.

The 81 suckling young of the untreated mothers presented the following clinical pictures:

(1) 31 showed no visible signs of paralysis.

(2) 50 showed some degree of paralysis—varying in severity from a slight gait impairment to a complete loss of function of the hind limbs and a marked reduction in forelimb action.

Claw flexion of the foretoes was frequently observed in these animals. Such rats moved only by the action of the forelimbs, with the hind extremities passively extended. They found it extremely difficult to right themselves when placed on their side or back and vigorous tail movement was the principal factor in enabling them to recover their equilibrium. Another consistent observation with these animals was the presence of a thin corneal film. The development of this syndrome may be a gradual process extending over a period of from 2 to 5 days, or it may have a sudden onset, being full flowered in the morning, when not apparent the preceding evening. Young rats that develop the paralysis may (1) die suddenly, (2) linger for a maximum period of 8 to 10 days and then die, or (3) recover spontaneously without the administration of vitamin E to the diet.

† Diet 808:

Casein (commercial)	27
Cornstarch (cooked)	30
Lard	22
Cod liver oil	2
Brewers' yeast	15
Salts No. 185	4

(With the exception of the cod liver oil, all ingredients of the diet were allowed to stand at room temperature for 2 weeks. The resulting rancidity of the lard destroyed any vitamin E in the diet. Cod liver oil was added just before feeding.)

This experiment was planned to correlate the clinical conditions of these animals with the observed histological changes.

Upon autopsy at 3 weeks of age, the gastrocnemius and soleus muscles were removed, spread on a strip of cork and fixed immediately in Zenker-formol or Susa fixative. Other muscles such as the sternohyoid, deltoid and trapezius were in some instances removed and treated as the above. The tissues were embedded by the rapid nitrocellulose method of Koneff and Lyons,[9] sectioned at 6 to 8 micra and stained with Harris hematoxylin-eosin, iron hematoxylin-aniline blue,[10] and iron hematoxylin-aniline-blue-methyl green.‡

Experimental. Degeneration was demonstrable in the skeletal muscles of all paralyzed suckling young of E-deficient rats. The progress of the malady may be divided into 2 phases—(1) a degeneration stage and (2) a regeneration stage.

The degenerative phase manifests itself in 2 pathological processes—firstly, a hyaline or Zenker degeneration of the fibers themselves, and, secondly, the infiltration of white blood cells and connective tissue elements with reactive multiplication of muscle nuclei.

Figure 1 shows the histological picture of the normal skeletal muscle.

The first stage of degeneration can often be demonstrated histologically before the animal shows any obvious signs of paralysis. The lesions are confined to separate or small groups of fibers, healthy normal muscle tissue being interspersed (Fig. 2). The lesion manifests itself as a waxy, hyaline or Zenker degeneration of the individual muscle fibers. In the necrosis of the fiber, the contractile substance becomes coagulated and breaks up into swollen homogeneous hyaline segments. These masses may attain a diameter double that of the normal fiber. As the degeneration progresses the swollen segments (1) lose their hyalinization and become granular, (2) become reduced in size, (3) and finally become debris in the intrasarcolemmal space. The muscle nuclei also undergo change. They are crowded against the sarcolemma of the swollen fiber segments and are pyknotic.

As the degeneration progresses an increasing number of the muscle fibers are affected (Fig. 3). The rapid loss of cross and longitudinal striations is striking. The fibers are non-continuous, segmented, amorphous masses. The cytoplasm of the affected fibers stains darker with eosin. The beginning invasion of phagocytic cells

[9] Koneff, A. A., and Lyons, W. R., *Stain Technology*, 1937, **12**, No. 2.

[10] Koneff, A. A., *Anat. Record*, 1936, **66**, 173.

‡ Developed by Dr. A. A. Koneff of the Division of Anatomy, procedure as yet unpublished.

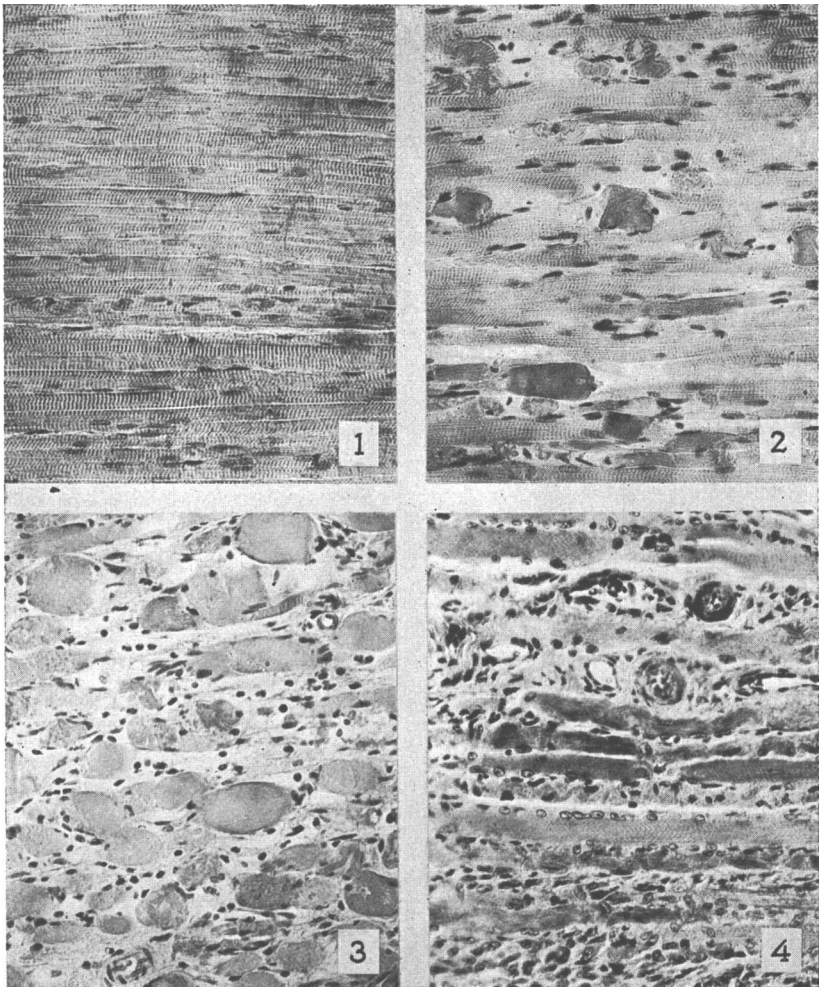

FIG. 1. Section of gastrocnemius muscle from a normal 21-day-old rat.
FIG. 2. Section of gastrocnemius muscle from a 21-day-old vitamin E-low rat with no obvious paralysis.
FIG. 3. Section of gastrocnemius muscle from a 22-day-old vitamin E-low rat with marked paralysis.
FIG. 4. Section of gastrocnemius muscle of a 24-day-old vitamin E-low paralyzed rat showing leucocyte infiltration and muscle nuclei multiplication stage.
All slides stained with hematoxylin and eosin. × 243.

is now noticeable. These histological changes are found in animals showing marked locomotive impairment.

When clinical signs of definite paralysis occur, such as dragging of the hind extremities, the second stage can be histologically demonstrated. This phase is characterized by the fact that there has been

an extensive infiltration of leucocytes and rows of muscle nuclei indicate the position of preëxisting fibers (Fig. 4). Some of the original muscle nuclei, displaced and distorted by the swelling of the fiber, are also found crowded on the sarcolemma. Later they undergo complete karyorrhexis and may disappear. The collapsed fibers often contain only granular debris and newly formed nuclei.

In the succeeding stage of this dystrophy, characterized clinically by an improvement in locomotion and lessening of the paralysis, there is already histologically a regeneration of part of the muscle fibers. Within an area filled with infiltrated leucocytes, connective tissue elements and debris, newly formed isolated fibers appear. In accordance with the description given by Forbus[11] of regenerating skeletal muscle, these fibers always arise in connection with the rows of muscle nuclei. Subsequently myo-fibrils develop between the nuclei and regenerated fibers with well defined cross and longitudinal striations appear. The nuclei stain lightly with hematoxylin and are at first centrally placed in the fiber.

Summary. The skeletal musculature of paralyzed young of E-low rats invariably shows a progressive degeneration which is correlated with the severity of the paralysis. In those cases where, as described in the preceding paper, a spontaneous recovery from the paralysis has occurred, a regeneration of the musculature can be observed to have taken place.

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Experimental Production of Arteriolonecrosis and Medionecrosis of Arteries by Means of Tyramine Injections.

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It is the opinion of many workers that certain forms of hypertension are produced by means of a pressor substance elaborated in ischemic renal tissue. Wolf and Heinsen[1] have expressed the belief that tyramine is in fact the pressor substance responsible for the development of hypertension in animals rendered hypertensive by

[11] Forbus, W. D., *Arch. Path.*, 1926, **2**, 318.

[1] Wolf, H. J., and Heinsen, H. A., *Arch. f. exp. Path. u. Pharmakol.*, 1935, **179**, 15.