BASOPHILIC DEGENERATION OF HEART MUSCLE *

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In 1910, Hewitt,[1] as a result of a study in the Department of Pathology of the University of Minnesota, published a paper entitled, "A Peculiar Degeneration Found in Heart Muscle Cells." Therein he described the lesion as "a small, round, oval, or irregular pale blue area inside of a single muscle cell." He continued, "With high power these degenerations show a slight bluish mottling, somewhat irregularly defined. . . . They sometimes occupy only a portion of the cell, at other times almost the whole of the cell is filled with blue staining material, but always enough of the cell remains to show that it is a heart-muscle cell." As far as the literature has been reviewed, there is no other reference to this type of lesion.

My investigation is based on a study of routinely obtained sections of the heart derived from 320 consecutive postmortem examinations. Blocks of tissue were taken from the septum and both ventricles of each heart that was studied; these were hardened in Orth's fixative and embedded in paraffin. The sections were then stained in the routine manner with hematoxylin and eosin, and in addition with various other stains which will be discussed later.

The lesion described by Hewitt was found in 107, or 33.43 per cent of the 320 hearts examined. The areas of degeneration were of microscopic size. It is my impression that the degeneration passes through several phases. With the hematoxylin and eosin stain, the degenerated portions were seen as basophilic patches which generally occupied the centers of the muscle bundles and frequently included the well preserved, often hypertrophied, nucleus. They always were of well defined limits and at the periphery of each was a zone of normal muscle tissue. No tissue reaction could be seen in the degenerated areas. In the immediate neighborhood, and even in the continuation of the involved muscle bundle, the normal structure was preserved. No gross change in the heart muscle could be observed.

In the early stage of the process these degenerated areas stained a rather dark blue, were fairly dense, finely granular, occasionally

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clumped, and sometimes included fragments of muscle fibers (Fig. 1). As the process advanced these areas stained a lighter blue and what was apparently vacuolization appeared (Figs. 2 and 3). In very advanced stages there was left only a fine network of basophilic, intertwining fibers, which included small tissue spaces (Figs. 4 and 5). In this stage the lesion was rather indistinct. If the lesion were very small, or if the heart muscle were cut transversely, the areas were difficult to find; otherwise they were easily distinguished. They might be scattered diffusely throughout the tissue and only a few could be found, and at other times they might be numerous.

The most frequent single site of the lesion (Table I) was the septum. Closely following this in frequency was the left ventricle; the right ventricle showed fewer lesions. Of the cases in which the lesion was found in more than one site, those in which the septum and left ventricle were involved were the most numerous. It is interesting to note that the lesion was found only five times in the right ventricle alone, and was found in combination in the right ventricle and septum only twice.

There was no significant difference in incidence as to sex. Of the 320 hearts, 204 were from males and 116 from females. The regions of degeneration were found in 70 hearts of males and in 37 hearts of females, or in a total of 107 of the entire 320 hearts.

Considering the incidence of the lesion, it is astonishing that only the preliminary report by Hewitt has been found in the entire literature, as far as it has been reviewed. Hewitt presented 2 cases of basophilic degeneration of the heart muscle which he had found in routine examination of sections of heart. The number of hearts he examined is not given, but his study covered 6 months. In my series of cases basophilic degeneration was found in about a third of the hearts examined routinely.

Hewitt stated that this peculiar degeneration occurred where there was marked proliferation of connective tissue and where there was evidence of pressure atrophy. In hearts I examined it occurred also where there was no proliferation of connective tissue, and the cells appeared slightly hypertrophied. Occurrence of the degeneration in areas of fibrous degeneration within myocardial scars was rather infrequent. In infarcted hearts basophilic degeneration was not seen in the muscular remnants within the fibrous tissue but was frequently found some distance away.

In order to ascertain the nature of the lesion several differentiating stains were used. With fat stain (scharlach R) the areas showed evidence of affinity for the basic component of the stain and appeared a darker grayish blue than the surrounding tissue. In sections stained for iron noticeable changes in the involved areas were not revealed. With Van Gieson's stain there were no special differentiating characteristics. With the Mallory-Heidenhain method the areas of degeneration showed some affinity for aniline blue, but stained a much lighter blue than the connective tissue. With the Mayer carmine method the areas stained distinctly light red, indicating the

TABLE I

Situation of Lesion

Location	Cases
Septum only	32
Left ventricle only	27
Right ventricle only	5
Septum and left ventricle	33
Septum and right ventricle	2
Septum and right and left ventricles	6
Left ventricle and right ventricle	8
Total	113

presence of some kind of mucin or of a substance related to mucin. Hewitt, however, stated that these areas did not take any characteristic stain for mucin. With Best's carmine method the areas of basophilic degeneration stained bright red and were readily distinguished from the bluish gray of the surrounding tissue. It must be kept in mind that the substance in these areas may be related to glycogen, in spite of the fact that the blocks were kept in formalin. It is worth mentioning that a similarity in staining reaction for mucin and glycogen exists in the areas of basophilic degeneration of the heart and in the corpora amylacea of the various organs. The presence of calcium in these areas has been excluded by the acid test. With the Orlandi silver stain the involved areas appeared very pale and gave evidence of some liquefaction. There was no argentophilic reaction to this stain.

To quote Hewitt, who used iodine in the form of compound solution of iodine (Lugol's solution), "these areas, when so stained and

examined under water, appear of a terra cotta pink, somewhat mottled." Although I carried out the procedures exactly as he described them, I could not obtain this reaction with the materials available to me. Hewitt further described, in sections stained with toluidin blue and thionin, "large granulated cells which often are especially abundant about the blood vessels . . . and which are thought to be the same as described by Lustgarten as the parasite of

TABLE II

Anatomical Diagnoses of Cases in which Basophilic Degeneration was found at Postmortem Examination of the Heart

Diagnosis	Hearts examined	Basophilic degeneration found
Malignancy	81	37
Heart disease	52	21
Cholecystitis with cholelithiasis	20	9
Gastro-intestinal ulcers	16	6
Pneumonia	16	9
Peritonitis	15	5
Brain tumor	21	4
Syphilis	9	4
Genito-urinary infection	7	4
Ulcerative colitis	5	2
Empyema of thorax	3	2
Acute pancreatitis	1	1
Electrocution	1	1
Drowning	1	1
Toxemia from burning	1	1

syphilis." This cellular reaction has apparently no local connection with the areas of basophilic degeneration. The presence of these large granulated cells could not be confirmed in any of my specimens, some of which were derived from patients whose condition was diagnosed as syphilis. Of Hewitt's 2 reported cases, 1 was an example of tertiary syphilis, and the other was a case of acute serofibrinous peritonitis with abscesses in the liver and mesentery.

In Table II is shown the frequency of occurrence of basophilic degeneration in my cases, together with the primary pathological diagnosis. The lesion was found most frequently in cases of malignancy and heart disease. It was also found in many cases of infection and inflammation, as well as in a single case each of electrocution, drowning, and toxemia from burns. Because of the multiplicity of condi-

tions with which basophilic degeneration has been found to be associated, it would be difficult to give any one disease entity as the etiological agent.

From Table III it may be seen that the lesion occurs frequently among subjects who have passed the age of 30 years and most frequently among those who are between the ages of 40 and 80 years. Malignancy and a diseased condition of the heart, in association with

TABLE III

Age Incidence

Decade of life	Hearts examined	Basophilic degeneration found	
		Number	Per cent
yrs.			
0–10	27	0	
10–20	8	1	12.50
20–30	17	1	5.88
30–40	40	9	22.50
40–50	43	16	37.20
50–60	70	29	41.42
60–70	73	31	42.46
70–80	39	19	48.70
80–90	3	1	33.33
Total	320	107	33.43

which the lesion was most frequently seen (Table II), generally afflict persons who are 40 to 80 years of age; thus, age seems to be an important, although probably not the only, factor concerned. The factor of toxemia cannot be ignored.

Hewitt quoted Mallory as follows: "The nature of this degeneration is of a hyaline change allied to hydropic degeneration with the presence of some mucin." In an article by Rademaker,[2] which deals with lesions caused by sarcosporidia in the heart muscle, there is a photomicrograph of a stage of the lesion which resembles slightly the picture of the early stage of basophilic degeneration. The change pictured by Rademaker, however, does not correspond in staining reaction to the areas under consideration. No sign or manifestation of parasites could be observed in the great number of sections studied. Because of the strict localization of the lesions, the possibility has to be considered that they are of parasitic origin, but since parasites were not found this possibility does not seem to me to be tenable.

Summary and Conclusions

A peculiar lesion of the heart muscle is described under the term "basophilic degeneration." One subject, in whose heart the lesion was found, had died as early as the 17th year of life, but most of the hearts were from subjects who had died between the ages of 40 and 80 years.

The most frequent sites of the lesion were the septum, the left ventricle, and a combination of the septum and the left ventricle.

Staining reactions showed that the areas contained mucin as well as a component related to glycogen.

It seems probable that toxemia played some part in the etiology of this lesion.

Hematoxylin and eosin was the most valuable stain, because it clearly differentiated the areas of basophilic degeneration.

REFERENCES

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2. Rademaker, G. A. Sarkosporidiën in de hartspier. *Tijdschr. v. Vergelijk. Geneesk.*, 1925, **11**, 297–309.

DESCRIPTION OF PLATE

Plate 69

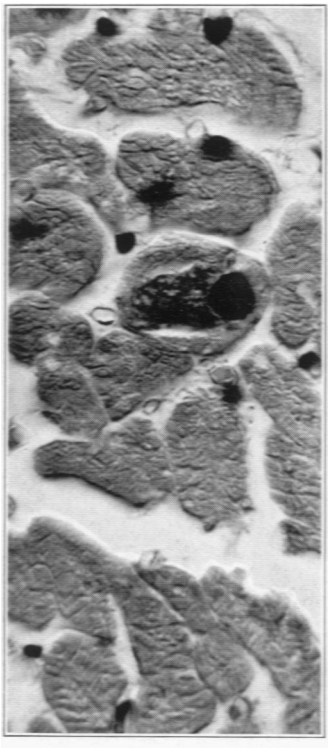
Fig. 1. Transverse section. The area of degeneration is fairly large, granular, and stains bluish purple. The nucleus is well preserved. Hematoxylin and eosin. × 700.

Fig. 2. Area of basophilic degeneration in a more advanced stage than is shown in Fig. 1. The periphery of the muscle cell is intact. Hematoxylin and eosin. × 200.

Fig. 3. Higher magnification of a portion of the section shown in Fig. 2. × 550.

Fig. 4. A fairly well advanced stage of basophilic degeneration. Fibers which stained pale blue are seen surrounding remnants of muscle fibers. × 200.

Fig. 5. Higher power of a portion of the section shown in Fig. 4. The area appears distinctly vacuolated. × 550.



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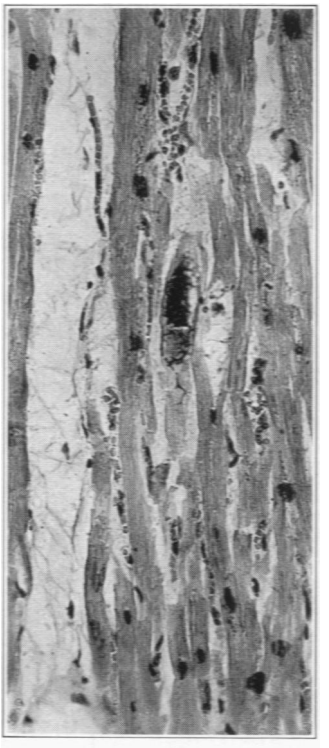

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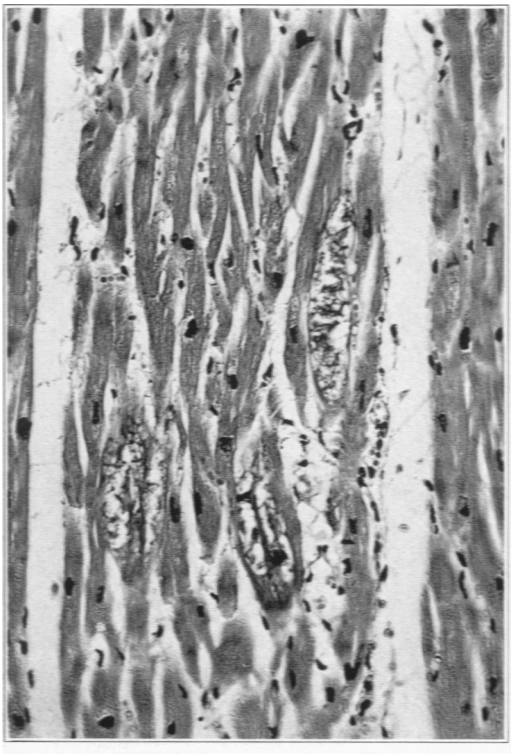

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