A HISTOLOGICAL STUDY OF THE SWEAT-GLANDS IN CASES OF CHRONIC NEPHRITIS *

HERBERT U. WILLIAMS, M.D.

BUFFALO, N. Y.

GENERAL CONSIDERATIONS

The belief that impurities might be removed from the body by means of sweating dates from ancient times. Civilized nations have shared this belief with savages. The use in all parts of the world of natural thermal baths, hot-air baths, vapor baths and wet packs testifies to a universal faith in the skin as an organ of elimination. The standard text-books on the practice of medicine, under the heading of the treatment of nephritis or uremia, recommend baths or other means of securing free perspiration. They usually imply, if they do not specifically state, that the work of the kidneys may be lightened through the excretion of solids by the sweat-glands. Some, like Von Noorden, doubt that the sweat-glands excrete a sufficient amount of solids to be of value, although agreeing that the removal of water may be beneficial.

Analyses of perspiration from healthy persons show that it contains only a small amount of solids in solution. Sodium chlorid predominates among these solids, which is of interest in connection with the theory that retention of chlorids in the tissues favors edema and with the use of sweating to relieve edema. Persons who exercise violently may, however, excrete an appreciable amount of nitrogen in the perspiration. In the experiments of Benedict, as much as 0.22 gm. nitrogen was excreted per hour (equivalent to nearly 0.5 gm. of urea¹). The phenomenon of an excretion of urea by the sweat-glands to the extent of coating the skin with crystalline scales is described in text-books.

It seemed to me that the facts just stated suggested that a study of the sweat-glands in cases of chronic nephritis might be at least interesting. However, it has not been the purpose of this study to establish any relation between nephritis and such well-known diseases of the skin as eczema, which has sometimes been ascribed. No cases of obvious skin disease have been considered. A further reason for examination of the

* Presented at the meeting of the Association of American Physicians, May, 1910.

1. Benedict: *Am. Medicine*, 1906, xi, 105.

sweat-glands in cases of chronic nephritis has seemed to be the relation, which is quite generally admitted, between gastro-intestinal inflammations and chronic renal affections. The practice of giving saline purgatives in the hope of aiding the kidneys in nephritis seems to be universal. In explanation of these gastro-intestinal inflammations some writers hazard the assertion that the intestine may vicariously assume the function of eliminating when the work of the kidneys is insufficient, and that the intestine may suffer in the process. By analogy, it appears not impossible that the sweat-glands likewise might suffer under similar circumstances. I have made no attempt to examine the literature, but if pathological conditions of the sweat-glands in cases of nephritis have been described, it is apparently at least not a matter of general information.²

NORMAL HISTOLOGY

A few features in the normal histology of the sweat-glands may be briefly reviewed. The duct, of course, begins as a spiral cleft in the epidermis which receives an epithelial covering of its own, continuous with the deeper layers of the epidermis, where it enters the true skin. The duct continues, to become the coiled portion of the gland, deep in the true skin or in the adjacent subcutaneous tissue. The structure of the duct extends into the coil for a considerable distance (about one-fourth of the length of the coil). The duct is lined with two or three layers of somewhat flattened epithelial cells, whose borders next to the lumen are differentiated into a narrow, homogeneous cuticle. The duct is surrounded by a delicate basement membrane, more delicate than that of the secreting portion of the tube. In the secreting portion of the coil, the epithelial cells are cubical or columnar, one layer deep (Fig. 6). Inside of the basement membrane are a few longitudinally elongated cells, not forming a continuous layer. They are usually regarded as muscle-fibers.

The lumen of the gland or duct may contain amorphous or granular eosin-staining material, evidently precipitated or inspissated secretion. It is stated that following active secretion the cells of the secreting tube become shrunken. These last two points are important in estimating pathological conditions. According to Unna, the sweat-glands secrete an oil or fat. The form of the coiled part of the gland is beautifully shown in the reconstructions of Huber and Adamson.³ The average diameter of the whole coil is a little less than 0.5 millimeter. There is an abundant plexus of blood capillaries among the tubes.

2. See the recent article by Cesario Demel: *Sull 'anatomia patologica delle ghiandole sudorifere*, Patologica, 1908-09, i, 25.

3. Huber and Adamson: *Contributions to Medical Research*, dedicated to Victor C. Vaughan, published by George Wahr, Ann Arbor, 1903, page 365.

TECHNIC

Specimens of skin were taken in all cases from the sole of the foot close to the plantar fold, which proved to be much the most satisfactory location. In about half of the cases, samples were also secured from the anterior surface of the abdomen. The sole of the foot was chosen because of its abundant supply of sweat-glands, its freedom from hairs and sebaceous glands, and the possibility of securing specimens without disfiguring the body. The statements made in this paper refer to skin from the sole of the foot almost entirely. A few trials were made with skin from the axilla, but the pictures secured were so confusing that this region was not used further.

A piece of kidney was taken in all cases. Alcohol fixation, paraffin imbedding and hematoxylin and eosin staining were found most satisfactory after trying various other methods. Sections were cut to a standard thickness of 10 microns or for special purposes to 6 microns.

PATHOLOGICAL HISTOLOGY

The cases included in the present study were seventy-five in number, mostly chronic interstitial nephritis; there were a few cases of large white kidney, pyelonephritis and tuberculosis of the kidney. The cases of chronic interstitial nephritis were of every grade, from the most trifling to the most extreme. At first, normal skin was taken for comparison from amputations of the foot from accident cases. It was soon found indispensable to know the condition of the kidney, and later, skin from autopsies only was used. The weakest point in the present work is the lack of a sufficient number of normal cases for comparison. Even from young adults, killed by violence and the like, a few contracted fibrous glomeruli and other evidences of slight chronic interstitial nephritis were frequently found.

Naturally, the skin was first examined for lesions analogous to those occurring in the kidneys. They may be grouped under several headings.

1. An increased number of cells—lymphocytes, polynuclear leukocytes, or other cells—was seen only a few times but there was no reason to connect them with the nephritis. No relation of such cells to the sweat-glands could be demonstrated, with a single somewhat doubtful exception.
2. An increase of fibrous tissue or thickening of the basement membrane about the sweat-glands was found only once in the seventy-five cases. In a structure so rich in fibrous tissue as the skin, this particular lesion is most difficult to determine.
3. Desquamation of the epithelial cells was also found exceedingly difficult to determine. In about ten cases the epithelial cells of the

Fig. 1.—Arteriosclerosis affecting a vessel close to a sweat-gland.

Fig. 2.—Solid material in the duct of a sweat-gland, resembling a cast in a renal tubule.

Fig. 3.—Secreting tubule of a sweat-gland, showing the lining epithelium much shrunken.

Fig. 4.—Secreting tubules of a sweat-gland with desquamated epithelium.

Fig. 5.—Secreting tubule of a sweat-gland with polyhedral epithelial cells in layers and having a small lumen.

Fig. 6.—Secreting tubule of a sweat-gland in the normal condition, for comparison.

secreting tubes were much shrunken and distorted. The alterations were certainly due in part to drying, which the exposed position of the skin makes possible; in part they were probably the result of active secretion shortly before death (Fig. 3). I have seen a similar shrinking of the epithelium in normal skin from an amputated foot. In a few cases pathological desquamation had undoubtedly occurred (Fig. 4). Some features suggested a relation between desquamation and shrinking of the epithelium from secretion. Post-mortem changes seem to take place more easily in the epithelium of the secreting tubes than in that of the ducts. With the technic employed, the finer degenerative changes in cells would not be demonstrated. Actual necrosis of the epithelial cells with loss of nuclear stain was not seen at all.

4. Cystic dilatation of the secreting tubes was seen five times. In each case only one small cyst was discovered in several sections. In one of these it was associated with probable desquamation in other tubes and atrophy. Moderate dilatation of the ducts occurred four times; it seemed to be without pathological significance.

5. Atrophy of the secreting tubes, if present at all, was exceedingly rare. What appeared to be atrophy might have been collapse of the tubes after active secretion.

6. Casts, or bodies composed of a small amount of amorphous, slightly stringy or granular material were quite often seen in the normal secreting tubes and ducts. In seventeen cases (of the seventy-five) homogeneous material was seen in the ducts or more rarely in the secreting tubes. In cross-section, such bodies could hardly be distinguished from casts in renal tubules. In longitudinal section they were never of firm consistency along a considerable length, as is the case with renal casts (Fig. 2). Usually only one such body could be found in many sections. These bodies occurred several times in association with kidney lesions of the most trifling character. As the sweat-glands are stated to secrete an oily substance, it is very doubtful that the bodies in question have at all the same significance as casts in the tubules of the kidney. Very rarely they contained cells or were composed of desquamated epithelium.

7. Recent thrombi of the large arteries or veins were noticed frequently; old calcified thrombi of small veins four times. The recent thrombi were regarded as agonal, and none of the thrombi were in the vicinity of the sweat-glands or seemed to have any relation to them. Small amorphous masses, hyaline or calcified or both, were seen twice in the connective tissue of the true skin apparently in lymph-spaces. Their significance could not be determined, but they seemed to have no relation with the sweat-glands.

8. Arteriosclerosis or hyaline degeneration of the arteries of the skin occurred in some degree sixteen times in the seventy-five cases (Fig. 1). The changes in the arteries were sometimes, though not usually, seen in the vessels supplying the sweat-glands; but on prolonged search they would probably be found near the sweat-glands in all cases that showed arteriosclerosis in the skin. No frequent association of the arterial changes with edema could be demonstrated. As the observations were made chiefly on skin from the sole of the foot it is possible that they do not represent correctly the frequency of arteriosclerosis over the skin of the body in general. In part of the cases, skin from the middle of the abdominal wall was also studied and changes in the arteries were found there much less often than in the foot. However, since the middle of the abdomen is poorly supplied with arteries it cannot be regarded as a satisfactory control to the plantar region.

Thickening, with increase in the number of the connective tissue cells, in the walls of the small veins was seen ten times in the seventy-five cases; in four instances it was associated with old thrombosis of these veins. While it sometimes occurred in cases that showed arteriosclerosis, it was also observed independently. It is likely that the changes in the veins were partly due to local conditions in the foot. I have observed similar changes in skin from the foot in normal subjects.⁴

9. Finally there remains to be described a condition of the sweat-glands of whose meaning I am uncertain. Text-books on histology seem to agree that the secreting portions of the coiled tubules of normal sweat-glands are lined by a single layer of cubical or columnar epithelial cells (Fig. 6). In the cases included in this study the secreting tubes frequently were lined apparently by more than a single layer of cells. The cells were so irregularly disposed that it could hardly be said that they were arranged in layers, but, roughly speaking, they appeared to be two or three layers deep (Fig. 5). The outlines of the individual cells were often difficult or impossible to distinguish. The condition occurred at scattered points and only for a short distance along a tubule, as was shown by the examination of serial sections. The whole diameter of the tubule was large but not larger than is often seen in normal cases; the lumen was small, often very small. That such tubules were secreting tubules and not ducts was proved by their large size, the distinct basement membrane, and the muscle-cells within the basement membrane. It was naturally exceedingly difficult to prove that the appearance of having several layers of cells might not have been produced by having cut across the coiled

4. See Martin and Meakin: *Peripheral Phlebosclerosis*, *Tr. Assn. Am. Phys.*, 1905, xx, 525.

tubules obliquely. At the suggestion of Dr. Huber, I tried reconstructing a portion of some of the tubes under discussion, but found that the direction changed so continually, not in one but in several planes, that it could hardly be said that any section was a true transverse section of a tubule. Furthermore, the course of the lumen often was more tortuous than that of the tubule as a whole. I have found secreting tubules lined by epithelial cells apparently in several layers in skin from normal cases, but rarely and in a less marked degree. The impression obtained from comparison of normal cases and cases of nephritis has been that the latter do actually show increase in the number of the epithelial cells in the tubules; and that the same may possibly occur to some extent in normal cases. As stated in the first part of this paper, its weakest point is acknowledged to be the lack of an adequate number of normal cases for comparison. In a measure this lack is compensated for by skin from mild cases of nephritis. In fourteen cases of nephritis counted as mild or trifling, the epithelial cells of the secreting tubes of the sweat-glands appeared to be in more than one layer only once; the same occurred fifteen times in sixty-one cases of nephritis regarded as moderate or severe.

Assuming that the epithelial cells actually are in layers, the significance of the change could only be conjectured. There is no evidence pointing to degeneration or desquamation; although no mitoses were seen, there appeared to be an increase in the number of cells. That, of course, does not prove the existence of a functional hypertrophy of the sweat-glands. It is interesting, however, to recall that Köster and others allege that the glomeruli and tubules of the kidney may become hypertrophied in chronic nephritis. It is also possible that contraction of the longitudinally disposed muscle-fibers beneath the epithelium might shorten the tubule and throw the epithelium into layers. I must also state again that the observations have been made almost exclusively on skin from the sole of the foot. The histories of hospital cases could not be relied on to record such a symptom as hyperidrosis if it had been present.

SUMMARY

The condition just described (Section 9) will evidently require a long series of investigations for its explanation, so that a tentative presentation may be admissible now. The remainder of the work may be summarized by saying that in the seventy-five cases of nephritis where skin from the sole of the foot was studied, arteriosclerosis was the only lesion that occurred in connection with the sweat-glands frequently enough to be of great importance. Although bodies resembling casts in the renal tubules were not rare in the sweat-glands, it is very doubtful that they have the

same significance as renal casts or that they are pathological. Desquamation of epithelium, an increase of cells about the tubules suggesting inflammation, and thickening of the fibrous tissue about the tubules, were uncommon changes. While two or more of the conditions above described were sometimes seen associated in a single case, no important connection between them could be demonstrated. It seemed best to limit the scope of the present paper to an enumeration of the findings, leaving any conclusions that may be drawn for a subsequent report after more extended research.

I am indebted to Dr. Charles G. Stockton for the suggestion that led me to undertake these studies.

Pathological Laboratory of the University of Buffalo, 24 High Street.