REGIONAL CHANGES AND CHANGES CAUSED BY AGE IN THE NORMAL SKIN

A Histologic Study*

WILLIAM R. HILL, M.D.,† and HAMILTON MONTGOMERY, M.D.‡

(Received for publication February 5, 1940)

Interest in the normal histologic changes in the skin of human beings at different ages and regions has been stimulated by the recent extensive studies of Ejiri (1–5) and also by those of Lynch (6) concerning changes of elastic tissue in the fetal skin.

Normal histologic changes, such as the thickness of the various layers of the epidermis and cutis and the number and characteristic appearance of the various dermal appendages, have been presented in many textbooks (7) on histology and dermatology. Very little emphasis has been placed, however, on changes occurring in different regions of the skin or in different age groups, especially concerning the elastic and connective tissues.

This study is divided into two parts. The first, which is the minor part, deals with the histologic changes in the skin of the webs between the toes, especially the web between the fourth and fifth toes, in which trichophytosis (ringworm or athlete's foot) commonly occurs. The second part, which is the major part, is a comparison of the normal findings in different parts of the human body in different age groups, with special reference to changes in the elastic and connective tissue.

Our survey is based on the histologic study of normal skin

* Submitted for publication January 31, 1940.

† Fellow in Dermatology and Syphilology, The Mayo Foundation, Rochester Minn.

‡ Section on Dermatology and Syphilology, The Mayo Clinic, Rochester, Minn.

obtained at necropsy in twenty cases.* These cases are grouped as follows:

	Number of cases in each group
Infants (7 months to full term)	4
Children 4-6 years	2
Young adults 27-39 years	6
Middle age 40-60 years	4
Aged 61-78 years	4

The tissue was obtained from the following situations: the web between the first and second and the fourth and fifth toes, as well as from the pubis, axilla, chest and scalp. Both alcohol and formalin were used as fixatives. The sections were stained with hematoxylin and eosin, Van Gieson's stain for connective tissue, acid-orcein and hematoxylin or elastin H for elastic tissue.

Ejiri's material for histologic study of normal skin was obtained by him at necropsy in fifty cases, and it included 718 specimens. At necropsy he was fortunate in securing specimens principally from the exposed surfaces of the body, namely, the forehead, chin, cheeks, bridge of the nose, upper lip, upper and lower eyelid, parotid region, back of the hand, and forearm. Ejiri in his extensive studies also made use of multiple differential stains for changes in elastic and connective tissue in different age groups and regions, whereas we limited our studies to the use of routine stains. However, the importance of these two series, ours and Ejiri's, lies in the fact that the material was taken from both unexposed and exposed parts of the body, a procedure which affords an excellent opportunity for comparison of changes in different regions. Furthermore, the range of ages in the two series is comparable.

NORMAL HISTOLOGIC ASPECTS OF THE SKIN OF THE WEB OF THE TOES INCLUDING THE HISTOLOGIC ASPECTS OF THE SWEAT GLANDS

Weidman (8) examined histologic sections of the fourth interdigit from a number of amputated human feet in the hope of

* This material was collected sometime ago by Dr. James Viecelli, with the hope of establishing an anatomic basis for the common occurrence of fungous infections between the fourth and fifth toes.

"finding specialized sebaceous or other glands which might indicate that there was a phylogenetic peculiarity of the glands in this position that might supply a peculiarly favorable secretion for the development of ringworm fungi." He wrote that he "was utterly unsuccessful in this (morphologic) effort." We also found no anatomic variation in the sweat glands or other structures, either in the skin of the web of the first and second, or the fourth and fifth toes, to account for the common occurrence of fungous disease (trichophytosis, athlete's foot) between the toes, and especially the fourth interdigit. Our cases showed no clinical evidence of the patients' having had fungous infection, but no cultures were made and no scrapings examined under potassium hydroxide were studied. It has been suggested, further, that there is a quantitative difference in the number of sweat glands and ducts situated in the webs between the different toes. Without resorting to the more nearly accurate method of wax reconstruction, but rather, on the basis of counting the number of sweat ducts in the epidermis per six high-power fields, we found that there was no difference between the number of ducts in the skin of the web of the first and second, and the fourth and fifth toes. In these situations, however, the ducts were found to be four times more prevalent in infancy (fig. 1 *a*) than in the remaining age groups. In specimens obtained from persons who had been from four up to seventy-eight years old (fig. 1 *b*), the sweat ducts were numerically equal in the skin of the toes. Regionally, the greatest number of sweat ducts were seen in the following order: toes (first and fifth), axilla, pubis, scalp, chest.

Recently, Pinkus (9), in a study of the "anatomy and pathology of the skin appendages," presented evidence "that the ducts of the eccrine sweat glands do not lose their walls where they enter the epidermis, but are lined by their own epithelium through all the strata of the skin." On the basis of study of our sections of the toes of infants especially, but also to a lesser degree in other age groups, it would appear that the sweat ducts retain their own walls within the epidermis. In our specimens obtained from persons who had been in the late age groups (sixty to seventy-

eight years), however, we were unable to note any basophilic changes about the sweat ducts in the epidermis which

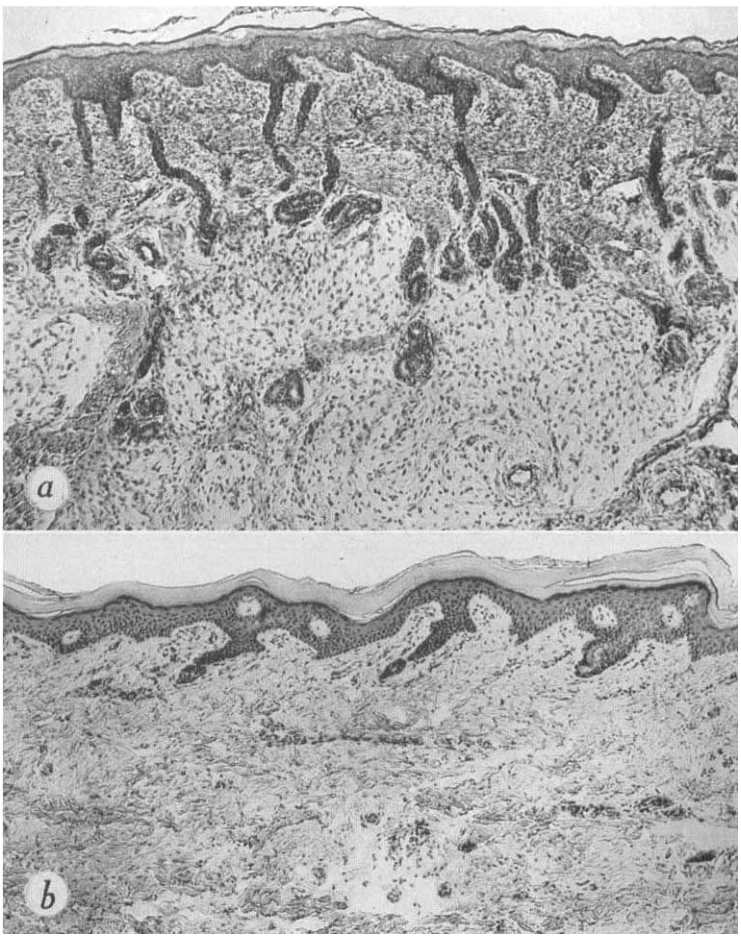

FIG. 1*a*. Section from a seven-months' infant: skin of toe, showing sweat ducts arising from each rete ridge, immature sweat glands, embryonal subcutaneous fat rich in nuclei (hematoxylin and eosin; × 70); *b*, section from a child, four years old: skin of toe, showing decrease in number of sweat ducts as compared with section in figure 1*a*. Essentially normal epidermis with prominent stratum corneum and stratum granulosum which are characteristic of this region (hematoxylin and eosin; × 70).

Pinkus wrote that he had seen in senile keratosis and which one of us (Montgomery) has seen as a common occurrence not

only in senile keratosis and other precancerous dermatoses but also in superficial epitheliomatosis, especially of the basal-cell type.

SIGNIFICANT HISTOLOGIC CHANGES IN OUR SERIES FROM THE COVERED PORTIONS OF NORMAL SKIN

Epidermis. I. Stratum corneum. There were no changes in this layer in relation to age. Hyperkeratosis was more marked on the toes than elsewhere, but was equally prominent between the first and fourth interdigits. It would be classified as grade 2 or 3 on the basis of 4. This layer was of equal extent in specimens from the pubis, axilla, chest and scalp. Ejiri (3) noted that plugging of the hair follicles and sweat ducts occurred in old age. In our series the sweat ducts tended to have more plugs in specimens obtained from persons who had been in infancy. We also found keratotic plugs in the axilla, independent of age.

II. Stratum lucidum. No distinct relationship exists between the condition of this layer and age or region. The layer may be absent in infants. Usually it appears to be increased in proportion to the amount of hyperkeratosis present.

III. Stratum granulosum. This was indistinct, spotty or absent in two-thirds of the sections obtained from infants. A single layer is seen in all sections obtained from children. One to three layers are present in middle age. The toes of the aged have two to four layers of cells. There is a suggestion, therefore, that this layer may increase with age. The stratum granulosum is most marked in the skin between the toes, and is equal in amount between the first and second, and fourth and fifth.

No regional difference is found between the other regions, pubis, axilla, and chest.

IV. Prickle-cell layer. No relationship between age and the increase or decrease in the number of cells in this layer was discovered. The individual cells show more vacuolization during infancy, whereas Ejiri (3) found vacuolization not only in the young but also in senile persons. Regionally, the cells themselves were normal, with the exception of the web of the fourth and fifth toes, where one-half of the specimens studied showed vacuolization and pyknotic nuclei. The greatest number of rows of cells were situated in the toes, the smallest in the chest, and in decreasing order, in the pubis, axilla and scalp.

V. Basal-cell layer and pigment. The basal-cell layer is normal throughout, and the basal membrane is intact. In contrast to Ejiri's findings, we found that pigmentation does not become more marked with advancing age on the unexposed skin. We discovered most pigment to be in cases of young adults. Regionally, the pigment was most marked in the pubis, next marked in the axilla, and finally, in the toes, where it was minimal to absent in extent.

VI. Rete ridges (pegs). Moderate atrophy of the pegs occurs in old age. The pegs are short and broad in young adult persons, and become more prolonged during middle age. One-half of the specimens obtained from those who had been infants had apparently normal pegs. Regionally, they appeared to be well defined in the toes, but were flat or absent in the chest, scalp and axilla. It is interesting to note in passing that in sections obtained from one infant in the region of the toes, each peg had a sweat duct entering from the cutis (fig. 1*a*).

VII. Papillae. Corresponding with changes in the rete ridges, papillomatosis is most marked in young adult persons. The pubic and axillary regions show more papillomatosis than do other situations. The papillae become flat or absent in the chest.

Cutis. I. Sebaceous glands. Atrophy of the hair follicles and sebaceous glands was noted in seven instances (fig. 2*a* and *b*). The atrophy bore no distinct relationship to age groups, having been found in sections obtained from persons who had been six to fifty-one years of age. There was a tendency for the atrophy to be regional, since it was seen four times in skin from the axilla, and the remaining three times in skin from the chest. The cause of the atrophy is not known. Ejiri (3) stated that the hair follicles were more dilated after fifty years of age than before. We could not confirm this observation.

II. Vascular changes. Changes in the superficial or deeper vessels in the cutis were very slight as a rule and did not go hand in hand with age. Both the dilatation of the superficial vessels and the amount of perivascular infiltrate, as well as the occasional intimal proliferation and thickening of the deep vessels, are more marked in young adult persons. Sclerosing tendencies with advancing age did not apply to vessels of the cutis. There is no increased broadening of the vessels beyond the ages of fifty to sixty years, as Ejiri (3) found in exposed skin. There are no significant regional changes. Thickening and proliferation of the deep vessels are more marked in the toes, particularly the fifth toe than elsewhere, a finding which might be anticipated on the basis of anatomic situation alone. A perivascular infiltrate which usually is very slight and consists chiefly of lymphocytes, showed no regional change or change caused by age. It was seen in specimens obtained from infants as well as those obtained from the aged, so that the time of onset cannot be determined. The causes of death in our twenty cases were tabulated to discover if any of these causes, especially infectious as contrasted to mechanical causes of death, played a role. We found no relationship between the cause of death and the character or amount of cellular infiltrate present.

III. Muscles, nerves, fat. There were no significant changes in the different regions or age groups except that the embryonal fat became transformed into alveolar, and finally into normal, adult adipose tissue.

IV. Collagen and elastic fibers. Concerning collagen fibers, we found in specimens obtained from infants a loose network of supporting tissue consisting of poorly-staining young collagen. The fibers were most numerous in the midcutis. The embryonal tissue, which was very cellular, contained oval cells with distinct nuclei and clear cytoplasm. In specimens from the age groups from four to sixty years, the collagen fibers were of the same length and thickness and had the same wavy contour. They tended to become homogeneous, especially about hair follicles and sebaceous glands in the midcutis, but in the papillary bodies and upper cutis the fibers were edematous. The collagen was relatively acellular in the aforementioned age groups. The cells had small, dark-staining nuclei and indistinct cytoplasm. In specimens obtained from the very aged, more than sixty years of age, where the whole cutis seemed atrophic, the collagen fibers were thinned, more elongated and had become stretched out so that they had lost their wavy appearance. A few cells were still scattered throughout the matrix. We found no regional differences in the collagen fibers.

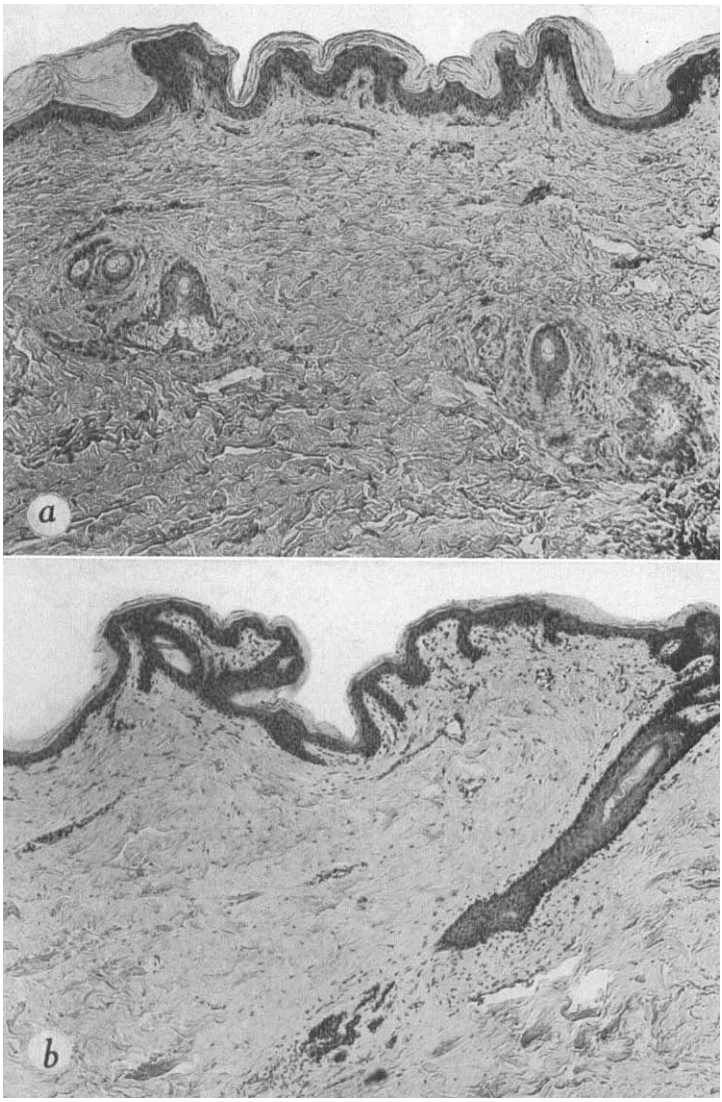

FIG. 2*a*. Specimen obtained from six-year old child: skin of the chest, showing hyperkeratosis and keratotic plugging, some atrophy of the prickle-cell layer, dense homogeneous connective tissue and distinct atrophy of hair follicles and sebaceous glands (hematoxylin and eosin; × 70); *b*, specimen obtained from a man fifty-one years of age: skin of axilla, showing changes similar to those in figure 2*a* (hematoxylin and eosin; × 70).

In specimens obtained from infants, the elastic fibers were similar in all instances. They appeared as thin, wavy threads, most prominent in the midcutis and in the intima of the deep vessels; they were few or were absent in the papillary bodies. The elastic tissue of the walls of the superficial vessels and dermal appendages was not well outlined. The observations in our specimens from infants therefore agree with those of Lynch (6). In children the elastic fibers are thick, short, and more darkly stained than in infants, especially in the midcutis. The fibers may be broken up in this situation and may appear as short, straight bacillary-like rods. Thin, branching elastic fibers are found in the papillary bodies. They are also readily visible in the walls of the dermal appendages. In the group of young adult persons, the elastic tissue becomes even more prominent in the upper cutis. The fibers form a loose but well-defined network in the papillary bodies, a network which is composed of fibers of equal size intersecting at various angles, or springing upward from a common base, such as is the case in the teeth in a comb. In the midcutis the elastic fibers assume bizarre configurations, ranging from those of the letters S and C, to those of a question mark, or corkscrew shape. As the subcutis is approached, the elastic fibers become more broad and straight than before, but they also begin to split up and fray. At times they group together in bundles. In specimens obtained from the last age group of forty to seventy-eight years, we noted immediately beneath the epidermis and extending downward from that point, surrounding the hair follicles and sebaceous gland, a continuous network of elastic fibers (figures 3*a* and *b* and 4*a*).

The network consisted of rolled and matted elastic fibers which were of approximately equal size and which possessed a similar reaction to stain. The individual fibers could be identified easily in the network, except that in some instances about the hair follicles and sebaceous gland they were compressed into bundles. The network was found in all sections studied obtained from persons who had been from forty to seventy-eight years of age, and in a specimen from the pubis of a person who had been six years old, similar but less marked changes were seen. It was not influenced by advancing age, since the observations made concerning specimens from persons who had been forty years old were as marked as those from persons sixty to seventy-eight years old (fig. 4*a*). Regionally, the network was best seen in specimens from the toes and pubis, but throughout this study we were not greatly impressed with the regional variation in elastic fibers on the covered skin. The membrana propria of the sweat glands and ducts was well visualized in the same groups as those described previously; however, it bore no relationship to age or region.

Granules staining the same as elastic fibers were seen in specimens from all groups, from infancy to old age. They consisted of round or oval granules of various sizes. We noted these granules in all parts of the cutis, but more so in the midcutis. They bore no relationship to region in our series, and did not become more numerous with advancing age.

Clumps or shoals of elastic tissue were present in only three instances (fig. 4*b*). They were oval, compact bodies taking the elastic tissue stain, situated in the papillary bodies, upper cutis, or about the hair follicles. We observed these clumps first in a specimen from a person who had been thirty-seven years of age. Studies for Gitterfäsern (lattice fibers) were not done.

Ejiri, in studying the normal histologic aspects of the human skin from exposed

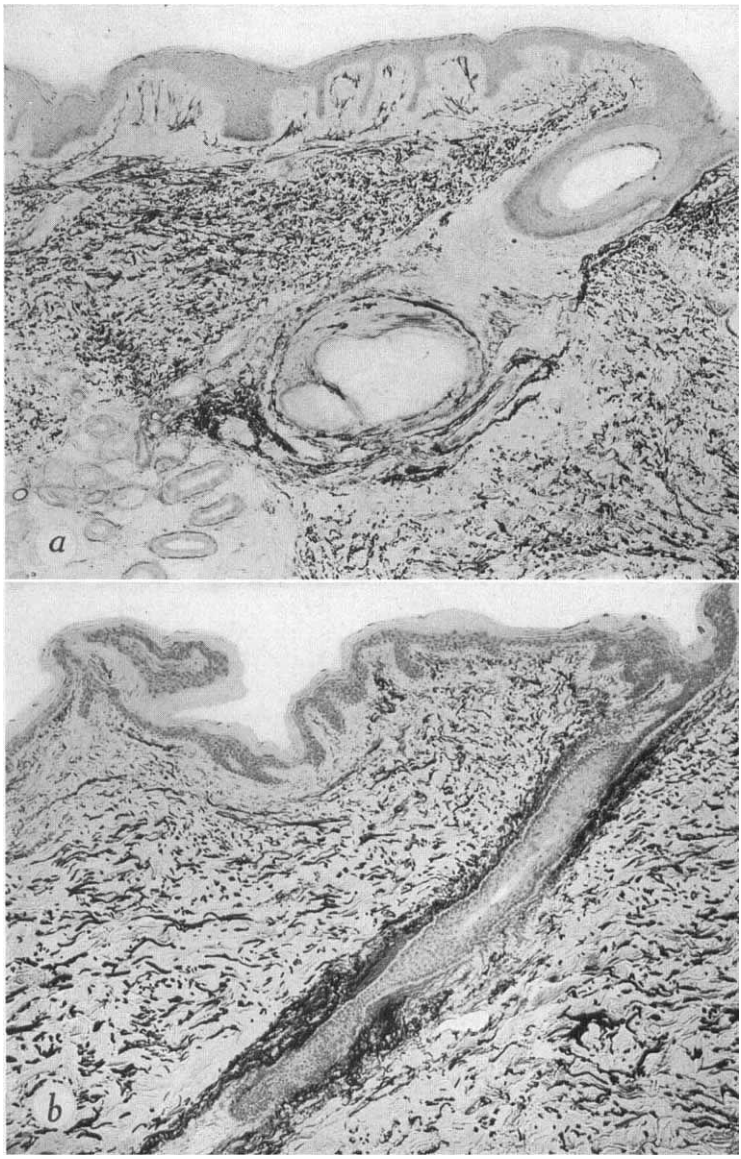

FIG. 3*a*. Specimen, taken from same individual as specimen in figure 2*a*, from pubis. Note normal arrangement of elastic tissue in papillary bodies and in the region of sweat glands and slightly increased network about sebaceous gland and hair follicle; also keratotic plugging of latter (acid orcein stain for elastic tissue; × 50); *b*, specimen from same individual as specimen in figure 2*b*; dense network of elastic fibers about hair follicle (acid orcein stain; × 70).

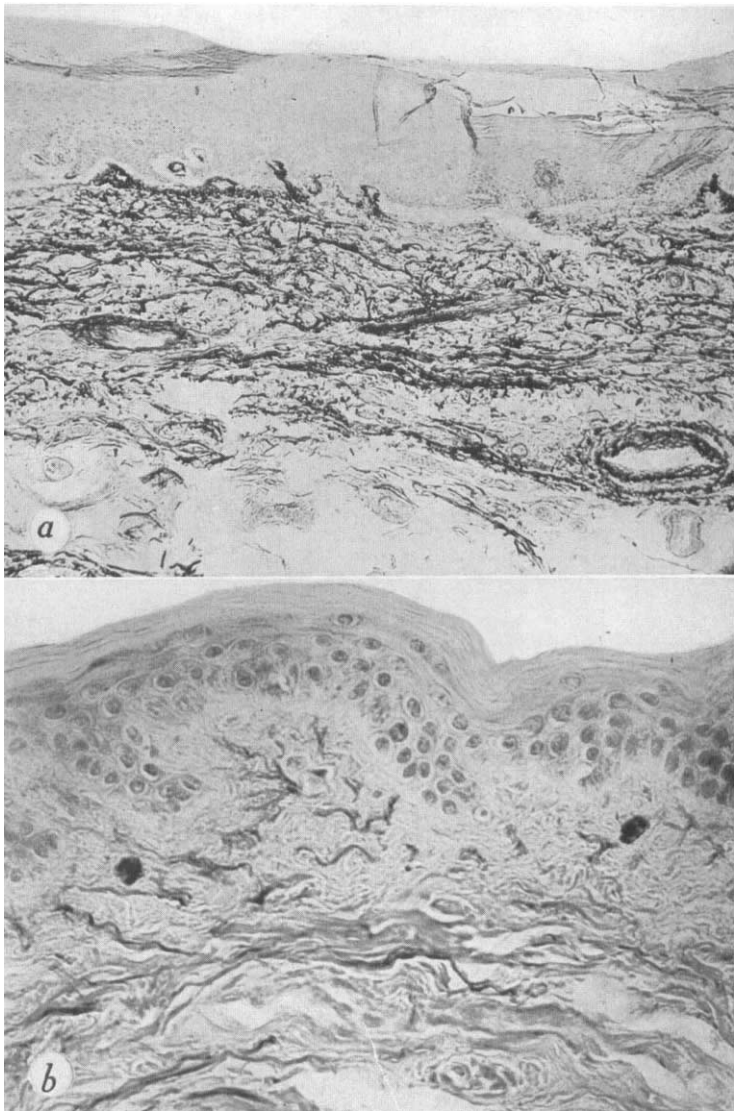

FIG. 4*a*. Specimen obtained from a man seventy-eight years of age: skin from toe, showing network of distinct elastic fibers beneath epidermis, some atrophy of the cutis and normal elastic tissue in walls of the blood vessels (acid orcein; × 70); *b*, specimen from a man thirty-seven years of age: skin from chest, showing two shoals or clumps of elastic tissue (acid orcein; × 300).

parts, found that the collagen fibers showed changes in association with advancing age. These changes consisted of atrophy and gradual disappearance of the fiber (4). The collagen also exhibited regional changes which began at different ages and proceeded in parallel with age (3). Basophilic collagen did not manifest any difference according to region or age or relationship to change in the elastic tissue.

Elastic tissue was altered with advancing age (4): the older the skin, the more severe the changes. The senile changes which Ejiri found consisted of broadening, granular disintegration, and vitreous and hyaline degeneration of the elastic fibers. These degenerative changes in elastic tissue were first seen in the subpapillary network, later in the midcutis and last in the subcutis. The fibers themselves became more coarse and broad with age.

Granular disintegration, concerning which Ejiri mentioned two types of granules both large and small, occurs at different ages. Large granules first appeared in specimens obtained from persons who had been twenty years old, and small granules in specimens from those who had been forty years old. Hyaline degeneration also was found to have begun at forty years. Both changes increased with advancing age. Ejiri noted that changes in the elastic fibers varied according to region (2). Concerning sex, the fibers were altered less in specimens from women than in specimens from men. In the aforementioned studies, Ejiri stated that he found no transitional state between collagen and elastic tissue, and he showed by differential stains that all the changes caused by age occurred principally in the elastic fibers and not in the collagen.

Ejiri (4) also noted clumps or shoals of elastic tissue lying directly under the epidermis and about hair follicles. They appeared in all specimens obtained from persons who had been more than six years of age, especially in the skin of the face. Ejiri believed these clumps to be part of the elastic fibers formed as the result of the overgrowth of certain fibers of the elastic tissue. He showed that they could undergo the same degenerative changes as elastic tissue. He discovered no relationship between the number of clumps and age.

DISCUSSION

In comparing our observations concerning the unexposed parts with those of Ejiri on the exposed parts, the following points can be noted: The changes both in the collagen and elastic fibers in our series were not very marked. The collagen underwent very little change in association with advancing age and although it appeared atrophic in specimens from the very aged, this atrophic condition may have been relative, since the whole cutis shared in the atrophy. In contrast also to definite changes in the collagen fibers in different regions on the exposed skin, we found no regional differences. Therefore, we feel that very little attention must be given to regional and age changes in the collagen fibers on the normal unexposed skin.

Observations made concerning the elastic tissue afford more opportunity for speculation. The clumps or shoals of elastic tissue found in the unexposed as well as the exposed skin appear to us to be a part of the normal elastic fibers, as mentioned by Ejiri. They are not subject to regional or age change. No explanation can be offered as to why they were not found as often in our series on the unexposed skin as in Ejiri's series.

We believe that the network of elastic fibers which lies beneath the epidermis and about the hair follicles and sebaceous glands, and which is seen chiefly in specimens obtained from members of the age groups of forty to seventy-eight years, also should be regarded as normal.

This network as seen in our specimens from unexposed skin does not represent a senile change, such as was found by Ejiri on the exposed skin, or as was seen by us in a review of cases of senile skin or so-called senile elastosis, since it exhibits no changes characteristic of senile skin from exposed parts. The aforementioned senile changes are as follows: using hematoxylin and eosin, it is possible to see a basophilic staining of fibers and basophilic masses in the upper cutis. If elastic tissue stain is used, these basophilic masses are observed to be divided into bundles by the superficial vessels; these bundles are also separated from the overlying epidermis by a narrow band of normal, unchanged supporting tissue. The bundles of changed fibers are made up of basophilic homogenous masses or of basophilic homogenous fibers. The individual fibers tend to be more broad at the periphery than in the center of the mass. With advancing age the whole region of changed fibers becomes more prominent, whereas the individual fibers are more coarse and thickened, and show granular and hyaline changes. Therefore, from the standpoint of situation, tinctorial change, and change in the individual fibers with advancing age, we can say that the network as seen by us in specimens of unexposed skin does not represent senile change.

As a matter of fact, in our survey of normal unexposed skin, we saw no evidence of senile change in the elastic or collagen fibers, so that on the basis of study of this material we are not able to

discuss the important statement of Ejiri, who claimed that on the normal exposed skin there is no transition between collagen and elastic fiber with advancing age. He showed by means of numerous differential stains that the senile changes occurred principally in the elastic fibers and not in the collagen. Unna and Gans, on the other hand, believed that changes in the senile skin consisted of those of collagen fibers as well as of elastic fibers, and that there was a merging of elastic and collagen fibers to form collacin. In opposition to the view of Ejiri, it has been the opinion of one of us (Montgomery) that merging of the collagen and elastic fibers frequently can be seen since "basophilic changes in elastic and collagen fibers are frequently seen in other dermatoses including xeroderma pigmentosa, senile keratoses," and "in the majority of sections of lupus erythematosus taken from the exposed surfaces of the body but is almost always absent in sections taken from the covered portions of the body (10)." It is not possible, on a purely morphologic basis, to offer, however, any definite proof of this merging of collagen and elastic fibers, and we must say that Ejiri's studies throw some doubt on whether this merging takes place.

SUMMARY AND CONCLUSIONS

In the histologic examination of skin taken from the web of the toes we noted no anatomic deviation by means of which we could explain the prevalence of fungous disease (trichophytosis, ringworm, athlete's foot) in this situation. There was no quantitative difference in the number of sweat ducts (and by inference, sweat glands) situated between the first and second, and the fourth and fifth toes, to account for the more common occurrence of fungous disease in the latter situation. The sweat ducts, moreover, in the skin of the web of the toes were found to be four times more numerous in infants, a group in which fungous disease is infrequent. As pointed out by H. Pinkus the sweat ducts apparently retain their own wall in the epidermis.

The condition of the stratum corneum of the covered parts bears no relationship to age, but has regional variation.

The stratum granulosum, prickle-cell layer and the rete ridge

(pegs) showed almost analogous regional characteristics in our series. On the specimens taken from both unexposed and exposed skin, the rete ridge (pegs) showed atrophy with advancing age.

On the basis of our study, it can be said that on the *unexposed* parts of the body, increase in pigmentation and vascular changes do not become more marked with advancing age. Since the opposite observations were recorded by Ejiri (3) concerning *exposed* skin of the body, it is suggested that external factors, such as exposure to light and the elements, may play a part in the aforementioned changes. There was no relationship between age, region, or the cause of death of persons from whom we obtained specimens at necropsy, and the character and amount of perivascular infiltrate, in our series.

Regional atrophy (chest and axilla) of the sebaceous glands and hair follicles was noted in seven instances in specimens taken from the covered skin, but this atrophy was not related to age.

The changes in the collagen fibers in specimens taken from unexposed skin were minimal, and no definite relationship to age or region was noted.

Observations concerning elastic tissue were the most important in both our series and that of Ejiri. The shoals or clumps of elastic tissue apparently are a normal observation in both the exposed and unexposed skin. The network of elastic fibers which was noted on the covered parts of the body is not related to senile change, and definitely differs from the degenerative changes occurring in the elastic tissue with advancing age as seen by Ejiri. Ejiri's observation of senile change on the exposed skin, however, corresponds to observations which we have noted in senile keratosis, and lupus erythematosus on the exposed skin. It is still a question whether there is a merging of elastic and collagen fibers to produce this change—a view which we are inclined to accept—or whether the elastic tissue alone is involved, as Ejiri believed. This problem must remain open for further study. The fact that in our sections obtained from the unexposed normal skin we saw no evidence of senile change in the

elastic or collagen fibers adds to the contention that the pathogenesis of this senile change is related to topographic anatomic conditions (exposed parts) and the effect of light and the elements.

REFERENCES

(1) EJIRI, ISABURO: Studien über die Histologie der menschlichen Haut: I. Mitteilung. Über den regionären Unterschied der elastischen Fasern der Haut. Jap. J. Dermat. & Urol., **40**: 173–174 (Nov.) 1936.

(2) EJIRI, ISABURO: Studien über die Histologie der menschlichen Haut: II. Mitteilung. Über die Alters- und Geschlechtsverschiedenheiten der elastischen Fasern der Haut. Jap. J. Dermat. & Urol., **40**: 216–217 (Dec.) 1936.

(3) EJIRI, ISABURO: Studien über die Histologie der menschlichen Haut: III. Mitteilung. Über die regionären- und Altersunterschiede der verschiedenen Hautelemente mit besonderer Berücksichtigung der Altersveränderung der elastischen Fasern. Jap. J. Dermat. & Urol., **41**: 8–12 (Jan.) 1937.

(4) EJIRI, ISABURO: Studien über die Histologie der menschlichen Haut: IV. Mitteilung. Über das Wesen der Altersveränderung der Haut. Jap. J. Dermat. & Urol., **41**: 64–70 (Feb.) 1937.

(5) EJIRI, ISABURO: Studien über die Histologie der menschlichen Haut: V. Mitteilung. Über die Histologie der menschlichen Haut bei verschiedenen Hautkrankheiten, mit Berücksichtigung der Altersveränderung der elastischen Fasern. Jap. J. Dermat. & Urol., **41**: 95–96 (Mar.) 1937.

(6) LYNCH, F. W.: Elastic tissue in fetal skin. Arch. Dermat. & Syph., **29**: 57–79 (Jan.) 1934.

(7) BLOCK, B., PINKUS, F., AND SPALTEHOLZ, W.: Anatomie der Haut. In JADASSOHN, J.: Handbuch der Haut- und Geschlechtskrankheiten. Berlin, Julius Springer, 1927, vol. 1, pt. 1, 564 pp.

(8) WEIDMAN, F. D.: Laboratory aspects of epidermophytosis. Arch. Dermat. & Syph., **15**: 415–450 (Apr.) 1927.

(9) PINKUS, HERMANN: Notes on the anatomy and pathology of the skin appendages. I. The wall of the intra-epidermal part of the sweat duct. J. Invest. Dermat., **2**: 175–186 (Aug.) 1939.

(10) MONTGOMERY, HAMILTON: Pathology of lupus erythematosus. J. Invest. Dermat., **2**: 343–359 (Dec.) 1939.