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II.

THE DEGENERATIVE CHANGES OBSERVED IN THE STRUCTURES OF THE HAND, FIFTEEN YEARS AFTER DIVISION OF THE MEDIAN NERVE ABOVE THE ELBOW.

THE DEGENERATIVE CHANGES OBSERVED IN THE STRUCTURES OF THE HAND, FIFTEEN YEARS AFTER DIVISION OF THE MEDIAN NERVE ABOVE THE ELBOW.

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(Plates XIX. and XX.)

It is not often that the opportunity of dissecting a hand 15 years after division of the median nerve presents itself, and that such changes as are here described occur. I venture therefore to bring this somewhat uncommon case under notice.

The left hand was removed from a man 73 years of age, an Essex labourer, who was hale and hearty and had always enjoyed good health. The hand and forearm were much wasted from atrophy, especially of the muscles. The index and middle fingers had in great part disappeared from a slow process of ulceration, conical stumps composed of the first and a small portion of the proximal end of the second phalanges only remaining; the ring and little fingers were fully flexed, fixed, thin and tapering, with commencing ulceration on the extensor surfaces of the terminal joints. In the thumb ulceration was in progress, but had, as yet, only destroyed the pulp and a small portion of the terminal phalanx, the nail being thickened and curved over the end. The skin of the whole hand was thin and shiny, but over the fingers and thumb it was of a purplish colour, except at the very extremities, where it was tightly stretched and of a pale colour and wax-like appearance. These appearances are fairly well shown in the coloured drawing (Plate XIX. Fig. 1). Over all the fingers and the greater part of the thumb, the skin was firmly fixed to the subjacent structures, and was also somewhat translucent, as if that which gives opacity and dulness to the natural skin had in great part disappeared. The thenar and hypothenar regions were hollowed, from extreme wasting of their respective muscles, and the intervals between the metacarpal bones on the dorsal aspects, normally occupied by the interossei, were also hollowed, so that the outlines of the several bones were very distinct.

Owing to the changes that had occurred in the fingers, their movements were either partially or completely interfered with, but there was limited flexion and extension at the wrist, as well as slight flexion, extension, and adduction of the thumb. It was found that sensation was defective over the whole hand, but after several trials no definite area of greater or more pronounced defect could be found, and complete absence of sensation did not occur in any part. It was, however, difficult to ascertain these particulars with precision.

On the lower and inner part of the arm, just above the inner condyle of the humerus, was a linear oblique scar, from 2 to 3 inches in length, which was not deeply fixed. Into the scar the brachial artery could be traced, but below it could not be felt. On the outer side of the artery, at the upper extremity of the scar, was a small rounded or ovoid very tender lump, which was presumed, by others as well as myself, to be the swollen central end of the divided median nerve, displaced somewhat from its natural position.

History.—Fifteen years ago, while the patient was chaff-cutting, his left arm was caught just above the elbow in the machine, and cut on the inner side clean to the bone; there was much bleeding at the time, and the hand became at once numbed and useless. He was taken to the London Hospital, and there treated. After 5 months he returned to work, the fingers, thumb, hand, and forearm being powerless. About a year after the accident, a certain degree of feeling returned to the skin of the hand. Two years later, that is three years after the accident, the tip of the middle finger began to fester and ulcerate, the nail dropping off, and the end of the fingers disappearing bit by bit, without the coming away of any pieces of the bone, or obvious sloughing and gangrene of the soft parts. Some time later the same ulcerative process began in the tip of the index finger. This ulceration was attended with but little pain. The activity of the ulceration depended largely upon the state of the weather and season of the year, for in the cold seasons this slow ulceration would commence and go on until the return of warm weather, when the ulceration would stop and the fingers heal, and remain so until the return of winter and cold weather. In this manner, that is to say, by progressive ulceration, a sort of liquefactive necrosis of soft parts, tendons, and bones, the distal portions of both index and middle fingers were removed. Six to seven years after the accident the ring and little fingers became slightly flexed. The flexion gradually increased, and the fingers became quite painful. Just 2 years ago, that is 13 years after the accident, the end of the thumb began to ulcerate, and it has continued to do so, with slight interruptions during the warm weather, up to the present time.

Owing to the pain in the ring and little fingers, and the trouble of the recurrring ulcerations, he desired to have the hand removed. This was done by Sir George Humphry, to whom I am indebted for the privilege of publishing this account of the case.

Bones and Joints of the Hand.

The skeleton of the hand (Plate XX. Fig. 2) showed the following:—

1. The terminal phalanx of the thumb was smaller and more spongy than natural, and the terminal tuberated part was much reduced in size. The first phalanx was quite natural.

2. The *second* phalanges of the index and middle fingers were represented by sharp-pointed cones of about one-third of an inch in length, with broad bases; the surfaces of these cones were smooth and well healed. The terminal phalanges had entirely disappeared, as well as the greater part of the second.

3. All the phalanges of the ring and little fingers were thinner and more delicate than natural, especially the second and terminal (the latter were lost in maceration), and they were fixed by the soft parts in a state of flexion. The remainder of the bones were natural.

There were no changes, besides such atrophy as occurs after prolonged disease, in the articular cartilages of any of the joints.

Nerves.

The *median* nerve, which measured one-sixth of an inch in diameter at the wrist, appeared as a whitish firm cord, with much fat adhering to it, the fine glistening surface of the normal nerve having quite disappeared. Under the microscope it was found to be completely transformed into bundles, which corresponded with the original nerve bundles, but consisted simply of wavy fibrous connective tissue, running as the nerve fibrils in the long axis of the nerve. There were, however, no traces of medullated nerve fibres or unmedullated fibres to be seen in any of the bundles which appeared at first sight so like the natural bundles. This change was simply a substitution of the nerve fibres and bundles by connective tissue fibres and bundles, without much, if any, diminution in size.

The *ulnar* nerve was also of nearly natural size, but tough in structure, and surrounded like the median with much fat, having lost its smooth glistening appearance. Under the microscope the connective tissue (peri- and endoneurium), was seen to be much increased, dense, and fibrous, and the nerve fibres were in various stages of atrophy, many having altogether disappeared. Most of the nerve fibres had partially lost their medulla, and owing to the increase of fibrous connective tissue they were more widely separated than natural. This condition resembles that produced by chronic inflammation of a nerve,—chronic neuritis,—and contrasts with that which had taken place in the median nerve, which was the result of division.

It is noteworthy that in these two nerves, median and ulnar, the size of the trunks was very near the normal, although, in the former instance, the nerve substance had completely, and in the latter in

great part, disappeared. Further, each nerve was, as noted above, adherent to the surrounding fat, and the free, smooth, and glistening exterior of a normal nerve was quite wanting. The undue adhesion of fat to the exterior of the nerves thus altered was probably due to extension of the sort of chronic inflammatory change in the interior to the exterior, binding the nerve to the surrounding tissue. I have noted the same in the nerves in cases of leprosy, even in parts where there was no tubercular infiltration.

The Skin.

The skin of the hand was, as noted above, thin, shiny and semi-translucent, except towards the extremities of the fingers and thumb, where it was of a purplish colour, owing to imperfect circulation. Under the microscope, the skin of the pulp of the thumb, where it had given way, was seen to be replaced by ordinary granulation tissue. Higher up, where the skin was thin and changed, the subcutaneous adipose tissue had completely disappeared, giving place to fibrous connective tissue in which there were innumerable fibres of yellow elastic tissue which, from the proportion in which it had occurred, must have been of new formation. In addition, the sweat glands had also in great part disappeared, leaving, in some places. small groups of gland tubules filled with altered and degenerated epithelial cells which were, in many instances, massed together and indistinct. The cutis vera was thickened, and contained an unusual number of yellow elastic fibres, and it was inseparable from the subjacent subcutaneous tissue which was altered, as above stated. The epidermis was thinner than natural, but there were no morbid changes to be seen in it.

It would appear, therefore, that the semi-transparency of the skin of the fingers especially noted in this case, and so common after permanent injury to sensory nerves, is probably due to the disappearance of the subcutaneous fat, and to the formation of fibrous connective tissue in which yellow elastic fibres are present in great abundance, and, in some measure, to the thinning of the epidermis itself.

Muscles.

The muscles, which were, without exception, pale and wasted, showed different degrees of atrophy. The abductor, opponens, and outer half of the flexor brevis pollicis were to the eye very pale, tough, and fibrous; whereas those supplied by the ulnar nerve, namely, abductor, flexor brevis minimi digiti, interossei, and adductor, and inner head of the flexor pollicis were changed in a similar manner, but in less degree.

A section of a portion of the abductor pollicis, under the microscope, showed that the greater number of the muscle fibres had disappeared, and that those remaining were in various stages of atrophy, the greater

part of the muscle having been substituted by dense, wavy, fibrous connective tissue. The largest of the muscle fibres were composed of distinct longitudinal fibrils, faintly striated transversely, and surrounded by a peripheral homogeneous substance, disposed in more or less narrow annular bands, connected by cross or oblique bands of the same material (Plate XX. Fig. 3). These homogeneous bands, lying within the sarcolemma, invested and bound together the central bundle of longitudinal fibrils. The nature of this material could not well be made out, but there were no fatty granules in it, and no evidence of fatty disintegration of the individual fibrils which were very distinctly seen lying side by side, as straws in a bundle. In the medium sized fibres these rings of homogeneous material were not discoverable, having perhaps disappeared. But, in the course of these medium sized fibres, there were, at regular intervals, ovoid node like enlargements of the fibres, which were due to minute node like enlargements of the individual fibrils. The nature of these node like enlargements of the fibrils I failed to ascertain. In the smallest fibres, some of which were composed of a bundle of several fibrils, and others of only two or three at most, the features above described as observed in the large and medium sized fibres were absent. The smallest of these small fibres faded away into the surrounding fibrous connective tissue, the fibrils disappearing, one by one, until the fibre itself became completely lost. As has been said above, the intervening tissue was composed of dense, wavy, fibrous connective tissue, in which there were only a few flattened connective tissue cells. In this tissue there were no fat cells, and there was no appearance suggestive of its substitution by adipose tissue, which is so frequently found to be the case in atrophied muscles.

The remaining muscles supplied by the median nerve were in a similar state, and showed the same histological changes.

In the muscles, supplied by the ulnar nerve, the wasting was not so marked nor the substitution by fibrous connective tissue so great. In some parts the fibres of these muscles were merely reduced in size, being otherwise natural; whereas, in others, they showed precisely the same changes as those described above in the fibres of the abductor pollicis.

The changes noted by me in the leg muscle of a dog, the lumbar portion of the spinal cord of which had been destroyed 10 days before the animal was killed, may be of interest in this connection, as they further illustrate what has been described above. As would be expected, the leg muscles rapidly wasted, and they were reduced to at least one-half their natural bulk. Under the microscope, the remaining muscular fibres, which varied in size as they do in a normal muscle, were seen to be, without exception, altered in their structure. Some were swollen, and throughout more or less homogeneous looking, the transverse structure being quite obscured. In others, the homogeneous looking substance was confined to the exterior, and was found as a thin layer lying within the

sarcolemma, and in most instances it was disposed in narrow or broad rings which were connected by bands of similar material. Within this homogeneous material the fibrils of the muscle fibre were seen very distinctly, the whole giving the appearance of so many fibrils bound together by rings of a homogeneous substance lying within the sarcolemma, or sheath. This appearance has given rise, I believe, to a view which is that first put forward by Vulpian, and since adopted by Weir-Mitchell and others, that the degenerating muscle fibres sometimes become transversely segmented.

There was no increase in the intermuscular connective tissue.

I find also that, in the atrophying muscle fibres of the dwindling tadpole's tail, similar changes occur.

It would seem, therefore, that the muscle fibre becomes separated into two constituents—(*a*) an external homogeneous material of uncertain nature, and (*b*) a central fibrillar structure, in which the fibrils are more distinct than in a normal fibre.

From observations in this case, and in others of a like nature, I am inclined to regard the condition noted above as the result of a separation of the two natural constituents of the muscle fibre, namely, the fibrils and the intervening homogeneous matrix, known as the sarcous substance—in the one, fibrils collecting together in the centre of the fibre, and appearing more or less distinct from one another; in the other, the sarcous substance accumulating within the sarcolemma and outside the fibrils, and becoming, after a time, disposed in, more or less, annular bands, giving an appearance suggestive of segmentation of the fibre. Further, the homogeneous material after a time disappears, and the fibrils, which are the last to disappear, become gradually transformed and merged into the surrounding fibrous connective tissue.

Remarks.

Reviewing the details of the case, I may remark that there was complete atrophy of the median nerve in the forearm and hand, after division above the elbow, 15 years previously, and partial or complete destruction of the greater number of the fibres in the ulnar nerve, owing to a process allied to chronic neuritis, the peri- and endoneurium being much increased at the expense of the nerve fibrils.

In consequence of the former lesion, the hand became immediately numbed and useless; sensation, though imperfect, was regained after a year, the median nerve being, as above stated, transformed into a fibrous cord. Was this restoration of sensation to the parts of the skin of the hand, which are supplied by the median nerve, due to the ulnar and radial nerves taking on its function? I am not prepared to offer any explanation, for it was extremely difficult to obtain from the old man any accurate data. Some slight power was regained in

the flexors of the forearm, which, as above mentioned, were much atrophied.

The skin, which was thin and adherent in parts, showed the semi-translucency and atrophy seen in cases of division of sensory nerves. Where this state of the skin was most marked, the subcutaneous tissue had lost its fat and become transformed into fibrous connective tissue, continuous with that of the corium. In this there was much elastic tissue in the form of fibres. The epidermis was thin, and the sweat glands on the palm were reduced in number, and much atrophied.

Perhaps the most interesting changes induced in the hand were those of slow ulceration in the fingers (index and middle), destroying them in their entirety, up to a certain point. This ulceration was largely dependent upon the cold, so much so that it ceased at the onset of the hot weather. I have only known one other case in which this slow ulceration occurred without gangrene or sloughing; and that was in the toes of a labourer, aged 48 years, whose arteries were hard, rigid, and small, but in whom there was no evidence of either central or peripheral nerve lesion. This ulceration, which may be called "liquefactive necrosis," was not accompanied by much surrounding inflammation, but was preceded by the transformation of the connective tissues, including tendon and bone, into granulation tissue, which gradually liquefied and escaped as a serous semi-purulent bloody fluid.

This form of progressive ulceration (liquefactive necrosis) is noted by Bowlby,[1] who mentions a case in which "nearly the entire tip of the index finger and a part of the middle were eroded in this manner within five months of the accident." These ulcerations he refers to injuries, in most cases received on the skin, the sensitiveness of which is diminished or wholly absent; but in the case mentioned by him ulceration continued, even while the hand was carefully protected from cold and other injurious influences. A few cases of gangrene of a whole finger, or part of one, have been reported by Hilton,[2] I'Anson,[3] and Root.[4] In each of these cases thrombosis or other blockage of the chief artery to the part occurred. But gangrene, as was pointed out by these writers, could not have occurred if the lesion had been confined to the artery and the nerve of the part uninjured.

DESCRIPTION OF PLATES XIX. AND XX.

FIG. 1.—A coloured drawing of hand, 15 years after division of the median nerve above the elbow. Two-thirds natural size.

FIG. 2.—Skeleton of same, showing changes in the bones. One-half natural size.

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[1] "Injuries of Nerves," p. 44.
[2] "Rest and Pain."
[3] *Med. Times and Gazette*, Dec. 30, 1871.
[4] *New York Med. Record*, 1882, p. 560.

FIG. 3.—Microscopic drawing of a section of the abductor pollicis, showing the different stages of atrophy in the muscular fibres: *a*, largest fibres; *b*, medium; *c*, small fibres. × 300.

FIG. 4.—Microscopic drawing of two muscle fibres, taken from the thigh muscles of a dog 10 days after complete division of the lumbar spinal cord: *a*, central bundle of fibrils which have lost their transverse striation; *b*, homogeneous substance arranged in a ring-like fashion inside the sarcolemma and outside the bundle of fibrils; *c*, accumulation of small round cells between the muscle fibres. × 200.

Fig 1. ⅔ natural size.

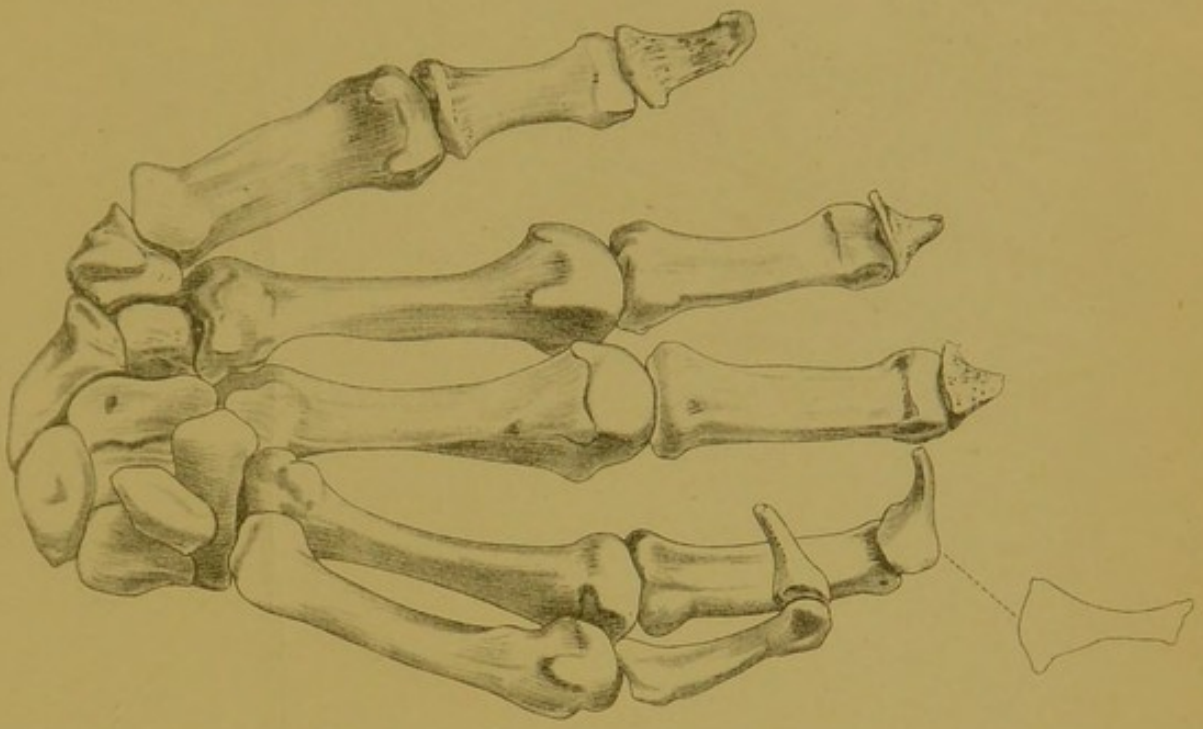

Fig. 2. ½ natural size.

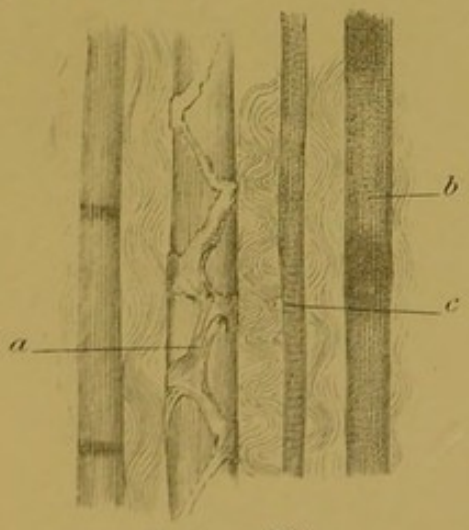

Fig. 3. × 300

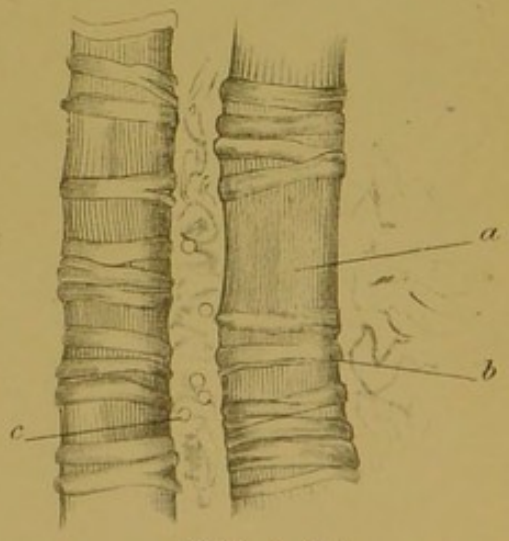

Fig. 4. × 200