A case of multiple neuro-fibromata of the ulnar nerve / by W.W. Keen and William G. Spiller.

A Case of Multiple Neuro-Fibromata of the Ulnar Nerve.

BY

W. W. KEEN, M.D., LL.D.,

PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF CLINICAL SURGERY, JEFFERSON MEDICAL COLLEGE, PHILADELPHIA,

AND

WILLIAM G. SPILLER, M.D.,

PROFESSOR OF DISEASES OF THE NERVOUS SYSTEM IN THE PHILADELPHIA POLYCLINIC, ASSOCIATE IN THE WILLIAM PEPPER LABORATORY OF CLINICAL MEDICINE, UNIVERSITY OF PENNSYLVANIA.

FROM

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES,

MAY, 1900.

Extracted from The American Journal of the Medical Sciences, May, 1900

A CASE OF MULTIPLE NEURO-FIBROMATA OF THE ULNAR NERVE.[1]

By W. W. Keen, M.D., LL.D.,

PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF CLINICAL SURGERY, JEFFERSON MEDICAL COLLEGE, PHILADELPHIA.

AND

William G. Spiller, M.D.,

PROFESSOR OF DISEASES OF THE NERVOUS SYSTEM IN THE PHILADELPHIA POLYCLINIC, ASSOCIATE IN THE WILLIAM PEPPER LABORATORY OF CLINICAL MEDICINE, UNIVERSITY OF PENNSYLVANIA.

Surgical Report by Dr. Keen.

B. L., a laborer from Northumberland, Pa., aged forty-seven years, first consulted me April 17, 1899. His father died of tuberculosis; mother, of unknown cause. Neither of them suffered from rheumatism. The patient has suffered for twenty years from rheumatism, especially in his knees. For many years past there have been some tender nodules in the palm of his left hand. He is doubtful whether they are made worse by bad weather. At first they were painful only when compressed in handling a spade, axe, or any other such tool, but gradually the pain became continuous and kept him awake many nights. It was often so severe that he could scarcely refrain from outcries when it darted through his hand. As he expressed it, "The jumping toothache wasn't in it compared to this pain."

In January, 1892, another surgeon removed two of these nodules. Stellate scars at each place mark the site of the wounds, which suppurated. No microscopical examination of the tumors seems to have been made. He has now nodules at the places marked *a* to *f*, Fig. 1. These existed at the time of the prior operation, but as they were not painful they were not removed. The one in the forearm, marked *a*, is painful only occasionally, when, by accident, pressure is applied to it. The others are all spontaneously painful.

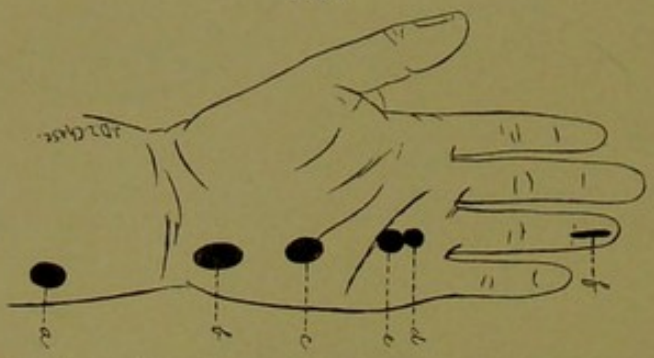
For twenty years also he has had a *fistula in ano*, for which two ineffectual operations have been done. Three openings about 3 cm. anterior to the anus, surrounded with a great deal of induration, were found.

Operation, April 18, 1899. I first made an incision above the wrist and exposed the ulnar nerve (at *a*, Fig. 1), in which I found a fusiform expansion, caused evidently by a mass in its interior. An incision made very carefully in the axis of the nerve enabled me to separate the fibres to each side, and with an Allis dissector to shell out from the interior of the nerve an oval tumor with a small filament 1 to 2 mm. in diameter at each pole of the tumor. It was quite a surprise to me to find so large a tumor, in view of its being so obscurely felt before operation. The same remark would hold true of all the others. A second incision was made at the eminence of the little finger (at *b*, Fig. 1), and a similar tumor again shelled out of the ulnar nerve. A third incision just

[1] Written for the Jacobi Festival volume. Read before the College of Physicians of Philadelphia, April 4, 1900.

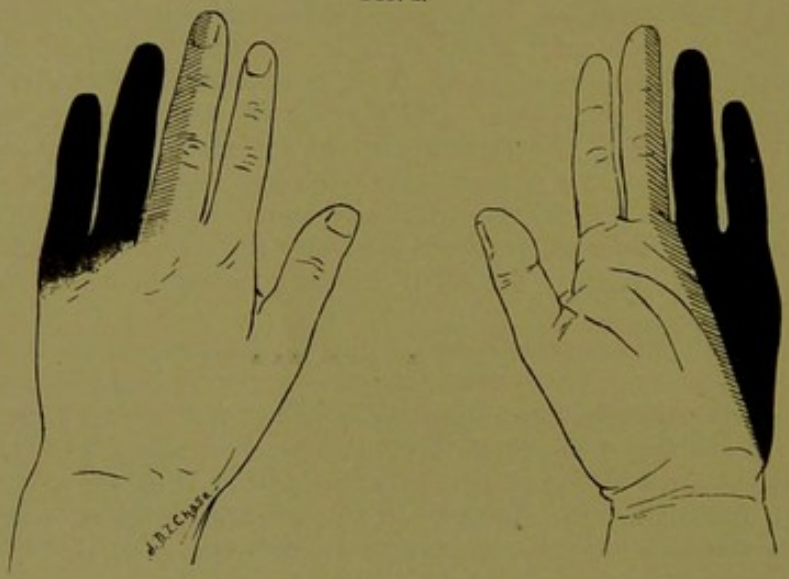
above the web, between the ring and the little finger (at *d*, *e*, Fig. 1), revealed two such tumors, and as I could now feel another tumor in the middle of the palm (*c*, Fig. 1), midway between the last two incisions,

FIG. 1



Showing position of the tumors. Compare this with Fig. 4.

FIG. 2.



Showing the condition of sensation in the left hand of B. L., April 18, 1899, just before operation. The black area shows hyperæsthesia for all qualities, excepting cold on the median side of ring finger. The parallel lines represent the hypæsthetic area. On the back of the middle finger the hypæsthesia was uncertain.

Sensation was tested for heat, cold, pain, and touch.

The ulnar side of the left hand was *hyper*sensitive for all qualities except on the median side of the ring finger; here cold was not perceived quite so distinctly as in the corresponding portion of the right hand. The median side of the ring finger, palmar aspect, seemed to be somewhat *hyper*sensitive to all qualities except cold. The ulnar side of the middle finger, both palmar and dorsal aspects, showed diminished sensation. When the patient was touched over the scar on the palm of the left hand—the scar made by a previous operation on the ulnar nerve—he perceived the sensation in another scar situated on the ring finger of the same hand. When he was touched over the scar in the ring finger, he located the sensation correctly. The hyperæsthesia was doubtless due to the irritation of the nerve fibres caused by the presence of the tumors. Pain prevented a firm grasp by the left hand.

I made these incisions continuous and shelled out all the tumors. On the pulp of the ring finger opposite the last interphalangeal joint (*f*, Fig. 1), two quite small tumors were found, and the entire nerve, with these

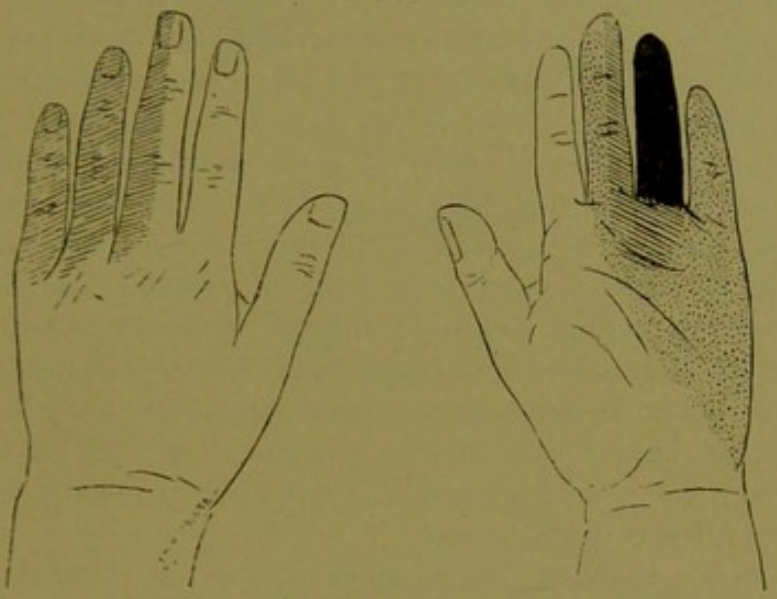
two tumors, was removed (see Fig. 4). All the tumors were oval in shape, with a small filament at each pole (see Fig. 4).

The fistula was then operated upon.

He made an uninterrupted recovery without febrile reaction, and left the hospital on the twelfth day, entirely well.

He writes me, under date of November 14th, that his present condition is as follows: He has no pain either in his hand or arm, and has full use of the hand, but still suffers from rheumatism.

FIG. 3.



Showing the condition of the sensation in the left hand of B. L., April 27, 1899, nine days after the operation. The black area represents the nearly anæsthetic area, the parallel lines on the palmar surface represent the hypæsthetic area, and the dots the hyperæsthetic area. On the middle finger the hyperæsthesia was uncertain. On the back of the hand the parallel lines represent the slightly hyperæsthetic area.

Sensation was tested for heat, cold, pain, and touch, and the limits of the areas corresponded for each form of sensation, *i. e.*, there was no dissociation of sensation. The palmar surface of the left ring finger was almost anæsthetic in all forms of sensation. The *ulnar* side of the middle finger was hypæsthetic, but the thumb side of the middle finger and the whole of the little finger, and the ulnar side of the palm as high as the wrist, were slightly *hyperæsthetic*; except that the portion of the palm above the middle and ring fingers was *hypæsthetic*; above the wrist disturbance of sensation was uncertain. The thumb and first finger exhibited normal sensation.

On the dorsal aspect the middle, ring, and little finger were somewhat more sensitive than the corresponding fingers of the right hand. The thumb and first finger were normal. The back of the hand was also normal.

REMARKS. In Dr. Spiller's report on such neuro-fibromata most of the essential facts are stated, and the most important references are given, and need not be recapitulated here. Operation is essential, for if left the tumor steadily increases in size. This results in constantly increasing pain, and by reason both of the pain and its consequent motor disturbances the usefulness of the hand is impaired or even lost. Moreover, from the constant pain the patient becomes very irritable. Malignant degeneration in a nerve after neuro-fibromata have been removed is by no means unknown, but the risk incurred by such an operation is

justifiable in view of the symptoms produced by the tumors, and malignant degeneration may occur in these tumors even when no operation has been performed. In the present case the mode of operation was clearly indicated, and when the tumors are central in the nerve, as in this case, they should be shelled out. If they exist upon the side, they should be dissected carefully from the nerve, doing as little injury to its fibres as possible, yet removing as far as possible all the diseased tissue. Whether all diseased tissue has been removed is an extremely difficult thing to determine absolutely, for from each pole of the tumor the disease may pass a considerable distance up and down the nerve, or it may exist at some other part of the nerve without causing clinical manifestations. If the tumor is too large or too intimately connected with the nerve to allow of either of these methods of operation, two resources still remain; first, a resection of the entire nerve or amputation of the limb. The latter is not uncommonly necessary in the leg, because such tumors, in connection with the sciatic, are apt to be very large and also to undergo malignant change. Resection of even so large a nerve as the sciatic does not always result in total paralysis, and even should this follow, sensation and motion may occasionally be restored either through lateral paths or by a greater or less regeneration of the nerve. Such complete regeneration I have seen personally more than once in the inferior dental nerve.

One danger attends operation, especially if all the diseased tissue has not been removed, namely, a rapid and malignant recurrence.

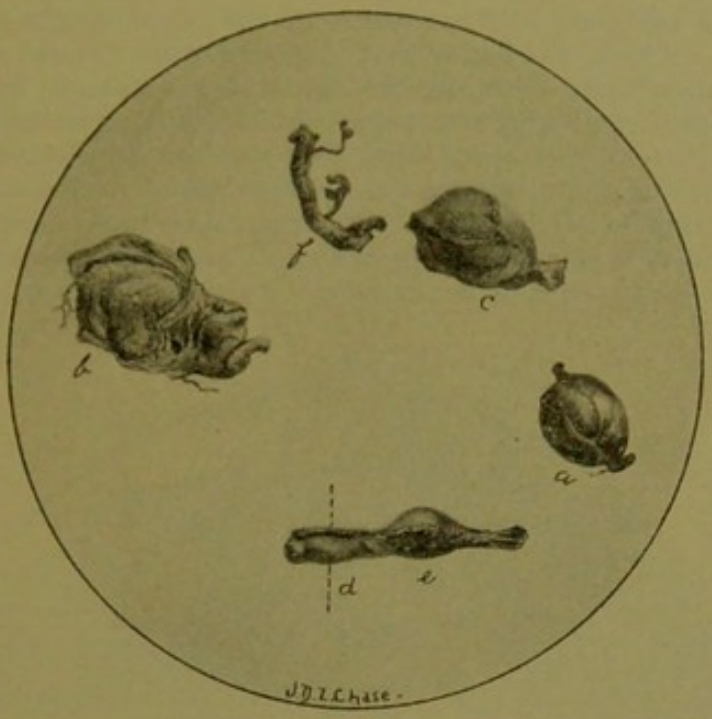
In Robert W. Smith's monograph, republished in 1898 by the New Sydenham Society, many admirable drawings of such tumors will be found.

Pathological Report by Dr. Spiller.[1]

The tumor designated in Fig. 4 as *c* was studied microscopically. Sections made about half-way between the two ends of the growth showed that the centre of the sections was formed by dense bands of connective tissue interwoven with one another and running in various directions. Most of these fibres had a transverse course, but some ran longitudinally, and were, therefore, cut transversely in transverse sections of the tumor. Numerous nuclei, deeply stained by Delafield's hæmatoxylin, were found mingled with the fibres, and most of these nuclei were elongated; some, however, were round. It is difficult to determine whether the latter were merely elongated nuclei, cut transversely, or were really round nuclei, but probably most of them were elongated nuclei. Toward the periphery of the growth the fibrous tissue was looser and contained many nuclei, and this looser fibrous tissue passed rather abruptly into the circular bands forming the perineurium (Fig. 5). Bloodvessels were rare in the centre of the tumor where the

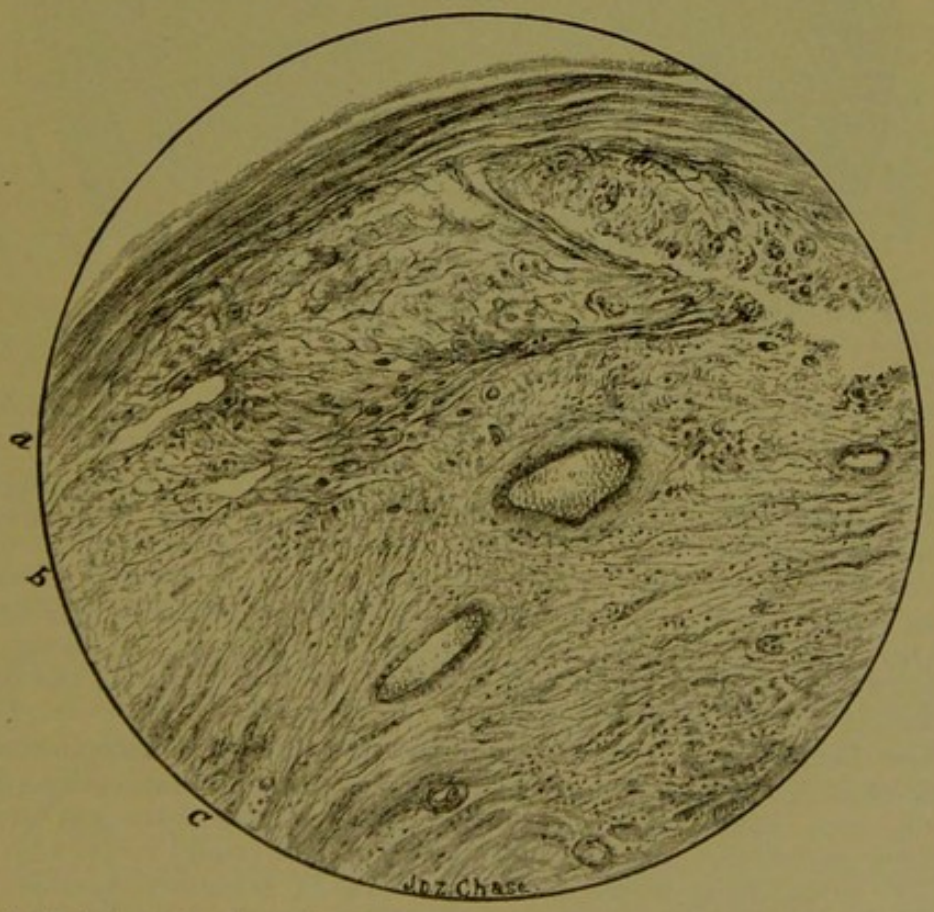
[1] From the William Pepper Laboratory of Clinical Medicine, University of Pennsylvania (Phœbe A. Hearst Foundation).

FIG. 4.



Actual size of the tumors removed.

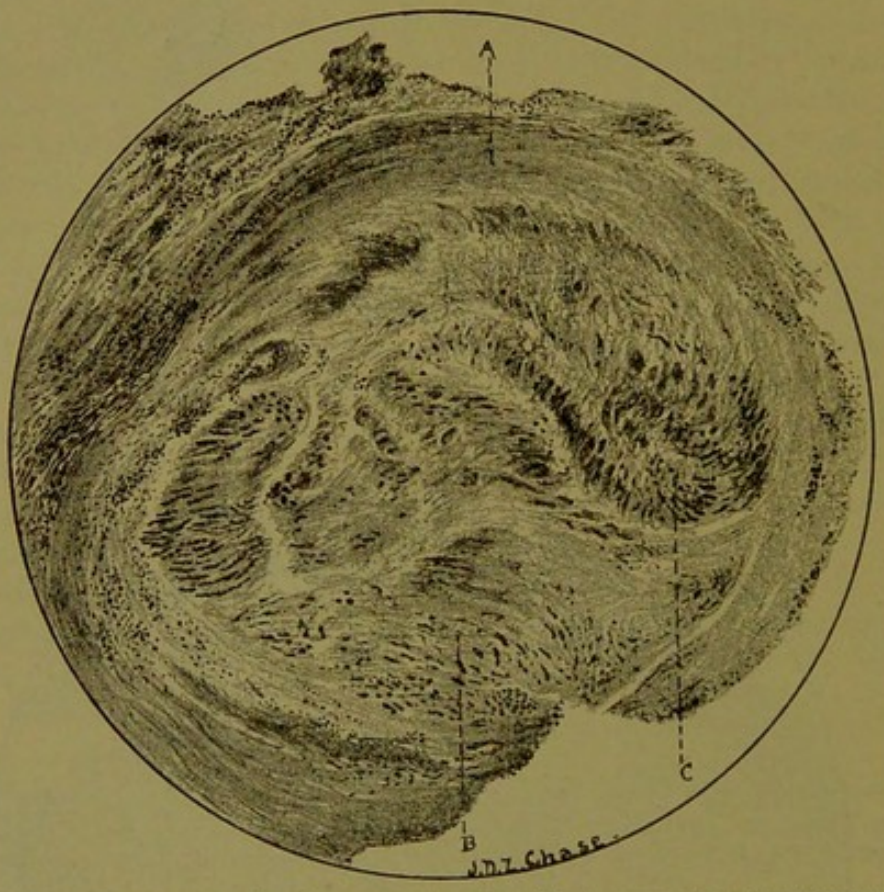
FIG. 5.



Oc. 3, Ob. 3. A section from the tumor taken near the centre of the growth. *a*, perineurium; *b*, loose connective tissue near the periphery of the growth; *c*, dense connective tissue forming the centre of the tumor.

dense fibrous tissue was found, but were quite numerous in the looser tissue at the periphery. About some of the vessels at the periphery of the growth an area was found that showed a groundwork not staining well with ammonium carmine, but containing numerous delicate wavy fibres arranged circularly about the vessel. By Weigert's hæmatoxylin method a few scattered nerve fibres were seen within the looser tissue at the periphery of the tumor, but none were found in the central dense fibrous formation. The perineurium was not much thickened. The proliferation of connective tissue evidently began in the endoneurium and in the centre of a nerve bundle. Nerve fibres were found in sec-

FIG. 6.



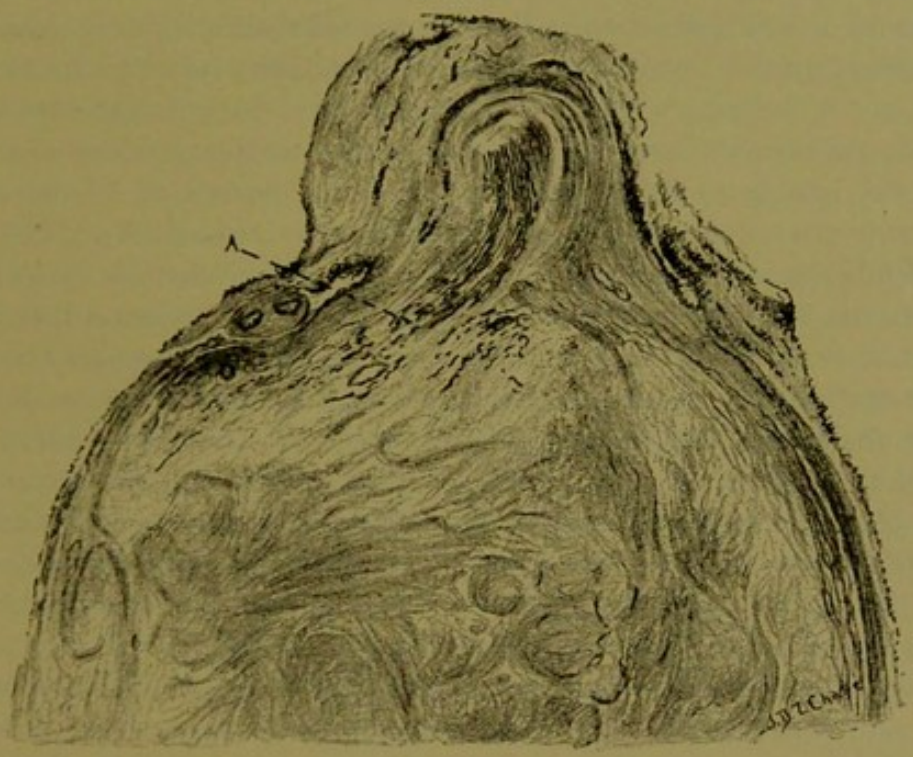
Oc. 3, Ob. 3. Transverse section from one extremity of the tumor, *c*, showing the nerve fibres widely separated from one another by proliferated connective tissue; A, perineurium; B C, nerve fibre.

tions taken from each end of the tumor (Figs. 6 and 7), and it was evident from these and the sections from the middle of the tumor that nerve fibres extended from one extremity of the tumor to the other, although they were not numerous.

The description of the tumor designated as *c* in Fig. 4 applies to the smaller growth designated by the letter *d* at the part marked by a horizontal line. In the tumor *d* the zone of looser fibrous tissue was between a dense central and a dense peripheral area. This small tumor also contained a few nerve fibres distinctly shown by Weigert's hæmatoxylin method. In some of the nerve bundles removed—seen as a narrow band upon the tumor *d* in Fig. 4—and cut with the tumor *d*, the connective

tissue proliferation was seen in an early stage; the individual nerve fibres were separated a little more than normally by a slight excess of connective tissue, and in some places where the connective tissue was in still greater amount the nerve fibres appeared somewhat atrophied, as though they had suffered from the pressure of the proliferated tissue. In these nerve bundles the proliferation was distinctly seen to begin in the endoneurium. These nerve bundles were distinct from the tumor *d*, but formed an integral part of the tumor immediately adjoining, designated as *e* in Fig. 4. This was proof that the proliferation of the

FIG. 7.



Oc. 3, Ob. a_2 (Zeiss). Longitudinal section of the tumor *c*, showing medullated nerve fibres entering at one extremity of the growth and passing to the periphery of the tumor (*A*).

endoneurium was not confined to one or two nerve bundles within the ulnar nerve, and it would indicate that at one part of the nerve one bundle was affected, and at another part another bundle.

The piece of nerve designated as *f* in Fig. 4 was found by microscopical sections to contain three nerve bundles presenting different degrees of thickening of the endoneurium, and the perineurium of these bundles was considerably thickened.

The connective tissue of the nerves in some persons exhibits a remarkable tendency to proliferation, and this proliferation may cause the condition known as generalized neuro-fibromatosis, in which multiple neurofibromata, multiple cutaneous fibromata, plexiform neuro-fibromata, elephantiasis of the skin, and pigment nævi occur.

To one unfamiliar with the literature the classification of fibro-neuromata with some of the forms of generalized fibromatosis mentioned would seem unwarrantable, and a brief *résumé* of some of the more

important papers is desirable for a proper understanding of this rather difficult subject, especially as most of the literature is in the German language.

The relation of these various pathological formations to one another has not been universally recognized. Virchow believed that a relation existed between the multiple cutaneous fibromata, the neuro-fibromata, and certain forms of congenital elephantiasis (Goldmann), and v. Recklinghausen[1] showed that the fibromata mollusca are fibromata developed on the cutaneous branches of nerves. Marie[2] states, in an excellent paper on this subject, that v. Recklinghausen's view is pretty generally accepted, but not by all. Marie does not include every fibroma molluscum under the generalized neuro-fibromatosis. In one of the two cases of general neuro-fibromatosis reported by him an autopsy was obtained. He was unable to find any fibromata on the nerves, or to find nerve fibres in the cutaneous tumors removed from the cadaver. The case clinically was a typical one of generalized neuro-fibromatosis, and in two cutaneous tumors removed during the life of this patient a few nerve fibres were found. The absence of nerve fibres in the tumors removed from the cadaver, of course, does not prove that these tumors did not have their origin in the cutaneous nerves. The cutaneous nerves are small and may be destroyed in fibromatous thickening. The examination of the growths removed by Professor Keen has shown me that the nerve fibres within the tumor may be entirely destroyed in places by the proliferation of the connective tissue, and this is doubtless true of the nerve fibres in the fibromata of the skin.

While certain writers have contended that the multiple fibromata of the skin arise in the connective tissue of the cutaneous nerves, some make the connective tissue surrounding other structures—about the roots of the hair, glands, and vessels—responsible for the proliferation. This question has not been positively decided. For example, Goldmann[3] reported a case of congenital plexiform neuroma (the first case in his paper) in which microscopically numerous fibromata were found in the skin, and all of these were in relation with cutaneous nerves. Apparent thickening of the adventitia of the vessels, of the hair sheaths, of the sweat-glands and sebaceous glands was in reality due to a fibromatosis of the nerves supplying and surrounding these structures. This case supports the view of the unity of the process in multiple cutaneous fibromata and multiple fibro-neuromata of the nerves. On the other hand, in a paper published by Finotti[4] three years later, different conclusions were reached. Finotti believed from his studies that the mul-

[1] v. Recklinghausen. Ueber die multiplen Fibrome der Haut, etc., 1882.
[2] Marie. Leçons de clinique médicale, Hotel Dieu, 1894-1895.
[3] Goldmann. Beiträge zur klin. Chirurgie, 1893, vol. x.
[4] Finotti. Virchow's Archiv., 1896, vol. cxliii. p. 133.

tiple fibromata did not originate exclusively in the nerves. The writers seem to agree that in structure the cutaneous fibromata and the fibro-neuromata of the nerves are very similar. The literature on this subject is given in a recent paper by Merken.[1]

The generalized neuro-fibromatosis is known also as v. Recklinghausen's disease and as elephantiasis nervorum. Under the latter term Hartmann[2] classes the neuro-fibromata of the nerves, the fibromata mollusca, cutaneous enlargements, and pigment spots—all are manifestations of a congenital tendency of peripheral nerves to tumor-formation. The designation of elephantiasis neuromatodes is employed by Scheven[3] to include plexiform neuromata, fibromata mollusca, and fibromatous thickening of nerve trunks.

The plexiform neuroma seems to be a part of generalized neuro-fibromatosis. P. Bruns[4] has had an unusual opportunity to study this form of growth—as the study of eight cases of this rare tumor may well be considered unusual. He says that the Rankenneuroma (plexiform neuroma) is one of the forms of congenital elephantiasis known also as the fibromatous diathesis, and is the result of fibromatous thickening of the nerves of a circumscribed territory. It differs only in form from the multiple fibromata of the skin and nerve trunks. This is shown by the congenital and occasionally hereditary tendency to the formation, the simultaneous appearance of the different forms in the same person, the same histological structure, etc. Bruns was able to collect in all, including his own, forty-two cases of plexiform neuroma from the literature (1891); in three of these heredity was observed through three generations; in the first two generations multiple cutaneous fibromata, multiple fibromata of the nerve trunks, and elephantiasis occurred, and in the third generation the plexiform neuroma appeared. Bruns, therefore, classes under elephantiasis the plexiform neuromata (Rankenneuroma), multiple cutaneous fibromata, multiple fibromata of the nerves, and colossal elephantiasis; and he shows that the disease may be hereditary, appearing in one form in one generation and in another in a following generation. The term elephantiasis neuromatodes seems to have originated with Bruns, but he distinguishes other forms: the elephantiasis teleangiectodes and the elephantiasis lymphangiectodes, according as the bloodvessels or lymph-vessels are involved.

The relation between multiple fibro-neuromata and elephantiasis was recognized in two cases by Jordan.[5] The vascular system was the source of a connective tissue hyperplasia causing great thickening of the skin and subcutaneous tissue and the formation of tumors in the nerves and

[1] P. Merken. Wiener klin. Wochenschrift, 1899, Nos. 32, 33, and 34.
[2] Hartmann. Beiträge zur klin. Chirurgie, vol. xvii. p. 177.
[3] Scheven. Ibid., p. 157.
[4] Bruns. Ibid., vol. viii. p. 1.
[5] Jordan. Beiträge zur pathologischen Anatomie und zur allgemeinen Pathologie, vol. viii.

muscles. Fibromata mollusca were found in both cases. In one patient the right lower limb had a circumference of 75 cm. and the left 22 cm., and the right lower limb was greatly deformed. Jordan was unable to classify these cases under any of the three forms of elephantiasis (elephantiasis fibromatosa, teleangiectodes, neuromatodes) known to him. Macroscopically the condition was one of elephantiasis fibromatosa with multiple fibromata mollusca, multiple neuromata, and thickening of the large vessels; microscopically the vessels were found to be the structures in which the hyperplasia began, so that in both cases there was a combination of different forms of congenital elephantiasis. Jordan doubts whether cases of congenital elephantiasis in which only the skin and subcutaneous tissues are affected exist—*i. e.*, cases of solitary pachydermatocele.

Herczel[1] was able to observe that in a pachydermatocele the proliferation of the connective tissue originated in the thickened fibrous nerve bands; that it was a true elephantiasis neuromatodes.

The frequency of pigment nævi in generalized fibromatosis has been noted by many writers, and in a careful microscopical study Soldan[2] has recently shown that these pigment nævi (Pigmentmäler) are in the majority of cases the first recognizable signs of a fibromatous process of the connective tissue of the nerves. The different forms of neuro-fibromatosis are conditioned by the localization, anatomical relations, and energy of growth.

This brief summary of some of the most important writings on generalized neuro-fibromatosis is sufficient to show that we are justified in classing under one head the neuro-fibromata of the nerves, the cutaneous fibromata, the plexiform neuromata, certain forms of elephantiasis, and certain pigment nævi. It does not follow, however, that all cutaneous fibromata arise in the nerves.

The causes of generalized neuro-fibromatosis are unknown. Reference has been made to the fact that heredity plays a rôle in some families, and in addition to the cases cited I may mention that Menke[3] observed neuromata in members of three generations—grandmother, mother, and son—and he says a heredity through three generations existed only in the cases cited by Herczel, Bruns, and Czerny. Most writers agree that the condition is not usually an acquired one. The tendency exists from the birth of the person, although the proliferation of connective tissue may not be observed until comparatively late in life. Trauma may in some cases cause the manifestation of a latent tendency in nerves.

Another important question that demands attention is in relation to

[1] Herczel. Ziegler's Beiträge, vol. viii.
[2] Soldan. Archiv für klin. Chirurgie, vol. lix., No. 2, p. 261.
[3] Menke. Berliner klin. Wochenschrift, October 31, 1898, No. 44, p. 974.

the tendency of these fibromata to malignant degeneration. Several investigators have shown that this danger is not an imaginary one. Goldmann (*l. c.*) demonstrated by one of his cases that an apparently benign neuro-fibroma may undergo malignant change, or, better stated, present a malignant course, and he quotes a number of similar cases. According to him, this malignancy is not a change in the character of the tumor, but is due to the fact that a sarcoma of the nervous system may occasionally show a slow growth for a long time.

According to Finotti (*l. c.*), numerous observations have demonstrated that solitary plexiform (Herczel) and multiple neuromata (Genersick, Czerny, Winiwarter, Westphalen) have a great tendency to change into sarcomatous tissue. His words are "Umwandlung in Sarcomgewebe." Distinct clinical differences between secondary and primary sarcoma—that is, neuro-fibromata that have undergone sarcomatous change and those that are sarcomatous from the beginning—do not exist, according to Finotti, at least not in the majority of the cases.

Trauma may be the cause of this malignant degeneration, but in some cases no cause can be demonstrated (Garrè, Hartmann and others). Hartmann states that one of a number of neuromata may increase rapidly in size, and when it is removed by operation another tumor may develop rapidly in the same nerve trunk at the site of the former growth —more frequently, however, in another nerve territory. The second tumor is usually more malignant than the first; it involves adjoining tissue, and comparatively late metastasis occurs, causing the death of the patient. Garrè[1] also noted the increased malignancy of the process after operation. Hartmann[2] reports a case which he says showed well the transformation of a fibroma of the nerve into a sarcoma, and he confirms the experience of others that the rapid increase in a neuroma, the occurrence of neuralgic pain, and sarcomatous degeneration occur at the same time. He refers also to the fact that in ten of the seventeen cases of malignant degeneration in fibro-neuromata mentioned by Garrè death was due to a return of the tumor.

Four cases of general neuro-fibromatosis, with multiple neuro-fibromata, were observed by Thomson.[3] In the first of these one of the tumors underwent sarcomatous change, with general dissemination of sarcoma and death after attempted removal; in the second also, after operative intervention, malignant change occurred. Scheven (*l. c.*) also refers to the pronounced tendency of the elephantiasis neuromatodes congenita to sarcomatous change, and to the fact that this tendency remains in the fibromatous nerves after a tumor that has undergone a malignant change has been removed. The surgeon can do nothing

[1] Garrè. Beitrage zur klin. Chirurgie, vol. ix. p. 465.
[2] Hartmann. Ibid., vol. xvii. p. 177.
[3] Thomson. British Medical Journal, October 10, 1896, p. 1024.

more than remove the malignant tumor; the tendency to degeneration remains in the widely developed pathological tissue. Scheven reports also a case of malignant degeneration in elephantiasis neuromatodes, and refers to the fact that in Finotti's case the sarcomatous transformation in the neuroma could be demonstrated microscopically.

We owe to Garrè's (*l. c.*) investigations the knowledge of the frequency of the degenerative change in neuro-fibromata. Garrè was able to collect sixteen cases from the literature—seventeen with one of his own—in which sarcomatous degeneration in congenital neuromatosis had occurred. There are, of course, many more cases of malignant tumors of nerves not the result of degeneration of a fibro-neuroma. In these seventeen cases those of sarcoma arising in cutaneous fibromata are not included. Garrè showed that in an eighth of all cases of supposed benign neuro-fibromata this sarcomatous change occurs.

It is important to know what constitutes a sarcomatous degeneration in a neuro-fibroma. Rapidity of growth is suspicious, according to Garrè, but is not always reliable; large size of the growth is not a positive sign, and even histologically the transformation of a benign fibroma into a sarcoma may be difficult to determine. The greater or smaller number of tumor cells is the determinative factor, but there are cases in which the diagnosis between fibroma and sarcoma cannot be made with certainty, and Garrè says that there are transitional forms between the neuro-fibroma and the sarcoma, and that these cannot be properly classed clinically or histologically. Paræsthesia, paresis, neuralgic pain, etc., are important in diagnosticating early and clinically the sarcomatous degeneration of a neuro-fibroma. The malignant change causes rapid destruction of the nerve fibres within the tumor, with the production of disturbances in motility and sensation.

It seems to me a broad and proper view to regard such neuro-fibromata as were removed by Professor Keen as an incomplete manifestation of generalized neuro-fibromatosis, although the process was confined to one nerve—the ulnar. The fibromatosis does not differ from that occurring in cases with more extensive clinical manifestations, and the limitation of the process so far is no proof that later we shall be unable to trace evidences of a more general fibromatous change. A number of cases have shown that the fibromatosis of nerves may remain undetected until the patient is well advanced in years. We understand likewise that Professor Keen's patient is exposed to the danger of malignant growth at any time.

The location of the tumors in Professor Keen's patient is especially interesting. Garrè, in speaking of his case, says that the presence of multiple small fibromata in the skin of the sole of the foot was very remarkable, and refers to the fact that v. Recklinghausen emphasized the immunity of this part and of the palm of the hand. Marie (*l. c.*)

likewise says that in generalized neuro-fibromatosis the tumors are not usually found in the hands and feet.

It is curious that only certain nerve bundles of the ulnar nerve were affected in Professor Keen's patient, but such a condition is well known. Goldmann (*l. c.*) says it is difficult to understand why in the same nerve trunk, even in the same bundle, the proliferation may involve only certain groups of fibres.

Bowlby[1] describes a specimen of multiple fibromata on a single nerve (posterior tibial) seen in the museum of the Middlesex Hospital. No tumors were found on any other nerve. This seems to have been the only case of the kind which had come under his observation when he wrote his book. A similar case was published by J. K. Mitchell,[2] and W. J. Taylor operated on a patient with neuro-fibromata of the foot, probably confined to a single nerve. As a contrast to Professor Keen's case and to Bowlby's I may mention that Smith reported one case in which the total number of neuro-fibromata existing upon the nerves removed from the body exceeded 800, and another in which upward of 1400 neuromatous tumors were removed with the nerves, and he felt that he was not exaggerating in stating that this patient must have had at least 2000 tumors. This work of Smith was originally published in the form of a very limited edition fifty years ago, but it was deemed of sufficient importance to be reprinted in 1898 by the New Sydenham Society. Some of the plates present nerves covered thickly with fibro-neuromata, but no neuromata shelled out of a nerve, as in Professor Keen's case, are pictured in this atlas. Indeed, Smith[3] stated that the results had not afforded much encouragement to the practice of dissecting out the tumor from the branches of the nerve among which it was entangled. According to Smith, there are few affections more rare than neuro-fibroma.

Smith was not able to trace nerve fibres through a neuro-fibroma, although in a few instances he observed some nervous filaments entering the superior extremity of the tumor. I have been able to detect the presence of nerve fibres in both extremities and also in the centre of one of the tumors (*c*, Fig. 4) removed by Professor Keen, and my success was probably due to the fact that I had Weigert's hæmatoxylin stain at my command. In the smaller tumor (*d*), nerve fibres were also seen within the tumor. This method was unknown when Smith wrote his treatise.

It is a merciful provision that the multiple neuro-fibromata are usually painless, and it seems extraordinary in contrast that the solitary tumor is often painful.

[1] Bowlby. Injuries and Diseases of Nerves and their Surgical Treatment, p. 493.

[2] J. K. Mitchell. The University Medical Magazine, November, 1897.

[3] Smith. A Treatise on the Pathology, Diagnosis, and Treatment of Neuroma. The New Sydenham Society, 1898.

Many investigators have observed that the proliferation begins in the endoneurium, as it did in Professor Keen's case. It is due to this mode of origin that these neuro-fibromata are elongated with their long axes parallel to the nerve. The perineurium offers a certain amount of resistance, especially as it often becomes thickened simultaneously with the growth of the tumor, and the fibroma grows especially in the direction of least resistance. In the tumor designated as *c* in the drawing (Fig. 4), the perineurium forms a sheath, surrounding on all sides the proliferated endoneurium, and in the centre of the tumor no nerve fibres could be detected, except at the periphery. This proliferation of the endoneurium was evident also in the tumor *d* (Fig. 4), and in small nerve bundles, adjoining the tumor *d* and removed with it, the proliferation of the endoneurium could be detected in its early stages. Neuro-fibromata do not always originate in the endoneurium. In a case reported by Finotti, for example, the fibroma began in the epineurium and was adherent to the nerve.

The entire nerve on which the neuroma is formed may lie in the centre of the tumor or surround the tumor as a sheath. According to L. Bruns,[1] the nerve fibres caught within the neuro-fibroma show a remarkable resistance to degenerative processes, which explains the absence or mildness of the clinical symptoms in many cases. I am unable to fully confirm this statement from the examination of the tumors removed by Professor Keen. In two tumors, *c* and *d*, I found the nerve fibres within the tumor entirely destroyed, except at the periphery of the tumors, while in the piece of nerve marked *f*, in which the proliferation was not excessive, the nerve fibres were quite well preserved. I would prefer to explain the absence or mildness of the clinical symptoms by the slowness of the process, by the fact that only here and there a nerve bundle is attacked, and that many fibres —the majority in fact—remain intact and do not lose their function, although considerably compressed, as the process is slow enough to allow the nerve fibres to become accustomed to the pressure.

[1] Bruns. Die Geschwülste des Nervensystems.