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SOME OF THE LESSONS OF NEURÓTOMY.

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It is not very many years since all that we knew of nerve sections, and their results, could have been put into a very small space ; but the increasing care with which the modern physician studies his cases has led in this, as in all directions, to novel and fast accumulating conclusions of the utmost practical value.

The sad opportunity of our late civil war afforded an unequalled chance to study this interesting subject, and a large experience has since added new opportunities. Out of this constant accumulation have come numerous essays, scattered here and there in journals, and embodying many facts of value which it is perhaps worth while now to bring together. Moreover, I have of late learned in regard to certain nerve sections a class of facts which, I believe, has hitherto altogether escaped notice. I shall deal, therefore, in this paper with the subject of neurotomy under two heads :—

1. The indications for nerve sections.
2. The consequences of nerve sections.

In discussing these subjects I shall of course avoid, as far as

possible, what is already old or commonplace medical knowledge, and shall dwell more largely on those points which are still novel, and many of which have neither found their way into the text books nor become familiar to the surgeon, as part of the light in which he should consider the propriety of a nerve section.

1. *Indications for Neurotomy.*

It becomes needful to discuss the question of a nerve section whenever a local irritation, either arising from disease¹ or from mechanical injury, gives rise to unmanageable peripheral symptoms (such as spasm, hyperalgesia, neuralgia), or to reflex neuroses of like nature affecting distant parts, or disturbing the circulation in the centres, as in the rare causation of vertigo.

Most of the questions which arise in this connection are easily answered; but there are certain points in regard to the various forms of pain which will bear some further examination, because their clinical history is such as to make it at times very difficult to decide for or against the operation of nerve section. Thus in the common case of neuralgia of the fifth nerve, we usually find the pain at first confined to a single branch of the nerve, and we have no evidence to make us sure that the cause of pain lies in the peripheral distribution of this branch. Indeed, we have as often reason to believe that it does not, and that the centre or the ganglion is at fault; but even when this is the case it is frequently clear that the peripheral expansion, owing to the state of the centre, has passed into a condition of hyperæsthesia, so that, whether or not the original cause lay in the surfaces, these have become secondarily the parents of pain, and in turn react on the sensitized centre. When, therefore, other means have been exhausted, I am frequently willing to cut a facial nerve branch, whether or not I am sure that the original cause of pain lies in the periphery. Later in the history of facial pain the matter is complicated by the spread of pain to other branches of the nerve; but even then, when I am clear as to

¹ Case of Section of Brachial Plexus, Dr. Maury, *Amer. J. Med. Sci.*, 1875.

the filaments in which it first appeared, I am willing to divide these filaments, and in my experience I find that I get, even under such circumstances, a fair percentage of success. The operation is here justified by experience—by the fact that the section in some way alters the central pain-making conditions; and lastly, because nerve sections in the face give rise to little inconvenience, and to none of the curious consequences which so often follow upon sections of the nerves of the hand. The question of the propagation of pain from branch to branch in a great nerve, is one to which I shall return at another place. I think we must concede, however, that this diffusion of pain is not always evidence of the increase or spread in the centres of an organic cause, but is due rather to what I might call, using a photographer's phrase, a *sensitizing* of the related ganglionic cells, so that in neuralgia, as in tetanus, the capacity to produce abnormal pain is capable of passing from cell to cell, and sometimes of thus affecting distant centres. Here at least, in a remarkable degree, pain is the parent of pain. In the extremities, and never, so far as I know, in the face, the propagation of pain is occasionally due to an ascending neuritis, resulting, in rare cases, in a form of sclerotic alteration in the nerves, the sheaths of which it reaches in its upward march.

I have reported elsewhere a remarkable example of this change, which I saw with Dr. Mears. I believe it less frequent than I once supposed it to be.

Among the most important matters to consider in regard to the propriety of a nerve section, is this very question of the possibility of organic change having extended up the nerve trunk. It is a grave question, because it is well for success in neurotomy to make the section above, or at all events near to, the limit of such change; and I have seen, over and over, failures on account of lack of care in this matter. In neuralgias without known cause the nerve is rarely visibly altered; but in the terrible traumatic neuralgias which fall on the hand, and usually on the median nerve, there is apt to be more or less extension of neuritis from the seat of injury. Save in very coarse changes, it is difficult to determine the state of the nerve at the time of

operation ; and mere inspection is not enough, since even the most practised touch will fail to settle a question which only the microscope can decide.

If the change be slight, we can afford to wait, since cutting off the irritating region is then competent, in most cases, to put the nerve in a state of rest above the line of section ; and when this result is attained, the organic changes gradually disappear. When, however, the sclerosis is notable, it rarely fades away, but seems to have acquired permanent power to propagate itself centrally.

I find that physicians are apt to believe that tenderness of a nerve-trunk above the point of irritation is a sign of organic change in the nerve ; but this is by no means true. In the early stages of ascending neuritis the nerve is horribly tender, but in an advanced sclerosis the sensibility is not nearly so great. In the vast bulk of local nerve lesions of the hand there is, however, the most notable sensitiveness of the main trunk ; in fact, there is always, after a time, in such cases, hyperalgesia, and this is of two degrees. In the lighter form the nerve-trunk is not remarkably tender, but pressure causes increased pain in the peripheral distribution in and beyond the point of traumatic disturbance. In the later and more severe form, pressure causes pain in the nerve itself, and also in the area of the neuralgia.

In these horrible traumatic neuralgias, electricity is of no value. Even when galvanism applied to the nerve-trunk has the curious ability to suspend, during passage of a current in either direction, the hyperalgesia of the painful areas, the current has no permanent therapeutic power. I mention the fact here, because we might naturally suppose that a current, which used on the nerve-trunk annihilates morbid sensation for the time, and enables us to touch the most sensitive regions without causing pain, would be certain to cure, if used assiduously. Yet such is not the case, and I have seen no good result in traumatic neuralgia from the most industrious use of electricity.

I am quite unable to say why galvanism possesses anæsthetic power in one of these cases, and not in another. I saw a few years ago two severe injuries of the median nerves in the same

part of the palm. In both, the fingers were painfully sensitive to the slightest touch. I galvanized three inches of the median above the wrist, using thirty cells. While the current passed, the analgesia of the fingers ceased to exist. I then reversed the current, which had been peripheral in direction, and was amazed to find the same result. Even twelve cells gave me the same effect, but an induction current was valueless. In the second case galvanism produced no good effect.

An excitable state of the main nerve-trunks in nerve wounds must be due to a propagation of sensitizing influences upward, or else to an acquired condition of the related centres.

The most startling sensitizing of a nerve, both motor and sensory, is obtained by chilling with a freezing mixture a limited portion until touch is lost, when the portion below becomes so excitable that the least tap over the main trunk causes motion of all the muscles which the nerve supplies, and also some pain, so that while tactile impressions do not pass the frozen part, those of pain do; showing, I think, as do many other facts, the distinctness of difference between the forms of nerve excitement which are caused by touch and by pain.

Since every nerve contains a certain number of recurrent fibres which find their way to the brain along trunks other than the trunk into which they primarily run,¹ it might have been expected that the nerves to which they finally convey impressions would share in the sensitiveness I have described. Thus the radial probably receives recurrent fibres from median nerve areas; but as yet I have been unable to find that the radial becomes sensitive when the median itself has been hurt. It certainly does not acquire such sensitiveness early, and I have doubts as to whether it ever does. Perhaps, since the recurrent nerve supply multiplies as we approach the periphery, the absence of the phenomenon in question may depend on the position of injuries which usually affect the palm. Lesions of the finger ends in the median areas would be more apt to give us sensitiveness in the radial trunk.

¹ 'Injuries of Nerves,' p. 60, S. Weir Mitchell.

2. *Nerve sections, and their consequences.*

The first question which arises when we have decided to resort to neurotomy, is one which at first glance it seems absurd to raise. It is, what nerve we shall cut. In the face, the answer is ready enough; but in the complicated distributions of nerves in the hand, it is not always so easy. The anatomists have somewhat misled us by their statements as to the innervation of fixed areas by certain nerves: whereas it is plain from the numerous cases of Letievant and myself, that it is to the clinical inquirer anatomy must look for a knowledge of surface-areas of nerve distribution, and that these areas differ widely in individuals. The uncertainty arises out of the curious variation of nerve supply to the hand. In some animals all the nerves but one may be cut without loss of sensation anywhere; and while in man this is by no means so completely or constantly true; case after case has been reported in which section of the median scarcely disturbed sensation.

How much of this preservation of sensation is due to anomalies, and how much to extreme differences in the amount of recurrent nerve supply, cannot as yet be known.

When a local injury falls on parts which are innervated by two nerves, or when it alights on the doubtful boundaries of two nerve-territories, there may be a good deal of reason to hesitate as to a nerve section.

The best means in these rare cases is to learn which of the main trunks is sensitive to pressure and to electricity, and how far benumbing pressure influences the morbid phenomena. But surgeons are rarely careful enough to make a thorough study of their cases, and I have several times known them to cut the wrong nerve. In one case, an injury of the palm caused epilepsy. The wound traversed the median and radial region. I found that pressure on the wound of entry (median) caused no result, while pressure on the wound of exit (radial) gave rise to violent fits. Section of the radial apparently cured the fits.

In another instance, a wound of the palm occasioned intense tenderness of the fore-finger and third finger, and also pain on

the back of the fore-finger. This latter induced the surgeon to try if pressure on the median and musculo-spiral would influence the pain. It gave rise to greatly increased suffering when applied to the former; but benumbing pressure by a tourniquet over the musculo-spiral not only annihilated the pain on the back of the fore-finger, but also in the median palm territory. He cut the musculo-spiral: the whole of the pain departed, only to come back within a week in a scarcely mitigated shape. The pain was relieved, as is pain in the infra-orbital nerve by removal of a sound tooth not in its territory. I cured the neuralgia by cutting the median. If, in this case, the surgeon had kept up the pressure on the median, by etherizing the patient so as to enable her to bear the force needed, he would not have made so grave a mistake. The tenderness of the median was in itself the true guide.

The operation of neurotomy is a simple one; but, as its object is to secure the permanent cutting off of a region of disease, the main point is to make sure that the excised portion of nerve shall not renew itself. I do not yet know how this is to be done; and, after a long and large experience, I find that the capacity of nerves to remake their lost parts is almost invincible, and is the true cause of many of our failures to attain permanently the object in view—the relief of pain.

If the pain recurs within five months, it is likely that the cause lies in more than one nerve, or that the trouble is, or has become, a central one. Nearly always a section gives relief for a time. If, at the close of five months, the areas cut off begin to be sensitive, and to regain *surface sensibility to touch*, the lost nerve-tissue is being remade; and if, after a time, electricity—interrupted or reversed, galvanic or faradaic—applied above the line of section causes motion in the muscles cut off by the neurotomy, it is of course put beyond doubt that the nerve has been yet more thoroughly restored. The return of function is always in this order: sensation first, motion last. I have tried many devices to prevent reunion, but none have answered. Doubling the lower end of the cut nerve, turning the ends aside, imbedding one or both in other tissues—one and all fail. The length of nerve removed has been supposed to be the most efficient factor in retarding or

preventing reunion ; but we need a careful study of this matter in animals to tell us to what extent separation of the nerve ends puts off the date of return of function, since there is some reason to suspect that mere section is as efficient as exsections which remove less than two inches. I mention it as a partly open question.

In the cases of secondary section, where the lower end of the cut median had been doubled on itself, reunion took place in eighteen months, and I could not distinguish the doubling in the large button formed, and out of which ran the delicate connecting filaments. One plan yet remains for trial, and that is, to divide the nerve and draw the ends past one another. This plan I am about to test in the dog, but I do not feel any confidence that it will succeed in preventing reunion.

To my mind, nothing is more strange than the bewildering certainty with which these nerve ends, however dealt with, succeed in threading the tissues between and reuniting.

The rate and sureness with which this process occurs is inversely as the age. Dr. Hodge's case of reunion of the radial is, I think, the briefest in time. Two inches of the nerve were removed.¹ In six weeks pain returned—a sign of little value for reunion if it stand alone ; but in nine or ten weeks tactile sensibility came back. Within eleven months the nerve was cut a second time, and found to have been thoroughly remade.

The indication then is, in every case to take away as much of the nerve as possible, avoiding as far as may be sections which involve motor nerves.

The consequences of neural resections vary somewhat with the nerve on which we operate, since, as I have already said, it is exceptionally rare to see nutritive disturbances in facial neurotomies, and common to observe them in the hand.

The first result of a nerve section is the almost sure relief of the neural pain. This consequence may be temporary or permanent ; and it may be delayed for a brief period, and then be gradual and more or less complete, these variations depending on causes already discussed. 2. The temperature rises in the area of distribution of the nerve, and in the course of months falls below the normal standard. I first showed

¹ Neurotomy, S. Weir Mitchell, *Amer. J. Med. Sci.*, April 1870.

this in regard to the nerves of the hand, and have over and over seen it illustrated in later cases. Whether it be true or not of the facial nerves I do not know, but shall learn on the earliest occasion. The proportion of vaso-motor nerves which reach a given area of face or hand by the nerve tracks of sensation, by the vessels and otherwise, may vary so as to efficiently affect the thermal phenomena, which follow nerve sections.

Nutritive alterations in the skin, nails, hairs, areolar tissues, and muscles, follow in a certain proportion of nerve sections. I have never seen any of these disorders after section of any branch of the fifth nerve. They are more common after resection of nerves which supply the feet. In the hand they are rarely seen when the radial has been cut, not often after ulnar section, but more often after divisions of the median nerve.

The favourite theory, that the parts rendered insensible are thereby exposed to mechanical lesions, does not answer to explain these facts, since they occur unequally in different nerves, and are seen in parts which have been zealously protected from harm.

Moreover, they seem to contradict the law of Brown-Séquard which has been so generally accepted, to wit, that partial or irritative lesions give rise to trophic changes, and that paralytic lesions occasion only such results as are due to prolonged inaction. This principle is commented upon with approval by Charcot in his recent lectures (*Syd. Trans.* p. 19), where he puts it in the following very distinct form: "At the outset I shall establish what I consider to be a fundamental distinction between these traumatic lesions of nerves: 1. The lesion sometimes consists of a clean and complete section, in which case the effects are merely, speaking generally, those resulting from the absence of nerve action; 2. Sometimes, owing to contused or lacerated wounds, the lesion is of such a nature as to set up irritation in the nerve, in which case, and then only, we see arise those trophical troubles to which I invite your attention. The disorders, following irritative (partial nerve lesions) are, affections of the skin, bones, joints, nails, hair, and *rapid* muscular atrophy."

"It may also be added (p. 37, note), that irritative lesions of muscles have been of late recorded by competent observers as following section or excision of mixed or purely motor-nerves."

These troubles were, however, limited to muscles and their connective tissues; and so far, with the above exception, no one seems to have dwelt on the possibility of the same kind of lesions following complete sections as follow those which are partial, and therefore presumably irritative.

Until recently I have myself admitted the correctness of Brown-Séquard's law, and for many nerves, as, for example, those of the face, we may still adhere to it; but as regards the hand nerves, and especially the median nerve, I shall now have occasion to prove that irritative trophic lesions are sometimes seen after entire section, and that, in a certain proportion of cases, complete section after irritation appears to give rise to, or permit the continuance of, somewhat anomalous forms of pain in the peripheral distribution of the cut nerve.

Section of median nerve at wrist by glass wound: healthy man, æt. 47; no history of syphilis; entire absence of sensation in median territory. From the eighth week frequent bullæ, followed by ulcers of the palmar face of the fore and middle finger; thickening and considerable enlargement of middle finger. The appearance of the ulcers, which when I saw him were numerous, was very singular. They resembled deep holes, cut out by a punch, and were almost dry, having, in fact, only the slightest discharge.

B. H., æt. 17: glass-cut; section, in palm, of median branches of fore-finger; complete insensibility of this part; the last inch of the fore-finger is purplish, excessively wasted, shining, and smooth. At the seventh day, the hand having been carefully guarded, a bulla broke out on the fore-finger, and left the whole of the face of the member ulcerated. The nail fell off, and after the ulcer healed frequent bullæ occurred. The new nail is deformed.

In these cases the sections were complete. In two others, in which there were incomplete lesions of the palmar median nerves, the trophic disorders were joint lesions, herpetic

eruptions, minute ulcers, shining skin, and deformed nails, and loss of hair on last phalanx dorsal aspect (one case). In both, median nerve exsections, to relieve pain, were followed by continuance of the trophic changes, and by frequent bullæ in one case. Entire section is not therefore always competent to put an end to irritative lesions caused by imperfect sections.

In one other case of complete median section, I have seen necrosis of the last phalanx of the fore-finger without exposure to violence.

It must be admitted that in the vast majority of cases of complete sections no marked trophic changes occur, but that in a small percentage these do certainly follow. The interest of the matter lies in the fact that they never are seen in the face.

I may be permitted again to say that most of the cases quoted were under my immediate care, and that the trophic accidents were not due to traumatic causes. Moreover, in some of them the bullæ and ulcers continued to appear for months.

The second group of facts to which I desire to call attention is still more remarkable. I have so far observed it only in median sections, and altogether but twice. Since I first observed the phenomenon in question I have had but one occasion to cut the median. It may therefore be exceptional or common.

The facts of the first case were these:—

Traumatic injury of median nerves in palm, in girl of 17 years. Intense pain in peripheral median distribution on motion of hand; total insensibility to pain and touch in fore-finger median regions, partial in rest of median areas.

Section of median at third month, 3 inches above wrist—removal of one inch of nerve. At the eighth day after operation I examined the hand with care, and found the following conditions. Again and again since, the same study has been made; and soon after my first inspection, Dr. Morris Lewis made the careful diagrams, which explain far better than any description in words can do the character of the sensory changes.

Between the dotted line — . — . — . (Diagrams 1 and 2) and the continuous line ———, lies a space within which the

sense of touch to a light impact (feather) was lessened or indistinct. The region far more than covers the usual area of median distribution; and in fact, as I have already said, nothing can be more uncertain than this territory, which nevertheless the Anatomies describe as rigid. Clinical sections enable us to see that it may extend to the middle of the third finger (medius) in one case, to the whole medius in another; to the half also of the fourth finger (ring) in a third instance; while in yet another case, the median was found to innervate in part even the ulnar side of the fourth digit.

Whether this extensive defect be due, in the present case, to an unusual distribution of median fibres, or to a reflex disturbance of central perceptivity, owing to the influence of the section, I cannot say.

Within the continuous line the sense of pain should, according to our old ideas, be annihilated, as it incloses territory most of which is usually supposed to be fed by the median nerve. But let us see what a curious state of things does really exist.

The areas, which are darkened (stippled), and which on the dorsum (Figs. 1 and 2) are far more extensive than those commonly innervated by the median nerve, have neither sense of touch, pain, nor temperature. Heat and cold, needle-pricks, pinching, and deep pressure, are alike unfelt. The singular distribution of this analgesic area will be noticed. It is seemingly most eccentric, and does not correspond to any special distribution of separate branches of the median nerve.

There are also within the continuous line two areas, the one marked by lines running in the axis of the limb, the second by transverse lines. The former territory has no tact-sense; but if the skin be pinched with a small forceps, or indented by the pressure of a blunt point, or firmly by the finger, the result is most agonizing pain, so that the patient may cry out.

In the area transversely marked, the pinching is not felt; but firm deep pressure causes pain; and in both territories the site of the pain is fairly well localised. In both of these areas the altered skin-spaces are insensible to the prick of a very fine needle, if this be oiled and introduced laterally into

Fig. 2

Fig. 1

the skin so as not to indent it roughly. If roughly or deeply buried in the skin, it causes pain. It should be added, that the patient was securely blindfolded during the process of testing.

The second case is yet more difficult to explain. Its history is, in brief, this:—

Miss T., at the age of 2½ years, ran a splinter into the right palm, where the median branches. The wound healed over it. At the age of 22 years, Miss T. bruised the region in question; severe pain ensued in the thumb, fore and middle fingers. Dr. Sapolini, of Milan, removed the splinter, Oct. 1871. It was lying among the nerve filaments, and its removal was followed by exquisite torment, with causalgia and hyperalgesia.

In Sept. 1871, Dr. Sapolini, finding that pressure on the median trunk made the pain worse, and that pressure on the musculo-spiral nerve eased it, cut out one inch of the latter nerve—result, no pain for eight days; then return of all the symptoms. The extensor masses of the fore arm wasted rapidly, and wrist drop of course ensued.

Feb. 1874: section of median low down in the fore arm. Result, in fourteen days entire relief, and anæsthesia and analgesia of median regions of thumb, fore finger, and up to an irregular line on palmar face of median finger. Tact was disturbed over a wider area, including the lower part of the whole palmar face of the ring finger.

In March 1876 there was great pain in and below the line of section of the musculo-spiral, and in its dorsal distribution on the hand. The extensors were as large as usual, and acting well. After much fruitless medication, I had the musculo-spiral examined at the point cut. It was thoroughly remade. Two inches were removed, including two large terminal buttons, between which ran the new nerve. Results, paralysis of extensors, and relief to this date, June 1, 1878.

In January 1877 Miss T. came to me complaining of a return of all the old pains in the median areas. Sensation was partly restored, and I could move the median thumb muscles by galvanising the main trunk above the line of section, although whether she could also effect this by will was

doubtful. It was but too plain that the median had partially remade its mischievous connections.

In May 1877 Dr. Brinton cut down on the median, and found large buttons as usual, but the filaments between were scarcely perceptible. Accordingly, I lifted the central portion above the upper button, wiped it dry, and put it on a piece of caoutchouc; then I faradised it gently, when the median humb muscles all moved freely. The nerve was then cut, and three inches removed.

After two weeks she was well enough to be examined with care, when I obtained the following singular facts, as shown in Diagrams Nos. 3 and 4.

Within the dotted line, and up to the continuous line, touch was impaired in various degrees, most on the middle finger. The area differs remarkably from that of the loss in Case 1.

In the areas of the diagram which are striated in the line of the limb there was very marked impairment of touch, and the most exquisite pain on pinching and on pressure, while the needle was painful only when carried in deeply below the skin.

The areas marked with transverse lines had no sense of tact, and did not feel pain when lightly—not deeply or largely—pinched, but were subject to intense pain on deep pressure with a blunt point.

The two cases here given are valuable, chiefly because they have been studied with unusual care. Most of such opportunities fall into the hands of surgeons, and the histories are anything but complete. Even of the later cases this is true; and I can scarcely recall a case in which the amount, character, and area of sensation-loss are stated fully and clearly. In my own examples we must remember that the median nerves in the palm had been subjected to prolonged irritation; then came section, and complete relief of active pain.

I shall first consider Case 1. We find what still exists unaltered, extensive loss of touch, with loss of the previously existent hyperalgesia of the surface; while in certain areas, different in each case, and most eccentric in their boundaries, we have two curious states:—

1st. Intense over-sensitiveness of subcuticular tissues, as shown by pain on pinching and pressure; and

Fig. 4.

Fig. 3.

2nd. More or less power to state the locality of the pain.

It is probable that my cases are not exceptions, and how shall we explain these facts? It is quite possible that like states existed before the operation; but this is hard to know, on account of the pain then given by an examination; but why should the operation, which annihilates touch, leave pain-power unaltered in the regions under the skin?

It is quite sure that there are frequent anomalies in nerve distribution, so that as a consequence the median gets more ulnar fibres than usual in the lower half of the palm; but this also is incapable of explaining the facts, since some of the new pain-areas are in the thumb, which has no such fibres in any case, while we find like pain areas also on the dorsal aspect of the fingers.

Moreover, why should such untouched connections not leave us areas of touch, even if lessened touch? and why should they only preserve or permit the parts to acquire an abnormal sub-surface sensitiveness to pain?

We have, of course, to believe that there remain connections of some kind with the centres: and we are obliged, I think, to fall back for explanation upon the recurrent nerve fibres, which Bernard, Arloing, and Trippier have shown to exist so widely.

The function of these nerves is as yet unknown, but the present cases show, I believe, that whatever be the normal activities of recurrent fibres, they may become the means both of feeling pain and of enabling us to localise it.

I am inclined to think, although I am not sure, that the changes which sensitize these fibres arise, at least in part, out of the previously existing irritations; but this is a question which can only be decided by future cases. If due to the section, the new sensitiveness may be a consequence of altered vascular states caused by the operation, since it is unlikely that the Wallerian degeneration of the neighbouring fibres could affect the recurrent fibres, which are left practically untouched, and have been sometimes seen to be unaltered in parts of nerves below the section. This alone seems sure, that the primary irritation or the section so influence the recurrent fibres, which reach the centre through the ulnar and radial connections of the median, as to give them new and

abnormal capacities to feel pain. At all events, these cases seem to open a novel chapter in neural pathology.

The second case is more complicated, because the musculo-spiral had been cut a year before the median. Yet not only was there the same phenomenon of pain areas, but a remarkable preservation of touch, far greater, in fact, than after the first median section. It is but too probable that already repair had begun in the musculo-spiral, since otherwise the preservation of sensitiveness to touch and pain rests inexplicable, even with the most liberal view of possible ulnar anomalies.

And now to return for a moment to Brown-Séguard's law. I have said that the present facts seem to contradict it. Certainly this is true of the simple nerve sections first related; but is it also true of the last and more remarkable cases?

We have here irritation long continued, intense peripheral pain and analgesia. We cut the main nerve, and pain areas still exist, inexplicable as due to coarse anastomoses. If we pre-suppose a descending neuritis, it would involve recurrent nerves as they enter the branches below the irritated point. Section of the nerve would of course fail to influence these recurrent fibres; but by raising the temperature, and though the local vaso-motor section induces palsy, it might well add fresh causes of irritation to those already affecting the recurrent fibres.

The latter of the cases I have adduced would not, therefore, contradict the law of Brown-Séguard.

In both of the cases last quoted, the areas in which pain was caused by deep pressure are insensitive to heat and cold as such, but both give rise, after a few moments' contact, to sense of dull pain. We may infer, therefore, that in these instances whatever fibres carried impression of pain and, in one case, of touch, were unable to perform the same office for thermal impressions.

In this condition I leave for the present this most puzzling problem in neuro-pathology. I trust that the chances offered to solve it through accidental sections, where there has been no previous irritation, will not be neglected.

The practical question which these phenomena leave to us is, whether it is not best at all risks to open the palm, and

remove the portions of irritated nerve-fibres, when section above them has failed to relieve pain. The two hands I have described are now useless, owing to the sensitiveness I have spoken of. There is no spontaneous pain, but the member cannot be used, since all pressure gives rise to intense distress.

Among the consequences of sections which I do not find mentioned, are the remarkable hyperalgesia in and near the line of wound; and, what I have seen thrice, troublesome and repeated herpes along the lips of the yet unclosed wound. Irritable and obstinate ulceration also attends the healing of these wounds in a small proportion of the cases.

Repeated section of the same nerve has been several times needful in my experience. It has been called for in these cases by return of the pains which were relieved by the first section.

If, however, I have correctly studied and reported the two cases last stated, we may come face to face with a hitherto unrecognised difficulty. Pain exists: we cut the main nerve; relief of spontaneous pain ensues, but after a brief time we have pain on pressure. If now at a remoter date this increases, and spontaneous pain be added, how shall we feel sure that the increase is due to a remade nerve? The test of increased surface-sensibility to touch is the earliest reliable functional evidence of such reconstruction, and precedes the return of muscular manifestations. It is, however, a less certain test than the diminution of atrophy in the muscular masses, and the capacity to move the muscles by currents, which include portions of the cut nerve above the line of section. This latter test is absolute, and enables us to feel sure that the nerve has been remade, and that a second operation has become justifiable. Whether it precedes or not the revival of will-power over the muscles, I have not been able as yet to determine with certainty; but I am inclined to think that it does anticipate in some cases the normal functional manifestations.

That the skin-sense returns before the muscles regain volitional or electrical activity depends, I presume, upon the fact that the nerve must be remade before the muscle can be reconstructed, and that until it is so reconstructed it cannot begin to respond to volitional or electrical stimulus.