needed is, it must be admitted, considerable, we feel that in many cases the information given has shortened the patient's stay in the hospital sufficiently to compensate for the additional outlay. The stereoscopic method is, of course, the ideal one, but it entails double expense, presents grave difficulties where many of the patients speak no English, and, except in a few cases, sufficiently exact information is given by the single flat plate.

Much work remains to be done before the roentgenologist can regard his knowledge of the chest as complete. In spite of all the work done, there remain many shadows whose interpretation is doubtful at best. For the unraveling of these problems we bespeak the continued coöperation of pathologists and clinicians.

A NEW SIGN OF NERVE REGENERATION.

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IN his work on "Nerve Wounds," Tinel directed attention to a new and important sign of nerve regeneration. This is termed "*le signe du fourmillement*," or the appearance of formication or tingling produced by pressure. This test, when taken in connection with the return of electrical conductivity and selective sensory regeneration to which I called attention in previous publications,¹ forms a triad of signs of regeneration which are very important from a practical standpoint, particularly in determining whether or not a nerve is spontaneously regenerating and thus postponing a projected suture, or in determining the actual success of a nerve suture. Thus the formication sign furnishes a very simple test for the detection of nerve regeneration.

Formication appears at a very early stage in nerve regeneration, usually at about the fourth or sixth week, while the return of electrical conductivity is a late development and usually only appears parallel with the return of voluntary movements. Formication in a nerve is a very important sign, for it indicates the presence of young axis-cylinders in the process of active regeneration. The anatomical and physiological² regeneration of a nerve always takes considerable time, since under the most favorable influences, the axis-cylinders do not grow

more than one or two millimeters a day. However, as I previously pointed out, electrical treatment actively affects the axis-cylinders in producing an increase in nervous energy.

Whether or not the formication sign can appear in defective regeneration leading to neuromata, can be determined only by future clinical study. Regenerating axis-cylinders are spontaneously capable of traversing a certain distance due to the neurotropism of the peripheral end, but if the axis-cylinders encounter an obstacle, become blocked and wander in the cicatricial tissue which impedes the advance, it seems reasonable to suppose that in these cases the formication will be limited to the area of the neuroma or scar tissue and not radiate down the peripheral distribution of the nerve. Here the formication will be felt only at the point of pressure and remain fixed there. There will be an absence of progressive formication in the cutaneous nerve distribution.

Since the test is a new one for all practical purposes, it seems best to quote Tinel's exact words in its description.³

"When compression or percussion is lightly applied to the injured nerve trunk, we often find in the cutaneous region of the nerve a creeping sensation usually compared by the patient to that caused by electricity. Formication in the nerve is a very important sign, for it indicates the presence of young axis-cylinders in the process of regeneration. This formication is quite distinct from the pain on pressure, which exists in nerve irritations. The pain indeed, which essentially indicates the irritation of the axis-cylinders and not their regeneration, is almost always local, perceived at the very spot where the nerve is compressed, or at least magnified at this spot; it always co-exists with the pain in the muscular bellies under pressure, very often the muscles are more painful than the nerve. Formication of regeneration, on the other hand, is but little or not at all perceived at the spot compressed, but almost entirely in the cutaneous region of the nerve; the neighboring muscles are not painful. As a rule it appears only about the fourth or sixth week after the wound. It enables us to ascertain the existence of this regeneration and to follow its progress.

"If it remains fixed and limited to one spot for several consecutive weeks or months, this is because the axis-cylinders in their regenera-

tion have encountered an insurmountable obstacle and are forced to group together on the spot in a more or less bulky neuroma.

"The fixity of formication on a level with the lesion and the complete absence of formication below the lesion would almost warrant our affirming the complete interruption of the nerve and the impossibility of spontaneous regeneration.

"If, on the other hand, the regenerated axis-cylinders can overcome the obstacle and make their way into the peripheral segment of the nerve, we see a progressive migration of the formication so provoked. Pressure on the nerve below the wound produces this sensation, and from week to week it may be met with at a spot farther removed from the nerve lesion. The presence of formication provoked by pressure below the nerve lesion warrants our affirming that there is more or less complete regeneration.

"The zone of formication so brought out, changes its place on the nerve at the same time that the axis-cylinders are advancing; it extends progressively towards the periphery at the same time that it disappears at the level of the lesion.

"The 'formication sign' is thus of supreme importance, since it enables us to see whether the nerve is interrupted or in the course of regeneration, whether a nerve suture has succeeded or failed, or whether regeneration is rapid and satisfactory or reduced to a few insignificant fibres.

"Formication lasts a tolerably long time; appearing about the fourth week, it persists during the entire regeneration, i.e., for eight, ten, twelve months or more, gradually drawing nearer the extremity of the limb. It ceases only when the regenerated axis-cylinders have almost regained their adult stage.

"Formication, however, may be absent, both on a level with the lesion and below it; this absence is an unfavorable prognostic point; it shows that the nerve regeneration is taking place imperfectly, mainly because of general disturbance of nutrition.

"The more it extends and shows itself towards the periphery of the nerve, the less marked it becomes, finally disappearing at the level of the portions of the nerve which are nearest the lesion. Consequently there is in the course of the nerve a wide zone of formication which can be brought on, spreads centrifugally,

corresponds to the zone of growth of the young axis-cylinders, and at last completely disappears when the nerve fibres have regained their fully formed state.

"Let us follow, for instance, the progress of formication on a sciatic nerve sutured in the middle of the thigh: about the fourth week the formication appears at the level of the suture; at about the eighth week it is ascertained to be a few centimeters below; after three months it reaches the popliteal nerves at the upper third of the leg, but at the same time it disappears at the level of the lesion; at the fifth month the nerve formicates on pressure from the popliteal space to the level of the malleoli; finally, in the sixth month, it has reached the feet, but has disappeared as far as the upper third of the leg.

"Formication is the best and almost only sign of regeneration of the nerve; for not only does it enable us to follow the progress of regeneration, but through its intensity, rapidity of migration, and the region in which it appears, it even supplies exact information regarding the quality, extent, or limitation of regeneration.

"If the axis-cylinders stray and lose themselves in the tissues next to the lesion, formication reveals them; thus, in an interruption of the musculo-spiral, André-Thomas was able to demonstrate the presence of stray axis-cylinders in the muscles of the forearm.

"Any nerve that formicates below the lesion is a nerve in course of regeneration, either partly or wholly; absence of formication over the entire extent of a degenerated nerve trunk is an almost certain sign of absence of regeneration."

The following cases of nerve injury are briefly reported in order to show how the test is carried out and its value when taken in connection with other clinical signs of nerve regeneration. If unusual stress is laid upon the formication sign, it is because we wish to emphasize its importance in these particular instances.

CASE 1. Bayonet wound of the right tibial and peroneal nerves, followed by immediate paralysis and loss of sensation in the motor and sensory distribution of these nerves. The nerves were sutured the day following the injury.

Seven months after the injury and suture, an examination revealed foot-drop, inability to flex or extend the foot or move the peroneal

muscles, and moderate wasting of the thigh and calf muscles. The foot was cold and cyanotic, the skin was glossy and the nails had grown very slowly. There was a disturbance of both protopathic and epicritic sensation over the lateral cutaneous, saphenous, superficial peroneal and plantar nerves. In the atrophied muscles there was a complete reaction of degeneration with polar inversion.

Pressure over the scar of wound and operation in the right popliteal space produced formication at the point of pressure radiating down the internal portion of the calf to the big toe, in the region of the superficial peroneal nerve. The sense of tingling in the big toe was quite distinct.

After six weeks treatment with galvanism and massage, the motor paralysis remained the same, but the trophic disturbance improved, the foot became less cyanotic and the nails began to grow. The formication sign became more marked, it could be elicited on slight pressure and radiated down the inner border of the calf and anterior surface of the foot, including the big toe. It now involved the distribution of the saphenous and superficial peroneal nerves and a portion of the plantar nerves over the entire area where sensation was disturbed, whereas at the first examination it was limited to peroneal distribution. The formication was now entirely in the cutaneous distribution of the nerves below the point of the lesion, while it had disappeared in the scar tissue at the point of pressure. This latter was important, since it seemed to indicate the advance of regenerating axis-cylinders from the point of lesion.

The formication was not fixed on the scar since fixity of formication would indicate that an obstacle had been encountered in the scar tissue or that a neuroma had formed.

CASE 2. Pressure ulnar lesion, coming on about a week after a major operation and followed by progressive numbness, weakness, coldness and tingling of the area innervated by the ulnar nerve. An examination about four weeks after the onset of the difficulty showed a weakness and moderate atrophy of the ulnar group of muscles, typical sensory disturbances and a partial reaction of degeneration. Pressure over the ulnar nerve at the elbow produced distinct tingling of the little finger, showing that the axis-cylinders were not destroyed but were function-

ing properly, in spite of the sensory disturbances, weakness and atrophy and partial reaction of degeneration. On the basis of this a good prognosis for complete recovery was given.

CASE 3. Following a fracture dislocation of the neck of the left humerus and an injury to the brachial plexus, the small internal cutaneous nerve was found torn. It was sutured about a month after the accident. About seven months later, although the condition had greatly improved, the entire arm was found weak with slight muscular wasting, sensory disturbances over the cutaneous distribution of the small internal cutaneous, musculo cutaneous and median nerves. There was a partial reaction of degeneration. No tingling on pressure over the sight of scar of operation over pectoralis. Pressure in axilla produced tingling over ulnar distribution of the hand; pressure on lower end of biceps muscle produced formication in the fingers along distribution of ulnar and median nerves. Since the ulnar and median nerves were involved in the brachial plexus injury, it seems that they were in process of regeneration.

CASE 4. Traumatic ulnar lesion caused by lacerated wound of the left lower arm from glass. Numbness appeared in the ulnar region immediately after the accident with loss of power and coldness in the little and ring fingers. An x-ray showed a piece of glass close to the ulnar bone. An examination seven months after the accident demonstrated a weakness and atrophy of all the muscles innervated by the ulnar nerve with typical sensory disturbances and a reaction of degeneration. There was no formication on pressure over the scar, and no tingling around the scar. Pressure on the upper portion of the arm, above the scar, produced formication in the little finger, a demonstration that conduction through the regenerating axis-cylinders was unimpaired from the normal portion of the nerve through the lesion to the peripheral distribution of the nerve. Pressure below the scar produced the same sensation.

CASE 5. Ulnar lesion of the left arm produced by a rifle bullet. The bullet entered midway into the ulnar aspect of the left forearm, stopped at the olecranon process and shattered

the upper portion of the ulna and the head of the radius. The ulnar nerve was severed at the time of the accident and was sutured about eleven months later.

An examination two years after the accident showed typical epicritic and protopathic sensory disturbances over the ulnar distribution and weakness and slight atrophy of the ulnar group of muscles. The scar was a little tender on pressure and the patient complained of a little spontaneous tingling in the region with occasional shooting pains along the ulnar nerve. Pressure over the scar at any point produced formication along the ulnar aspect of the hand and radiating to the little finger. Pressure over the ulnar nerve at the elbow also produced tingling along the ulnar aspect of the hand and the little finger. This case demonstrated the same fact as did Case 4, namely, a persistence of regenerating axis-cylinders in the vicinity of the lesion. In this case, however, the time that had elapsed between the suture and the testing for formication was greater than any of the series, nearly two years. It proves, as Tinel has pointed out, that formication may last a long time, although its persistence in this instance was greater than in any of Tinel's material. It showed that the axis-cylinders were still in an active process of regeneration and had not yet regained their adult and mature stage.

CASE 6. Ulnar lesion produced by a bullet wound in the ulnar side of the right forearm. An x-ray showed a foreign body 3 inches below the skin mark on the anterior surface of the right forearm near the ulnar. An examination nearly three weeks later showed weakness of the muscles innervated by the ulnar nerve with typical ulnar sensory disturbances. There was no muscular atrophy. Electrical tests showed a complete reaction of degeneration. Pressure above the scar of the wound produced formication of the ulnar side of the hand and of the little finger. Pressure below the scar produced the same sensation, but less intense. Evidently we are dealing here with a very rapid regeneration of axis-cylinders, since marked formication could be produced by pressure above the nerve lesion.

To summarize briefly, we have in the formication sign a valuable test for the detection of nerve regeneration. The test is very easily applied, but should be carefully done in each case, as the tingling produced by neuroma formation

may lead to error. In neuroma formation or in the early stages of regeneration without neuroma formation, the formication is limited to the level of the lesion. In the neuroma formation also, where the regenerating axis-cylinders are blocked and may consequently lose themselves in the surrounding tissues, the formication remains fixed at the level of the lesion. In actual regeneration of the nerve the formication progresses over the zone of the growth of the axis-cylinders and can finally be detected along the partial or entire cutaneous distribution of the nerve. For a time it may involve the entire cutaneous distribution, but as regeneration becomes complete, it finally can be detected only in the extreme periphery.

The exact cause of this formication it is difficult to state, but since it can be produced by a far lighter pressure than formication in an uninjured nerve, it probably is due to an increased sensitiveness of the young axis-cylinders. It is best, however, not to rely upon the formication sign alone. The test should be carefully correlated with the other investigations of the nerve lesion, such as protopathic and epicritic sensibility, regenerating pain points, and electrical reactions.

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DIAGNOSIS AND TREATMENT OF SYPHILIS.*

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THE responsibility which rests on the physician of making an early diagnosis of syphilis is very great and cannot be too frequently brought to his attention. The majority of people consult the general practitioner first, and he is the one who must be made to realize that the life and future usefulness of the patient suffering with syphilis depends upon the early diagnosis and

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