Stretching Nerves by Movement before Nerve Suture.

Nerve fibres pass through the two well-known stages of forming, first, a granular protoplasmic band, and then a hyaline band—the “band fibre.” The former lasts two or more weeks—its duration varying in different fibres—and its appearance suggests that it is very little extensible. Fibres in this stage sometimes show great inequalities in the granular band, which might be due either to tension or to inequalities in protoplasmic formation. It is unlikely that they are due to tension since the nerve in the early period after severance is free to move. In two to three weeks after nerve severance the cut peripheral end becomes more or less fixed to the surrounding connective tissue, and a given movement causes a somewhat greater pull on the nerve. I have tested the extent of this on the sciatic nerve and its branches in rabbits and cats. By complete extension or flexion of the limb the nerve may be straightened, but its tension so far as I have seen is too slight to cause injury, and I have not found that it causes any rupture of the degenerating fibres. It may, I think, be concluded that, in the pre-suture period, fairly free extension and flexion movements are not likely to injure either muscle or nerve. Naturally, forcible movements are always to be avoided.

In the pre-suture period there are some definite advantages in a flexible splint, allowing a certain amount of movement. Passive movement can be carried on at frequent intervals by the patient, and, when flexors or extensors are not paralysed, limited voluntary movements can be made, sufficient to prevent the wasting in the non-paralysed muscles which accompanies disuse.

Stretching Nerve by Movement after Nerve Suture.

We may consider first the simplest case—namely, that in which the nerve is not shortened. In this case movement will tend to strain the sutures and rupture the nerves growing from the central into the peripheral end. But connective tissue soon joins the ends, and binds them—at first loosely—to the surrounding tissue. Restricted movements can be made without injury, since these put extremely little tension on an unshortened nerve. When the connective tissue has become firm, tension on the nerves will not injure the nerves at the suture as readily as it injures the newly formed fibres and the “band fibres” in the peripheral part of the nerves, consequently whether full movement can be made or not depends on whether the tension caused by it is sufficient to injure the peripheral part of the nerve.

The following experiments, a further account of which has been given elsewhere,⁴ bear on this question. In cats the peroneal nerve (Experiments 1, 2, 3) or the tibial nerve (Experiment 4) was compressed on one side sufficiently to break through the axis cylinders without breaking through the nerve sheath; the limb was left without a splint, so that the muscles would be extended by their antagonists for a greater or less time, according to the posture of the animal. The animals with cut peroneal nerve were allowed to walk about as they pleased; that with the cut tibial nerve was kept in a cage for a week and then allowed gradually increasing exercise. The recovery of nervous control was rapid. In Experiments 1 to 3 reflex abduction of the fifth toe was obtained after nineteen days; stimulation of the peroneal nerve caused fairly good contraction of all the extensor muscles of the leg in twenty-one days (Experiment 1), and strong contraction after thirty-six and thirty-eight days (Experiments 2 and 3). In Experiment 4, in which the tibial nerve was cut, the animal, after forty-eight days, could keep the heel well off the ground in walking; stimulation of the tibial nerve caused contraction of the flexors of the leg, and stimulation of the posterior tibial nerve—though with currents considerably stronger than normal—caused contraction of the muscles of the foot. On microscopic examination, all the nerve fibres were found to have undergone Wallerian degeneration.

These experiments show that in animals a considerable degree of movement does not prevent rapid regeneration in an unshortened nerve. The definitely ascertained facts with regard to the effects of nerve severance are so similar in man and animals that the results given above are, I think, applicable to man. I conclude that in cases of suture in man, when the nerve is not shortened, slight movements can be begun in a few weeks and rather rapidly increased in extent. Early movement probably has the advantage of elongating the connective tissue binding the nerve to the surrounding structures. The connective tissue in its later stages tends to fix the nerve and thus to cause the peripheral part of the nerve to be subjected to a greater strain during movement. In consequence, in cases

of nerve compression in which there has been considerable connective tissue formation, it is necessary in the later stages to be more cautious about movement than in cases of immediate nerve suture.

In the great majority of cases in man the nerve has to be shortened, and until the ends become firmly joined a very slight movement may be sufficient to rupture the fibres at the junction, and thus to cause a more or less serious delay in regeneration. Obviously the greater the shortening of the nerve the greater the risk. But even when the junction is firm there is still the risk of injuring the new fibres and “band fibres” in the peripheral part of the nerve, especially in the smaller branches, by even slight movement. There are unfortunately no comparative observations on the degree of strain degenerating and regenerating and normal nerve fibres will stand. If new fibres and “band fibres” throughout the peripheral end of the nerve can stand as much strain as the normal nerve, there seems no reason why movement should not be begun as soon as the union of the nerves is firm. If, on the other hand, new fibres and “band fibres” stand much less strain than normal nerves, it may be necessary to wait until the nerve fibres have become fully developed up to their terminations, and this in some cases would take many months. In any case, it is important to shorten the nerve as little as possible. It would, indeed, probably be better to insert a piece of fresh nerve, not more than half an inch, when much nerve has to be excised, but this can only be settled by experiment.

There is one other point I would mention. It is generally recognized that if a nerve has been severed the sooner it is sutured the better. The main reasons for this are that the longer a muscle is left to atrophy the longer time it takes in recovering its normal weight. At best it is a slow process. It is probable also that nerve regeneration is quicker if it is sutured before the central end has formed a large neuroma and before the “band fibres” have decreased in diameter. The practical difficulty is in distinguishing between complete nerve compression which will recover without operation and nerve severance which requires operation. Tinel⁵ considers that this often takes two to three months. In simple compression new fibres are formed in the part of the nerve just below the point of injury long before there is any sign of recovery on stimulating muscles and motor points. If, then, this region could be stimulated without the stimulation spreading to the normal nerve it would give rise to sensation, and compression diagnosed. In certain cases it would, I think, be possible to do this by passing a needle covered, except at its point, with shellac through the tissues on to the nerve and stimulating with faradic shocks of gradually increasing intensity. If there were no sensory reaction a month after the injury a diagnosis of nerve severance would be much strengthened.

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NOTE UPON A HELPFUL DIAGNOSTIC SIGN
IN RUPTURED DIGESTIVE ULCERS.

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SEVERAL years ago I saw a patient, a hawker, upon his admission to the Royal Victoria Infirmary, Newcastle-on-Tyne, under Professor Rutherford Morison. He was suffering from acute general abdominal pain of a few hours' duration, and so acute was it that he maintained a constant screaming such as incommoded the other patients in the ward. His doctor, a very careful practitioner, stated that the patient had many times consulted him for alleged sudden attacks of acute abdominal pain, which had just as suddenly passed off. Despite repeated careful examinations nothing abnormal had been discovered, and he came to be regarded as a probable malingerer.

Upon admission his overwhelming pain and a board-like rigidity of the anterior abdominal wall were evidence that

Some intra-abdominal viscera had ruptured. At operation a ruptured duodenal ulcer was found and dealt with. The feature about the case most deeply impressed upon my mind was the presence of a transverse ring of constriction across the abdomen at the level of the lower margins of the ribs, and extending into the flanks on either side.

I had not noticed this sign before, but since then it has often stood me in good stead in the diagnosis of ruptured digestive ulcers, particularly in an atypical case; my reason for recording it now is that it has just dawned upon me that as a helpful diagnostic sign this ring of constriction in perforated digestive ulcers is not generally known. Without claiming to have made an original observation, for at present I have no opportunity of investigating the literature of the subject, I have never previously either seen or heard this sign described. Some surgeons with experience of general hospital emergency work must be familiar with it. I cannot say definitely if it is limited to ruptured digestive ulcers, or if it is also seen in some other acute intra-abdominal lesions. My impression is that I have also seen it in one other instance, namely, a traumatic rupture of the jejunum high up, but I am not positive about this without reference to notes which are not at present accessible.

The constriction is usually present, and does not always disappear with general anaesthesia, although it does disappear when the condition has advanced to the stage of general abdominal distension. There is no marked hyperaesthesia, and the patient is quite unconscious of any feeling of tightness at the site of the constriction. It is not confined to spare or emaciated persons, and is a different thing altogether from the scaphoid abdomen seen in emaciation, etc. The appearance is as if an invisible rope was constricting the abdomen, dividing it into an upper portion which has a convex aspect centrally, and a normal lower part. Viewed laterally, the region of the "rope"

forms the apex of a vertically situated obtuse angle. It may be that it is an attempt of nature to limit the effects of the perforation to the upper portion of the general peritoneal cavity. The sign was present in my last two cases of ruptured ulcer, described later, and I was able to point out the phenomenon to the surgeon who administered the anaesthetic in each instance. The site of constriction is shown in the illustration as a dotted line. It represents the level of the lowermost limits of the costal arch, and may be termed the "infracostal line." In passing, it may

be mentioned that this line is *below* the level of the transpyloric plane, while it is *above* the level of the umbilicus. The ring of constriction corresponds to that portion of the anterior abdominal wall supplied by the ninth intercostal nerve, and is certainly due to muscular contraction.

The muscles involved are the two recti abdominis in front, with the external obliques, the internal obliques, and the transversales laterally. The contraction takes place at a situation where the abdominal wall is unsupported by bone on its anterior and lateral aspects, but it should be emphasized that the constriction does not apply to the whole of the ilio-costal space but to its upper part only. All of the muscles just mentioned share in the general protective reflex rigidity, but the extra contraction—forming the ring of constriction—requires some explanation. It cannot be solely due to the accentuation of one of the upper lineae transversae of the recti muscles, because the constriction extends beyond their limits into either flank. Of the three lateral muscles the transversalis is the most capable of producing a constriction because it is able to exert a direct transverse pull, whereas the oblique muscles in contraction by themselves would tend to straighten out any such tendency to a constriction.

The ninth intercostal nerve, supplying its segment of the muscles of the upper part of the anterior abdominal wall

travels in an almost transverse direction after leaving the shelter of its intercostal space.

In addition to the vagi nerves, the stomach and duodenum gain a sympathetic nerve supply from branches originating from the fifth to the eleventh thoracic spinal nerves, through the greater and lesser splanchnics to the coeliac plexus; and Cunningham's *Textbook of Anatomy* (third edition, p. 704) states that sympathetic nerve fibres "transmit to the cerebro-spinal system afferent fibres from the viscera."

In view of these factors—muscular and nervous—it is reasonable to assume that the powerful stimulating impulses of origin, the results of the perforation, are conveyed by the sympathetic fibres to the coeliac plexus and from these to the spinal cord when the whole nervous system is probably involved. Afferent impulses cause the wide pupil dilatation seen in shock. They reach the vasomotor centre with a resulting splanchnic dilatation, and they stimulate the motor nerve cells in the cord so that there is general rigidity of the anterior abdominal wall muscles.

ILLUSTRATIVE CASES.

Case 1.

P. J. L., aged 35, was admitted to the Royal Naval Hospital Ship *Plassy* for acute abdominal pain. Eighteen hours previously he had sudden overwhelming pain in the upper abdomen which doubled him up. He sweated, vomited blood, and thought he was going to die. For many years he had had epigastric pain coming on a quarter of an hour after food; there were no interscapular radiations of the pain, and more food did not give ease. He had never had melaena, a cough, or increased pain on inspiration; flatus had been passed recently, and micturition was normal. Upon admission his facial expression was anxious, he was collapsed and cyanosed. The pulse-rate was 112 and weak, the respirations 20 per minute, temperature 100° F., and the tongue furred and moist. *There was a ring of constriction across the abdomen at the level of the lower margins of the ribs.* He had board-like rigidity of the whole belly wall, there was dullness in both flanks, and the liver dullness was normal. The heart and breath sounds, pupils, knee-jerks, testes, and hernial sites were normal. Rectal examination showed no abnormality. A diagnosis of ruptured pyloric ulcer was made. This was confirmed at operation, and the patient made a good recovery from it.

Case 2.

P. C., aged 25, was admitted to the R.N.H.S. *Plassy* suffering from acute general pain in the abdomen of four and a half hours' duration. The pain at onset was sudden and appalling, he shouted out, sweated, and vomited. For a considerable time previously he had suffered from epigastric pain after food, with pain between his shoulder blades; there was no history of haematemesis or melaena. He attributed his ailments to obstinate constipation. During my investigation of the case he was constantly screaming out with pain and disturbed the other patients. His pulse-rate was 60 per minute, temperature 98° F., respirations 30 per minute, and a normal tongue. Abdominal respiratory movements were absent, but a *transverse ring of constriction could be seen at the level of the lower margins of the costal arch.* There was general rigidity of the belly wall muscles, also general tenderness of the abdomen. The remainder of the routine examination was negative. Operation confirmed the diagnosis of a ruptured gastric ulcer, and he made a good recovery.

PRIMARY AND SECONDARY IMPETIGO IN SOLDIERS.

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DURING April, 1917, out of a total of 1,786 patients admitted with skin complaints into — General Hospital it was found that 1,411 suffered either from primary impetigo, or from impetigo grafted upon some other condition. This secondary form may be so severe as to mask the underlying causal condition, leading to errors both of diagnosis and treatment, whereby disease is spread and cure delayed. In this paper four types or classes will be described. Special attention is directed to the mode of distribution, since this alone is usually sufficient to guide the observer to a correct conclusion.

I. TRUE IMPETIGO CONTAGIOSA.

Contrary to what might be expected, this condition, so tediously common in civil practice, rarely occurs among the troops in France. As is well known the causal agent, a streptococcus, gains entrance through some slight