GARRIGUES (H. J.) d

ANÆSTHESIA–PARALYSIS.

BY

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ANÆSTHESIA-PARALYSIS.

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NEW YORK.

The discovery by which surgical operations were rendered painless is the fairest leaf in the rich wreath of laurels won by American surgery, ranging in its universality of application even above ovariotomy and ecphyadectomy.[1]

This blessing to suffering humanity, by which alone the gigantic strides of modern surgery have become possible, is, however, not free from danger. It was soon noticed that some patients, while being operated upon or even before the operation began, died. It was furthermore noticed that occasionally the extensor muscles of the forearm and the hand were paralyzed, a phenomenon that found an easy explanation in the arm having been allowed to roll out and hang in such a way over the edge of the table that protracted pressure was exercised on the region where the musculo-spiral nerve, after leaving the groove on the humerus, turns forward and becomes superficial at the lower end of the deltoid. This paralysis is in every respect analogous to that observed in a drunken man falling asleep with his arm hanging over the back of a chair; or in laborers carrying great weights on their shoulders; or after childbirth, when the patient is unable to use the muscles innervated by the peroneal nerve, that is to say—to bring the foot in dorsal flexion, to extend the toes, or rotate the foot outward—or unable to rotate the thigh inward or to bring it forward on account of a paralysis of the superior gluteal nerve, in both of which cases the paralysis is due to a pressure exercised on the lumbo-sacral cord where it passes over the brim of the pelvis and becomes compressed between the head of the child and the bone.

It is also a well-known fact that, if too much force is exercised in tightening the rubber tube or bandage used in Esmarch's bloodless method of operating, the patient is apt to wake up with a paralysis of the muscles supplied with nerves from the trunks thus exposed to injury.

But there are other kinds of disturbances in the functions of the

[1] The terms *ecphyaditis* and *ecphyadectomy* are derived from *ecphyas*, the Greek name for the appendix vermiformis, and, being composed of purely Greek roots, are preferable to the hybrid formations *appendicitis* and *appendicectomy*.

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nervous system connected with the administration of anæsthetics which have received little or no attention in this country, and only within the last two years have been described in Germany and France. When I observed my first case of this kind nothing was yet written upon the subject. The phenomenon being entirely new to me, I was inclined to look for its causation in the great anæmia of the patient; but soon it became clear that pressure, at least, was an important factor in the production of the faulty innervation observed in such cases.

If we take into consideration that in my first case it took six months to cure the patient; that in some of those observed abroad the affection has lasted for years; that some patients suffer considerable pain; and that some have lost their lives from the effect of the anæsthetic, it is evident that we have to deal with a group of symptoms which are of considerable importance, which demand our serious study, and which we must, as far as possible, try to avoid.

Before going any further, I shall give the history of my cases. I am fully aware of the very imperfect way in which the nervous abnormalities have been examined and recorded; but, to begin with, I am not a specialist for nervous diseases; and, secondly, the nervous disturbances were in most cases of minor importance compared with the serious operations that had been performed on the patients. But, deficient as the histories are, they may still be available for calling the attention of others to the matter, who then from the beginning may observe similar cases more closely, or associate neurologists with them to investigate all involved questions more fully. These lines may also serve as a warning to the young men who usually are intrusted with the administration of anæsthetics, for, as we shall see later, the evil can in most cases be avoided by proper attention to the position of the patient during anæsthesia.

Case I.—Mrs. R., aged forty-four years, Canadian, nullipara, was referred to me by Dr. R. W. Taylor. She had been suffering from menorrhagia for five years, and had been bleeding for six weeks when first seen. She was in a very anæmic condition. On February 17, 1893, I curetted her uterus, using ether as the anæsthetic, and Robb's leg-holder over the left shoulder. For the information of those who do not know this apparatus, I may add that it consists of a strong band of two layers of heavy muslin having in each end snaps that enter into iron rings sewn to the muslin. By this means the band is made to form a ring just above the strongly flexed knee, while the middle of the band goes in a slanting line behind the back and up over the left shoulder, which is padded with a folded towel or a layer of cotton.

Ether was administered by Dr. Leon F. Garrigues. The arms were flexed at the elbows and the hands rested on the sides of the face. The curetting stopped the bleeding effectually and permanently; that is to say, since then she has had normal monthly periods and was when last seen, some months ago, in good health.

When she recovered from the etherization her right arm, upon which

there had been no kind of pressure, was lame. First the extensor side alone was affected, but later the flexor side was similarly implicated. She could not move the limb at all. The fingers were in a half-flexed position, but could be passively extended. The whole extremity was somewhat swollen. Sensation was benumbed. Off and on she had some pain in the arm and the skin would become red in changing areas. Rubbing with spirit of camphor had no effect. Then faradization was employed daily, to which later was added massage. At the same time the system was built up with maltine, wine, iron, quinine, and strychnine. At the end of four months the arm and hand were yet a little weak. Then she went to the seashore, took baths, and returned at the end of six weeks perfectly well, both as to the paralysis and her general health.

Case II.—Mrs. N., aged forty years, German, was seen by me in consultation with Dr. Fred. M. Bauer, transferred to St. Mark's Hospital, and operated on March 31, 1894. Ether was administered by Dr. Martin Schuh. The left tube and ovary, which were bound with fresh adhesions to the intestine, were freed and removed. In the right broad ligament was a hæmatoma reaching half-way up to the umbilicus. The coagulated blood was removed, an opening cut in the vaginal roof, and a T-shaped soft-rubber drainage-tube drawn up into the cavity in the broad ligament. The very brittle tissue was difficult to tie. The patient lost a good deal of blood, and the pulse became weak. A gauze drain was carried from the upper opening in the broad ligament out through the lower end of the incision in the abdominal wall. The patient made a good recovery.

It was discovered, we do not exactly know when, that her left arm was paralyzed. When she was out of danger in regard to her peritonitis and hæmatoma of the broad ligament the arm was treated daily with faradization. She left the hospital after a month, but came for some little time to continue the electrical treatment until she was well.

In this case the legs had been extended and no pressure had been exercised on the left shoulder.

Case III.—Mrs. H., aged twenty-eight years, German. I performed double salpingo-oöphorectomy on her in St. Mark's Hospital on October 17, 1894. Ether was administered by Dr. Dann. The incision in the abdomen was just long enough to admit two fingers. There were no adhesions, and the inflamed and cystic ovaries were easily removed. The next day the whole left arm was found in a condition of semi-paralysis and the sensibility was much impaired. On the 29th—twelve days after operation—the arm was better but weak, and faradization was begun. She was discharged well, so far as the arm was concerned, on November 17th.

Case IV.—Mrs. H., the same as Case III. The abdominal pain continuing, I removed her uterus by vaginal hysterectomy on January 21, 1895. Dr. Goldberg gave the ether. The patient did not lose much blood, but other difficulties caused the operation to last over two hours.

Three days elapsed before the patient complained of her leg. Then it was found that the whole left lower extremity was almost motionless, and that there was nearly complete insensibility of the area supplied by the crural nerve and also of that supplied by the sciatic nerve from the middle of the thigh down. There was also great tenderness at the seat of the crural nerve at the left groin, as well as of the great sciatic

nerve, a little above the popliteal space, the first of which points corresponds to the place where the hip-joint is being strongly flexed and the latter to that where the bandage presses on the thigh while using Robb's leg-holder. She was treated with faradization and soon got well.

Case V.—Mrs. S., aged thirty-four years, German, always nervous, was subjected to vaginal hysterectomy by me, at St. Mark's Hospital, on October 21, 1895. Dr. Pfeuffer gave the ether. I used the clamp method, and had trouble in arresting a deep hemorrhage. The operation was tedious, and she lost much blood, so that she became nearly pulseless. When she came to, she complained of numbness of the right arm. She died of heart-failure the next morning. No autopsy.

The first to call attention to the paralysis sometimes following anæsthesia was Büdinger, assistant to the late Billroth's clinic in Vienna. He published in *Archiv für klinische Chirurgie*, Berlin, 1894, vol. xlvii. pp. 121–145, an article entitled "Ueber Lähmungen nach Chloroformnarkosen." He described nine cases, but says that by questioning the staff of other hospital-divisions he had found that these cases were not rare, but had so far not received any attention either from the surgeons or the neurologists.

As the subject is yet so new and little known in this country, I add a brief abstract of Büdinger's cases.

Case VI. (I.)—A woman, aged twenty-nine years, was operated on for carcinoma of the pylorus. Duration of operation two and one-half hours. Immediately after awakening, the right arm, which had been held upward during the operation, was found completely paralyzed. The arm was now found extended, the forearm in supination, and the fingers slightly flexed. She had no power to exercise pressure. Sensibility and reflexes were normal. The left pupil was twice as large as the right, which reacted slowly. There was no vasomotor disturbance. She died eleven days after the operation. There was no macroscopical or microscopical change to be found in the brain, the spinal marrow, or the nerves, but the roots of the brachial plexus were not examined.

Case VII. (II.)—Man, aged forty-four years. Extirpation of colon ascendens for carcinoma. Duration of operation one and one-quarter hours. The right arm was strongly extended in the shoulder-joint, and the elbow-joint was held at right-angles. Immediately after the operation there was complete paralysis of the arm and shoulder. The sensibility was diminished and the reflexes weakened. The patient died next day. No autopsy.

Case VIII. (III.)—An explorative incision was made on a woman, aged forty-six years, suffering from carcinoma of liver and stomach. Duration of operation one-quarter hour. The left arm had been held flexed at right-angles at the elbow-joint and extended a little beyond a right angle at the shoulder-joint. During the night following the operation the left arm was found completely paralyzed. The patient lived seven weeks, and at the autopsy there was found softening of the brain.

Case IX. (IV.)—On a man, aged twenty-four years, part of the intestine was resected on account of perityphlitis. Duration of opera-

tion two and one-half hours. The left arm was only extended a little beyond a right-angle during the anæsthesia, but when the patient awoke there was great weakness of the whole arm. The motions were slow and imperfect. The patient died during the night. At the autopsy the brain was found very anæmic and somewhat moist.

Case X. (V.)—Supravaginal amputation of uterus for a myoma. Duration of operation two hours. Both arms were tied to the upper part of the table, so that they formed angles of 120° with the thorax. The forearms were supinated. The next day the right arm was found paralyzed. All movements of the forearm were abolished; in the fingers slight flexion was possible. The shoulder could only be elevated very little. The sensibility was much diminished. Faradization. The limb was yet weak three or four months after the operation, but at the end of six months there was complete recovery and no atrophy.

Case XI. (VI.)—A woman, aged thirty-one years, was operated on for a kidney-tumor. She was lying on the left side. The right arm was paralyzed and numb. Twelve weeks after the operation movements were yet slow and uncertain.

Case XII. (VII.)—Woman, aged forty-three years. Hysterectomy for myoma. Arms held as in Case X. Complete paralysis of right arm. After six months the movements were yet slow and weak.

Case XIII. (VIII.)—Female, aged forty-three years. Oöphorectomy for myoma. Duration of operation one and one-quarter hours. Arms held as in Cases X. and XII. The following day the right shoulder, arm, and forearm were found paralyzed. There was pain on pressure above the clavicle, not on the brachial plexus in the axilla. Hand and fingers were normal, The sensibility was diminished on the forearm. She improved, but the final result is not known.

Case XIV. (IX.)—Woman, aged thirty-eight years. Resection of pylorus. Immediately after the operation the right arm was found paralyzed and insensitive from the elbow to the finger-tips. The right eye was the seat of a nearly complete amaurosis, which soon got better, but during a whole year she had double vision. A few weeks after the operation the right shoulder became painfully sensitive. In spite of electric treatment it took more than a year before the hand and fingers became somewhat movable and regained sensibility. Eighteen months after the operation the right palpebral fissure was smaller and the right pupil narrower than the left. There was some atrophy of the muscles. Two and one-half years after the operation she was nearly well.

Placzek,[1] of Berlin, has published the case of a woman upon whom laparotomy was performed for salpingitis. Shortly after awakening she complained of pain in the left arm. Next the muscles of the thumb and the interossei diminished in size. There was partial loss of electrical excitability, with the reaction characteristic of degeneration, diminished nervous irritability, and slow muscular contraction.

Franke,[2] of Elberfeld, had a case of a girl, nineteen years of age, who was laparotimized Immediately after she came out of the anæsthesia the right arm was found completely paralyzed. There was loss of sensibility of the outer surface of the arms. The faradic reaction was normal. At the end of three months the paralysis remained and only a few movements were possible.

[1] La Médecine moderne, Paris, 1895, p. 198.
[2] La Tribune Médicale, July 17, 1895.

Vautrin,[1] of Nancy, has had three cases, two of paralysis of the shoulder, and one of the face. The operations were performed for a small papilloma of the tongue, hydrocele, and a tumor of the breast. One of the patients took only very little chloroform.

In the discussion on Vautrin's paper Gross said there had been a fatal case after herniotomy in Strasburg. Hemiplegia developed in the evening. The autopsy showed a clot in the brain. In another fatal case there were found cerebral emboli.

Krumm,[2] of Worms, contributed four new cases from the clinic to which he is attached, and has written a monograph on the subject. Büdinger mentions three other cases of brachial paralysis happening after operation performed by Bardenheuer, Thelen, and Bernhardt.

In regard to the etiology of anæsthesia-paralysis, the cases may be divided into those of peripheral and those of central origin, the former of which are much more common than the latter. It is evident that the choice of the drug used as anæsthetic is without importance. In the French cases chloroform was used, in those occurring at Vienna either chloroform or A.-C.-E. mixture, and in my own ether alone.

While many of the cases have occurred after protracted operations, others, such as Büdinger's Case III., one of Vautrin's, and my own Cases I. and III., were observed after short and easy operations.

Loss of blood before or during the operation may be of some importance as a predisposing cause. Children and emaciated persons are more liable to be injured. But the real exciting-cause in the cases of peripheral origin is pressure. It appears from the preceding histories that the paralysis has been observed in the extremities, the face, and an entire half of the body. That of the arm is the most common. Büdinger has shown experimentally that this paralysis is due to pressure occurring between the clavicle and the anterior surface of the first rib, and bearing on the brachial plexus where it emerges between the scalenus anticus and medius. The pressure takes place when the arm is elevated alongside of the head, as often done during laparotomies performed in Trendelenburg's position, or brought out from the body as in amputation of the breast. Krumm found the pressure to take place between the clavicle and the transverse process of the fifth and sixth cervical vertebræ. Braun thinks that it is the head of the humerus that presses on the brachial plexus, just as the pulsation in the radial artery can be arrested by drawing the arm up.

Kron has shown on the cadaver that by elevating the arm backward and outward and simultaneously rotating it outward the median nerve is being stretched over the head of the humerus, and the same happens to the ulnar nerve when the forearm is flexed and strongly supinated.

[1] Paralysies Chloroformiques. Médecine moderne, August 31, 1895, vol. vi. p. 572.

[2] Volkmann's Klinische Vorträge, No. 139. Leipzig, 1895. Ueber Narkosenlähmungen.

But there is hardly any doubt that in most cases of brachial paralysis the pressure takes place as described by Büdinger between the collar-bone and the first rib.

The plexus is especially exposed to injury by this pressure if the nerves are stretched, which takes place if the head is drawn to the side opposite to that on which the arm is being elevated, or if the head is allowed to fall back.

Among my cases there are only two (Cases I. and II.) of complete paralysis, and that was seated in the right arm in Case I. and in the left arm in Case II. In Case III. the left arm was in a condition of paresis, and in Case V. a similar state had taken place in the right arm. For all these cases I adopt the explanation offered by Büdinger of more or less complete compression of the brachial plexus between the clavicle and the first rib. In Case IV. the left leg was the site of the affection, which is easily explained by the pressure exerted on the crural nerve at the inguinal fold and on the sciatic nerve at the posterior surface of the thigh just above the knee, in consequence of the cramped position in which the body is held by Robb's leg-holder.

In cases of pressure on the brachial plexus the upper roots—fifth and sixth cervical nerves—are more liable to be caught between the bones than the lower—seventh and eighth cervical and first dorsal. In such cases the paralysis attacks the deltoid, the brachialis anticus, the biceps, and the supinator longus muscles, while the other muscles of the extremity may escape. On the other hand, the muscles of the shoulder are implicated in some cases, their nerves coming from the same plexus.

If the lower roots are compressed too, the forearm and the hand are more or less paralyzed; but the less degree of pressure exercised on the lower roots explains that the paralysis is often less pronounced in these parts, and that motility returns sooner in the fingers than in those parts of the extremity which are situated higher up.

In a few cases there were disturbances in the eye: the palpebral fissure was diminished in size; the pupil was contracted; there was amaurosis, and later double vision. These ocular disturbances are, according to clinical and experimental studies, due to a lesion of the communicating branch from the first dorsal nerve, which is probably due to stretching or to neuritis.

There is also more or less disturbance in the sensory sphere. There may be complete insensibility or numbness. Sometimes there is spontaneous pain or tenderness on pressure. Sensitive points may develop in the course of nerves. They are attributed to chronic descending neuritis or myositis. In one of Büdinger's cases such a sore point could be felt on the deltoid two years and a half after the operation. The electric excitability is diminished, and the muscles are slow to contract.

When the upper roots alone are compressed there are less disturbances in sensation. In the lighter cases of plexus-paralysis they are therefore rarely present; but in compression of the lower roots or when the whole plexus is involved, sensation is annihilated or obscured in the domain of the cutaneous branches of the ulnar, the internal cutaneous, the musculo-cutaneous, the median, and the radial nerves.

It has been noticed that even when the muscles innervated by the circumflex nerve—the deltoid and teres minor—are paralyzed the corresponding skin retains its sensibility. In my first case there were swelling of the affected arm and appearance and disappearance of redness on changing areas of the skin, showing implication of the vasomotor nerves. In most cases the abnormalities in the motor or sensory sphere appear immediately; in others there is a gradual development. In some cases the paralysis has led to atrophy, but this seems more an exception than a rule.

Anæsthesia-paralysis of central origin is much rarer than that of peripheral origin, and is rather obscure. It may be due to cerebral apoplexy or emboli, either of which would produce ischæmia in the surroundings and secondary softening of the brain. People who oppose a violent resistance during the anæsthetization, and old people with arteriosclerosis, would be more liable to such occurrences. Or it may be due to a primary softening of the brain (see Case VIII.), directly brought on by the influence of the anæsthetic on the nerve-tissue, analogous to the acute nephritis often observed after long operations, which latter, however, soon disappears, and to the acute parenchymatous degeneration that has been found in the muscles, the heart, and the liver.

The paralysis of central origin appears as hemiplegia or hemiparesis; but it is not unlikely that so-called chloroform- or ether-death in some cases really is due to apoplexy. In this connection I may mention that one of my patients, an old woman, upon whom I operated for prolapse of the uterus, and who was under the influence of chloroform one hour, was seized with acute mania. The later developments of this case are unknown to me.

The differential diagnosis between central and peripheral cases is, as a rule, not difficult. In the peripheral cases the lameness corresponds to one or more nerves upon which undue pressure has been exercised, or to the brachial plexus. There appear sometimes hyperæsthetic points in the course of a nerve. The electric irritability is diminished, and the muscles contract slowly.

The prognosis is in the lighter cases good, both as to complete recovery and the time needed for a cure; in the more pronounced cases of plexus-paralysis it seems also to be good as to final result, but it may take many months or even years before a cure is effected. In the central cases the prognosis is, of course, much more serious and doubtful.

As to treatment, prophylaxis should first attract our most serious attention. Pressure on special nerves should be avoided, and the arms should never be raised above the head, but, so far as possible, rest in an easily flexed position on the chest. In using leg-holders the parts exposed to special pressure should be carefully padded with cotton-batting. The head should be supported on a pillow, and, if the patient vomits and the arm is raised, the head should be bent toward the arm, and not away from it. As to paralysis of central origin, we can hardly take any prophylactic measures beyond abstaining as far as possible from operating on very old persons, and abridging the duration of the anæsthesia as much as possible. In this respect it is often preferable, if several operations are needed, to operate in two sittings rather than to keep the patient too long under ether.

In regard to curative treatment electricity occupies the first place; but since it has been found that its application shortly after the operation is very painful, it is advisable to wait about a week before having recourse to it. All my cases have responded nicely to faradization Krumm recommends to use galvanism and place the cathode on the point of lesion, and later to use labile and stabile electrization both above and beneath the seat of the lesion.

Besides electricity, massage and hydrotherapy are undoubtedly of some value. Among drugs strychnine is the most important, and may be given together with iron, quinine, arsenic, extract of red marrow, and a nourishing diet.

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