ON THE ELECTROLYTIC TREATMENT OF TUMOURS AND OTHER SURGICAL DISEASES.*

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In bringing my researches on the above subject under the notice of the profession, I hardly think that an apology will be necessary for the circumstance that a physician should endeavour to inaugurate a new treatment of such diseases as fall more particularly within the province of the pure surgeon. I trust we are all votaries of Catholic medicine, of that one and indivisible science which embraces all the ills mortal man is heir to, whether they are external or internal, and whether mechanical, chemical, or dynamic remedies are required for their removal. There are few surgeons now-a-days who are not fully alive to the advantage to be gained by the administration of constitutional remedies in the treatment of surgical diseases; and I take it that no physician can be really successful in the practice of medicine who is not well acquainted with surgical pathology and therapeutics. Several instances are on record where surgeons have suggested and carried out valuable improvements in the practice of medicine; and I should consider myself well repaid for the trouble I have taken in these investigations, if it were generally acknowledged, as I believe it will be, that an actual advance has thereby been made in the science and practice of surgery.

It is well known that a continuous galvanic current, apart from the physiological effects which it produces on living bodies, has likewise certain physical and chemical effects, with which everyone should be acquainted who intends using this agent in the treatment of disease. Indeed, the continuous current is able, not only to produce a high degree of heat during its transmission through a conducting wire, but also to decompose into their elements any chemical compounds which are brought under its influence. What is less universally known is, that we may, by modifying the galvanic arrangement and its application in a certain manner, bring about chiefly calorific, or, on the other hand, chiefly chemical, effects. The calorific property of the continuous current has, for some considerable time past, been used in surgery, where it is known as the galvanic cautery; while the chemical or electrolytic effects of the current have hitherto been almost entirely neglected; and it is the object of the present communication to introduce the scientific use of the electrolytic effects of galvanism into surgical therapeutics.

I will, therefore, first explain, as concisely as possible, what takes place in a galvanic battery which has been properly charged. The consequence of the chemical action of the liquids upon the solids of the battery is, that the natural electricity is decomposed, and active electricity liberated; that is to say, we find a positive current travelling towards the negative electrode, and a negative current travelling towards the positive electrode, both currents having the tendency to neutralise each other. If water or

saline solutions be placed into the circuit of the battery, these compounds are decomposed, oxygen and acids being attracted to the positive pole, while hydrogen and alkalies accumulate at the negative pole.

The amount of electricity which is produced within a battery, depends upon the intensity of the electromotive force, or the surface of the plates of which the battery is composed; but we must carefully distinguish between the quantity of electricity produced, and the quantity of electricity which is travelling in a certain space of time through a wire by means of which the poles of the battery are connected. The amount of electricity travelling depends not only upon the intensity of the electromotive force, but also upon the resistance offered to the passage of electricity through conducting bodies, and upon the tension with which it is driven through a conjunctive wire. All bodies through which an electric current is propagated, offer a certain resistance to its passage, and consequently diminish its intensity. Even if the current be transmitted through silver wire, which is the best conductor of electricity, it encounters a certain resistance to its propagation, and loses a certain amount of its intensity. Now we find that, the worse the conductivity of bodies is through which the current travels, or, in other words, the more resistance it encounters in its passage, the greater is the amount of heat produced. This is the reason why platinum wires are used for the galvanic cautery; for, except mercury and lead, which, for obvious reasons, could not be used for such purposes, platinum is the worst metallic conductor of electricity, which it conducts several million times less well than silver. Silver, copper, gold, and even iron, are far better conductors than platinum; and, therefore, give out far less galvanic heat than the latter metal. Thus, if a platinum wire be interposed between wires of silver, copper, gold, or iron, these latter will scarcely ever show any elevation of temperature, while the platinum wire will be easily rendered incandescent, and be brought to a white heat. For the same reason, the amount of galvanic heat is greater in proportion, as the conducting wires offer less volume to the action of the liberated heat. Thus, if we insert a thin platinum wire between two thick platinum wires, and close the circuit, only the thin wire will be rendered incandescent, because it conducts electricity less well than a thick wire.

The human body is a conductor only by the warm saline solution it contains, and conducts from ten to twenty times better than cold distilled water, after the epidermis has been removed or well moistened, for the epidermis in its dry state offers a very great resistance to the passage of the current. But all liquids conduct much worse than metals; an electric current will more easily pass through a copper wire ten thousand miles in length, than through a layer of water one inch in length; and one of the best conducting liquids with which we are acquainted—viz., a concentrated solution of sulphate of copper—conducts electricity sixteen million times worse than metallic copper. Professor Weber has shown that the human body conducts fifty million times worse than copper; while it appears, from the researches of Professor Eckhard, that the muscles are the best conducting tissue of the animal body; that the cartilages, tendons, and nerves, conduct electricity about twice, and the bones about nineteen times, worse than the muscles. These numbers correspond with the amount of water contained in the animal tissues; and we may put it down as a general principle that, the larger the quantity of water, the better will be the conductivity of the tissues.

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The muscles contain 76 per cent of water; resistance=1.

The tendons contain 62 per cent. of water; resistance=2.1.

The cartilages contain 62.5 per cent. of water; resistance=2.

The nerves contain 52.5 per cent. of water; resistance=2.1.

The bones contain 5 per cent. of water; resistance=19.

If, therefore, the human body, or part of it, is placed into the circuit of a galvanic battery, the resistance to the passage of the current will be such that only little electricity can be collected, unless care be taken to increase in proportion the resistance of the electromotive apparatus itself, which is done by increasing the number of pairs; that is, by forming a voltaic pile. The greater the number of pairs, the higher will be the tension; that is, the more easy will be the transmission of electricity.

It is evident, from these purely theoretical considerations, that no galvanic heat can be produced if the current be applied in such a manner that the whole body, or part of the body, is placed within the circuit of the battery; as is done, for instance, if a needle connected with the negative pole be inserted

into the depth of a tumour, while a moistened conductor connected with the positive pole is placed outside on the skin. I have, however, taken the trouble to set this question at rest by actual experiment. I immersed the two poles of the battery, at a certain distance from each other, into animal fluids, thus letting the current travel from the positive to the negative pole, and *vice versa*; and I then read off the temperature, at the poles as well as in the liquid itself, on a Negretti and Zambra's thermometer, which allows variations of one-tenth of a degree of Fahrenheit to be distinctly determined. Now I found that, whether I used five, ten, fifteen, or twenty cells of the battery, no elevation of temperature took place. The effects of a current administered in this manner are, therefore, simply electrolytic, and have nothing whatever to do with the galvanic cautery.

[The author then gave an account of some physiological and microscopical researches on the action of electrolysis on living tissues, part of which has already appeared in this JOURNAL.]

I now proceed to say a few words about the battery required for the electrolytic treatment, and for which the following qualities appear to be necessary. It

Fig. 1.

should furnish a large quantity of electricity and possess considerable electrolytic properties; it should give a constant and reliable current; it should be easy of management, so as to avoid loss of time and trouble in charging and discharging it; it should not easily get out of order, and it should be of such

a bulk as to render it possible to carry it easily about. The present battery appears to me to unite all these conditions; it has been constructed for me by Messrs. Weiss, to whom I am obliged for the zeal and ingenuity with which they have carried out my instructions.

Amongst the so-called constant batteries in which there is little or no variation of current for a considerable period, say two or three months, that constructed on Daniell's principle continues to occupy the foremost rank. Daniell's battery is not so powerful as those constructed by Grove and Bunsen; but this apparent drawback is amply compensated by the high degree of constancy and reliability which is the characteristic feature of the former arrangement. The original battery consists of zinc immersed into salt water or acidulated water, and of copper immersed into a solution of sulphate of copper, there being a diaphragm of porous earth between the two liquids. This arrangement has lately been so modified that no salt or acid is used, and that the zinc is immersed into the solution of sulphate of copper, while the copper is put into ordinary water contained in porous cells, the whole pair being placed in a porcelain vase. This is the arrangement which I have used for several years past with great advantage in the treatment of nervous disorders, and which I have described in the *Lancet* for August 15th, 1865. This battery gives a very reliable current; but it is unfit for transport, on account of its great bulk and extremely heavy weight. In the present battery, the porous cell and the porcelain vase have been altogether dispensed with, the latter being replaced by vulcanite, which is much lighter and quite as durable as porcelain; while the former is compensated for by the copper of the pair being perforated, and the holes filled up with leather, which is easily penetrated by moisture. The zinc is then immersed into the solution of sulphate of copper, as usual; but, in order to prevent the liquids from splashing when the battery is carried about, they are intimately mixed with sawdust; so that a dry pile is produced, which is quite as effective as the ordinary arrangement. The current furnished by this battery continues reliable for three months. During the whole of that time, no thought need be given to the battery, which is always ready to act, and only very gradually loses a certain amount of its intensity. Every three months, it should be taken to pieces, the zinc cleaned, and a fresh solution of sulphate of copper substituted for the one previously used. The weight of the battery is about thirty-five pounds; and it is, therefore, sufficiently light to be taken in and out of a patient's room. No acid fumes are developed, and the instrument is by no means unsightly.

The effects of this battery on animal substances are always the same at the negative pole, whatever may be the nature of the conductor used, because metals are not changed by hydrogen or free alkali. At the positive pole, on the other hand, the effects vary according to the chemical nature of the conductor. Thus, for instance, on immersing a gold needle connected with the negative pole, and a steel needle communicating with the positive pole, into the white of an egg, a peculiar substance is formed round the negative pole, which looks at first sight like a coagulum or clot, but is in reality no clot at all, but a sort of froth, which consists of the particles of albumen mechanically driven asunder by the nascent hydrogen, and chemically altered by the evolution of free alkali, the presence of which may be shown by its action on litmus and turmeric paper. At the same time, an entirely different effect is produced at the positive pole, where the steel needle is oxidised; and, by the development of sulphuric acid and chlorine, sulphate and chloride of iron are formed, which impart a yellow-reddish colour to the albumen, with which they form an organic compound. If the current be applied in this manner, no coagulation is caused anywhere; but if the nature of the

positive electrode be changed, by substituting a brass wire for the steel needle, immediate coagulation is produced round the positive pole, which is due to the action of sulphate of copper on albumen. By substituting a steel needle at the negative pole for the gold needle, the same peculiar substance is formed there which was produced round the gold needle. I may remark here, that this is very similar to the foreign body which may, by electrolysis, be safely deposited in an aneurismal sac, and round which we may expect a slow and gradual deposition of lamellated fibrine to take place.

The disintegrating effect of the negative pole on muscular fibres may be well shown by inserting the negative needle into a small piece of raw beef, where the froth which at once appears on the fibres denotes the chemical action of the current on the same. If it be allowed to pass through it for some time, entire destruction of the substance is brought about. Of course, in the living body, this disintegration would be much more rapid, because there the tissues are thoroughly soaked in a saline solution at a temperature of 98°.

I will now say a few words about the instruments which I employ for conveying the galvanic current into the depth of the tissues. The prototype of all is a fine needle of gold or gilt steel for the negative pole, the circuit being closed by placing a moistened sponge connected with the positive pole outside on the skin. (Figs. 1 and 2.) I always employ dif-

Fig. 2.

ferent conducting-wires for the two poles, in order to be able to tell at once the direction of the current; viz., wires insulated by silk for the negative pole, and such insulated by India-rubber for the positive pole.

Most of the other instruments are modifications of the needle. I use conductors from which two, four, six, and eight needles are made to branch off, to suit the requirements of the different cases as they present themselves. (Figs. 3, 4, 5, 6.) Sometimes cir-

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

cular-shaped conductors are required (Figs. 7 and 8). For the treatment of piles, conductors with a larger

Fig. 7.

Fig. 8.

surface are better suited; viz., blunt blades (Fig. 9),

Fig. 9.

and round plates of different size (Fig. 10). All

these conductors are made of gold or gilt metal, and insulated by ebonite.

Fig. 10.

I now proceed to consider the pathological conditions in which the electrolytic treatment has been, or may be expected to prove, serviceable. These are:

1. Tumours;
2. Certain diseases of blood-vessels;
3. Serous effusions; and
4. Strictures.

I.—TUMOURS.

In tumours, the electrolytic treatment acts in a threefold manner; viz., through mechanical disintegration by the nascent hydrogen; chemical destruction by free alkali; and modification of nutrition by the dynamic effects of the continuous galvanic current on the vaso-motor nerves of the parts brought under its influence.

1. *Nævus*. Although *nævus* is not commonly dangerous to the patient affected with it, yet it entails a good deal of trouble and annoyance; and, being most frequently seated on the scalp and face, gives rise to great disfigurement. Moreover, it should be recollected that *nævus* is liable to be inflamed by disease or injury; that ulceration may ensue, exposing parts of its substance, and forming irritable and open bleeding sores, which rarely heal soundly. It is, therefore, generally desirable to have a *nævus* removed.

The very large number and the exceedingly different kind of operations which have from time to time been recommended for the cure of *nævus* seem to show that hitherto no method has proved entirely satisfactory in its results; for I expect that it is in surgery as it is in physic—viz., that the larger the number of remedies recommended for the cure of a particular disease, the less is generally their actual value. I believe, therefore, that a method so safe and so successful as the electrolytic treatment will prove a positive boon to surgeons in their management of these tumours.

I will now relate the details of a case of *nævus* which was successfully removed by this proceeding.

1. *Case of Nævus of the Eyelid: Operation: Cure*. In July 1866, Mr. White Cooper requested me to see with him a lady, aged 28, who had a congenital *nævus* of the right lower eyelid, of the size of a small pea, which it was thought desirable to remove. I expressed the opinion that this might be safely done by the electrolytic treatment, without hæmorrhage, and without subsequent inflammation, suppuration, or sloughing. We therefore met on the 23rd of July, in order to perform the operation.

As the patient was of a highly sensitive constitution, chloroform was administered by Dr. Allan, of Hyde Park Terrace, the ordinary medical attendant of the lady. As soon as she was fairly under the influence of it, Mr. White Cooper introduced a needle connected with the negative pole of ten cells of the battery, into the right half of the tumour; and I closed the circuit by placing a moistened electrode, connected with the positive pole, to the skin of the neck. The current was then allowed to pass for two minutes, after which the needle was withdrawn.

Not a drop of blood was lost, either on introducing or on withdrawing the needle. The patient recovered well from the chloroform, and said she felt no pain in the part that had been operated upon, but

merely a slight stiffness. The right half of the tumour appeared shrunk and shrivelled up, while the left half had not been altered in any way. This was an interesting circumstance, as it showed that, even in such a small tumour as the one described, the action of the current could be exactly limited to that portion of it which was in contact with the needle.

We met again on July 26th, when the same operation was performed on the other half of the tumour; but this time the patient objected to the use of chloroform, and bore the trifling pain of the galvanism extremely well without it. I have not seen the patient since; but received, on October 13th, a note from Dr. Allan, in which he expressed himself as follows. "Mrs. — is in the country; but, last time I heard from her, she said the *nævus* had disappeared. A dozen years ago, I wished it to be removed, but no one would do it; and the able and esteemed oculist whom she then consulted deprecated all interference. At length I persuaded her to have another opinion (that of Mr. White Cooper). The result was your employment of galvanism, with the happy effect of complete obliteration of the evil."

What can be done with *nævus* can be done with many other tumours by the electrolytic treatment. I subjoin three other cases, the issue of which was equally satisfactory.

2. *Case of Papillary Growth in the Armpit: Operation: Cure*. A lady, aged 27, consulted me on November 21st, 1866, on account of a small papillary and highly vascular growth, which had first appeared in the right axilla since the commencement of 1865, and had somewhat rapidly increased in size during the last few months. It was one-third of an inch long, and one-fourth of an inch wide in its widest part. I introduced a needle connected with fifteen cells of the battery into the base of the tumour, and allowed the current to pass for three minutes. No chloroform or ether-spray was used. The current had not acted many seconds when a peculiar change was observed in the tumour, which lost its flesh-colour and became quite white, as if it had been frozen. When the needle was withdrawn, circulation in the tumour had evidently quite ceased. There was scarcely any pain during the operation, and none at all afterwards; nor was any blood lost.

Nov. 23rd. Tumour entirely shrivelled up, looking like a thin brown leaf just adhering to the skin. The operation was, therefore, not repeated.

Dec. 20th. The eschar fell off about a week after the operation. There is now no sign that there ever was a tumour; no scar, nor even redness of the skin, being perceptible.

3. *Case of Molluscum of the Right Eyelid: Operation: Cure*. A married woman, aged 32, was sent to me by Dr. Tilbury Fox on November 29th, 1866. She had a very hard globular sebaceous tumour, with a broad base, just under the right eyelid; its size was between a large currant and a small hazel-nut, and it had a dark point on the summit. The tumour disfigured the face considerably; and it somewhat interfered with the sense of sight, for the patient could not look straight at anything without feeling giddy. As the stratum of corium over the tumour appeared considerably distended, and as I was anxious that no scar should be left after the operation, I only used a current of five cells in this case on three different occasions; viz., on November 29th, and December 1st and 7th.

Jan. 10th. Nearly the whole of the eschar has come off, leaving a soft red surface. At the inner edge, a small piece of tumour still adhered to the skin, for which I applied again a current of five cells for about one minute. Feb. 5th. No trace is now left of the tumour.

In this case, the treatment lasted somewhat longer than usual, because I acted with very low power. The tumour might have been removed by a single operation; but then a scar, which is always an eyesore, might have been the consequence, which I thought it better to avoid, especially as there was no occasion for hurry.

I should add, that in this case, as in the others, not the slightest bad symptom arose during the progress of the treatment.

[To be concluded.]

Reviews and Notices.

THE PHYSIOLOGY AND PATHOLOGY OF THE MIND.

By HENRY MAUDSLEY, M.D.Lond., Physician to the West London Hospital; Honorary Member of the Medico-Psychological Society of Paris; formerly Resident Physician of the Manchester Royal Lunatic Hospital; etc. London: Macmillan and Co. Pp. 442.

THE present work will give a fresh impetus to the study of the various forms of insanity in this country. No other department of medicine stood in greater need of a vigorous and philosophic treatment. It has long been in a state of almost hopelessly indefinite confusion. This is partly owing to the inherent difficulties of the subject, partly to the fact that most of those who have treated on it have been more or less blinded by the influence of prevalent psychological doctrines; it is also in great part owing to our almost utter ignorance of the pathological states upon which the various forms of insanity are dependent. The subject, then, needed handling in an independent manner by one who was capable of throwing aside the old traditions, and of approaching his task unbiassed save by the teachings of a sound physiology, and who at the same time possessed an adequate practical acquaintance with the diseases in question, and a mind of sufficient grasp rightly to appreciate and coordinate the various phenomena indicative of mental weakness or aberration. How well Dr. MAUDSLEY has succeeded, we hope all interested in the subject will ascertain for themselves. We can promise them a rich treat in the perusal of his work, not only from the originality of many of his views, but also from the vigorous and thoughtful style in which they are worked out.

The book is made up of two distinct parts. The first comprises the Physiology of Mind, in which the author's aim has been "to treat of mental phenomena from a physiological rather a metaphysical point of view", and also "to bring the manifold instructive instances presented by the unsound mind to bear upon the interpretation of the obscure problems of mental science." The second part of the work, on the Pathology of Mind, as the author says, "may stand on its own account as a treatise on the causes, varieties, pathology, and treatment of mental diseases, apart from all question of the proper method to be pursued in the investigation of mental phenomena. Though distinct in itself, however, it needs for its proper comprehension the reader's familiarity with the physiological exposition of the first part: hence the reason barring its separate publication, which would have been otherwise desirable.

In the opening chapter of the work, the author whilst justly extolling the advantages of the physiological method in the investigation of mental phenomena, points out some of the defects of the psychological method "of interrogating self-consciousness". Many of these defects are real and genuine; but we think he goes much too far in his indiscriminate condemnation of metaphysical philosophy. Surely the discussion of some of the deep and fundamental questions treated of by philosophers has its use; and the fact that such subjects are again and again recurred to by some of the master-minds of each century is sufficient evidence of the inherent interest of these questions to the most cultivated intellects. Psychology is not coextensive with metaphysics; and if, in spite of all the interrogations of self-consciousness by those whom he would call metaphysical psychologists, our knowledge of the phenomena of mind has not received an adequate increase, we see with Dr. Maudsley that this is due in great part to the lack of a physiological method, and to the absence of the light afforded by well-established facts of nervous physiology. But, since it has only been of late years that this light has been forthcoming, we do not agree that it is a reason for the wholesale and magistral condemnation of metaphysical inquiries. This dissent is the more needed, because such studies not only include subjects which are entirely beyond the range of psychology proper, but some which are and must be considered also by even the most physiological of psychologists. When Dr. Maudsley speaks of "metaphysicians" generally as "faithful to the vagueness of their ideas, and definite only in individual assumption," we cannot help feeling that his laudable zeal in advocating a physiological method has warped his judgment as to the merits of those who have been pursuing an opposite mode of inquiry. Practically, too, Dr. Maudsley admits the importance of the studies which he decries; for he frequently quotes with just respect from the works of Hobbes, Hartley, Spinoza, and James Mill. In some parts of his book, and notably so in the chapter on the Sensory Centres and Sensation, we do not find our author quite free from the "vagueness" with which he reproaches the metaphysician; neither do we find, with all his hatred of metaphysics, that he has yet by any means completely emancipated himself from the admitted defects of the metaphysical modes of expression. How, by the bye, does he explain the title of his book? Was it impossible to have chosen one more metaphysical than "The Physiology and Pathology of the Mind"? In this case, to use his own language, "the abstraction from the particular is converted into an objective entity;" and, if we looked at the outside of the book only, we might be led to suppose that Dr. Maudsley was himself doing that which he so much condemns—namely, "unwarrantably separating, by an absolute barrier, the mind from the body." A perusal of some of its contents would, however, soon undeceive us, and would show that, for some reason, the author has chosen to label a treatise of a most "positive" kind with one of the most metaphysical of titles. A super-scription more in harmony with his own views would have been, *The Physiology and Pathology of the Brain and Spinal Cord*, with a notice in the preface to the effect that the pathology was only partially treated on, so far as it bore on insanity.