On the

Electrolysis of Malignant Tumours,

with a

Description of a New Regulator.

By Roderick J. J. Macdonald.
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Experience seems to show that Malignant Tumours which have been removed by electrolysis do not evince so strong a tendency, either to return in the wound, or to produce secondary infection of the system, as do those which have been excised in the usual way by the knife, and therefore this method deserves a calm investigation and a patient trial.

Many cases of the successful application of electrolysis have been put on record among which the following case of Dr. Neffels is quoted:  

Medical Electricity J. Althaus M.D. 2nd Edt. p. 648
by Dr. Althaus.

The patient was a member of the American Congress, and aged fifty-six. In 1868 he consulted a number of eminent surgeons both in London and Paris who were unanimous in their opinion concerning the cancerous nature of the tumour, which occupied the left mammillary region. They all refused to operate as the case was even then looked upon as one of general infection of the system, and it was therefore thought that a surgical operation would only accelerate the inevitable fatal result. The tumour was however eventually excised by Dr. Marion Sims in Paris. Soon after the wound had healed, the axillary glands of the left side began to enlarge and formed in January 1869 a hard swelling of the size of a fist. The patient and Dr. Sims were both at that time in New York, and the same surgeon again excised the tumour which was exhibited at a meeting of the Pathological Society of New York, and examined microscopically by competent histologists who pronounced it
to be cancerous. Diffuse erysipelas set in after the second operation with fever and severe constitutional disturbance. The temperature rose to 106°F and there were rigors and delirium. The patient rallied after a time but the wound healed very slowly. Grafting was hardly completed when a fresh tumour began to develop in the right mammillary region which grew rapidly and soon attained the size of an orange.

Further surgical proceedings now appeared inadmissible especially as the general health of the patient had given way. Dr. Heffel therefore proposed the electrolytic treatment. He introduced on three separate occasions in April and May 1869 at first two, then three, and lastly four gilt needles separately into the tumour and connected them by means of the series-fuses conductor with the negative pole of a Danielli's battery the positive electrode being placed on the skin in the neighbourhood of the tumour. He began with a current of ten cells which was
gradually increased to thirty. The first operation lasted two, the second five, and the third ten minutes. The needles were removed without any haemorrhage taking place.

Immediately after the operation the tumour appeared considerably larger from the hydrogen which had been evolved in it, but it was softer and more elastic to the touch. No fever or other unpleasant symptoms supervened. On the contrary the patient who had been very feeble anaemic and cachectic, became stronger from day to day, and the tumour gradually began to shrink. Two months after the first application it had almost entirely disappeared, and three months after no trace of it was left. The general health of the patient had improved pari passu, and was, when last seen excellent. No fresh tumour had appeared anywhere.

One year and a half after treatment Dr. Neistel reported that the patient continued well, and stated that he had similarly

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New York Medical Record 1 Oct 1870 p. 385
treated eleven other malignant tumours, mostly sarcomas, with successful results and that in no case had the tumours returned.

Prof. Eppch of Almutz reports four cases of Sarcoma and two of Lupus which were cured. Of eighteen cases of cancer chiefly Epithelomas of the lip, thirteen were cured, two were improved, in two there were no results, and one died. In one of these cases there was ulceration of the lower lip and the whole of the chin and the corresponding part of the lower jaw was covered with debility. Both submaxillary glands were engorged. Four applications were sufficient to destroy the tumour which was followed by good cicatrization.

In a case of Myxo-Sarcoma of the leg of the size of a child's head in which the current was made to act from the 27th January to the 13th February, suppuration supervened and the patient was discharged cured on the 15th April.

London Medical Record, 5th March 1873.
An osteo-sarcoma of the right thigh larger than a child's head, and a secondary cancer of the mamma were also removed.

Prof. Semmola, Univ. of Naples, gives six cases in five of which amputation had been recommended by experienced surgeons. They were, epithelioma of the breast of the size of an orange; a filio-sarcoma and three sarcomata of the breast, and a cysto-sarcoma of the upper third of the arm. He used steel needles and Stöhrer's and Onimus' batteries. With Stöhrer's the deviation of the galvanometer was 90° and with Onimus' from 60° to 75°. In small tumours one needle was inserted but as a rule he found it better to pass both needles deeply into the tumour converging them near its centre. The constant current was applied as many as three times in the twenty-four hours and allowed to flow for an hour at a time.
In one case the treatment was ended in twenty-four sittings, in another it extended over seven months. In the cystic sarcoma inflammation and destructive suppuration set in. After two applications of electricity.

Mr. R. Newmann records¹ a case of Mammary cancer which was excited and recurred in the cretina but was afterwards treated successfully by electrodysis.

Mellor Bead and Rockwell relate² a case of epithelioma of the lip which was cured by electrodysis. The patient, a female, aged sixty-five noticed a small hard lump of the size of a pea on the left side of the lower lip in Sept. 1871. On Jan'y. 19th 1872, it had reached the middle line. The surface was warty and bled readily. The growth was treated for twenty-five minutes with five uninsulated needles, and eighteen

¹ New York Medical Record 1881, xx, 706-709
² De loco. 1872 Vol ii, p. 292
cells, and in two days the entire tumour had sloughed away.

The following is another of their cases:


Mrs A—, of Chicago, fell under our observation Sept. 4th, 1856. Since the 1st Meh. there had been a tumour on the right breast, that had gradually increased in size. The tumour was the size of a hen's egg, and was hard to the touch. At times she had suffered from intense lancinating pain. A number of medical men in the West had seen the tumour and had pronounced it to be cancer, and had advised its removal by the knife. She distress of the patient after she had learned the true nature of her disease was very great. As an experiment purely, and in the hope only of being able temporarily to relieve the pain, we tried faradisation of the tumour. After the second application there was a manifest diminution in size, and the pain

'“Medical and Surgical Electricity,” M. B. Beard & Rockwell 1871, p. 657.'
was notably diminished. After the fifth application Sept. 14, both the tumour and the pain had entirely disappeared: The patient left the city overjoyed with the result. Since that time we have heard nothing of her.

They were the first to treat tumours by Faradic electrolyzation. Their plan is to apply the Faradic current externally by means of moist sponges while the galvanic current is allowed to operate internally by means of needles connected with the negative pole. In this treatment the tumour is submitted to a three-fold action - the electrolytic processes of the galvanic current, the mechanical action of the Faradic current and also its local anaesthesia which somewhat diminishes the pain of the electrolyzation.

Mr. Boyd Wallace showed models illustrating the treatment of zygoma by electrolysis at the meeting of the Odontological Society, 5th March 1883. In one case, that of a lady a large zygoma

of six years' growth sprouting from the back of the upper jaw had been entirely removed by this means. The treatment however extended over six months. Another softer and more vascular growth had been destroyed by electrolipos in six sittings.

'"During electrolipos a three-fold action goes on viz. 1. Decomposition of the fluid constituents of the tumour 2. Absorption which in some cases is not observed during treatment but goes on slowly for some weeks afterwards and 3. Disintegration and Atrophy. Oxygen and Airions go to the positive pole while Hydrogen Alkalis and colouring matter go to the negative. The action at the negative is much greater than at the positive. Water is lost, the tissues become drier and the fibres begin to lose their adherence and fall apart. The electrolytic process becomes less and less active because there is less fluid on which to act. In some hours after the needles are removed the process of drying and

Disintegration goes on until the portion that lies between and near the pores shrivels and contracts.

Dr. Althaus studied the action of the current upon the various tissues of the body and observed:
1. That no animal tissue can resist the disintegrating effect of the cathode.
2. That the rapidity of its action depends on a. The electromotive force employed.
   b. The density of the tissue.
   Bone resisted for a very long time but ultimately yielded.
3. That the action at the Negative pole is,
   a. Mechanical — the evolved hydrogen separating the tissue elements, and
   b. Chemical — the alkalies acting as a caustic.

In living bodies he noticed that the part electrolysed shrunk or atrophied without either suppuration or sloughing occurring. He considers that "electrolysis acts by profound...

Medical Electricity 2nd ed. p.
by modifying the nutrition of the parts.

D. Gemmola considers that it cures in one of three ways, either

1. By producing small foci of inflammation with consequent sclerosis the tumour being converted into a small indurated and harmless lump.

2. By producing a colloid and fatty degeneration especially in tumours which have this tendency.

3. By exciting destructive inflammation with suppuration of the tumour.

D. Nefke is inclined to believe that electrolysis produces remote constitutional effects by altering the condition of the protoplasm of the cells in which the poison of the cancer is contained, and by the propagation of which the disease becomes constitutional. As soon as the protoplasm has by the electrolytic process lost its specific contagious qualities the cancer is pre.


rented from reproducing itself and gradually disappears through the process of absorption.

It seems to me that malignant growths not only wear out the patient by pain, and by diverting nutrition from other organs but also that their poisonous products deteriorate the blood and thus help to bring about the characteristic cachexia.

I am inclined to believe also that the system has a certain resisting and eliminating power which enables it whilst a tumour is small to throw off these poisonous products as they are formed as well as to prevent its cancer-cells from lodging permanently in other organs and so to escape from general infection for a time; but that in the case of a large tumour the system is poisoned by the excess of products which it is unable to dispose of.

And I think that in many operations by the knife in which the incisions are not made wide of the disease, the spec-
ific cells and plasma are suddenly, mechanically, liberated in large quantity in the wound, absorbed by the open veins of minute veins and lymphatics and swept into the blood stream, causing rapid constitutional infection, secondary tumours in internal organs and a return of the disease in the wound itself. In some of these cases it would hardly be correct to speak of the disease as returning in the wound, because it has not been entirely removed from it. And when Paquelino's thermo-cautery is used the wounded surface is as large as in excision by the knife and not infrequently the assistant who has charge of the hand-bag varies the supply of air so that at times during the operation the cautery is at a white heat and cuts like a knife. In electrolysis, on the other hand, the wounded surfaces are very small, and are occluded by the presence of the needle in the wound, and when the current begins to flow, if the needles be of zinc, the caustic action of the alkaline which appears at the trinitrate end of the chlorate
Of zinc at the anode destroys those surfaces first of all at which secondary infection would be most liable to occur. On this account therefore it seems to me that the risk of secondary infection at the time of the operation is very great in operations by the knife, and considerably diminished by Paquelin's cautery, but that by electrolysis it is almost entirely overcome. It is probable that the protoplasm of the malignant cells is altered so that their vitality is lessened and their activity lessened and either they degenerate partially, atrophy, and become absorbed, or else sloughing and suppuration occur and the ulcer which is left granulates and heals.

Prof. Groth considers the following to be some of the advantages and disadvantages of this method:

1. Very extensive tumours may be destroyed without the loss of a drop of blood, which is important where there is great prostration.

In some cases of small tumours especially where there was any hope of procuring absorption of the tumour without suppuration and sloughing, it would be an advantage to use needles insulated for one third their length with hard rubber, coccolide, or shellac.

Squier Mann has described a needle insulated with shellac. The shellac is applied by heat care being taken to avoid too high a temperature as, if the heat be excessive, the lac will become fissured. The point of the anodal needle will become fissured yet the insulation remains perfect.

Insulation however is not absolutely necessary. When it is desirable to use several needles the silver or nickel conductor, recommended by Althaus serves the purpose admirably.

Gold or gilt and platinum needles have no caustic effect.

Electrolysis is chiefly obtained by the galvanic
current but can be produced both by the electro- magnetic and magneto- electric.

In the purposes of electrolysis intensity with moderate or fair quantity is required such as is obtained by a considerable number of elements of medium size. Major Beard and Rockwell found 2, by the decomposition of a solution of iodide of Potassium that a given number of large Smee's elements produce greater decomposition than the same number of small Smee's elements with the same solution.

Stöhrer's zinc-carbon battery when freshly charged causes in a given time much more decomposition than the same number of Smee's elements of pretty nearly equal size, but that it rapidly weakens when much used.

For electrolytic purposes large elements are preferable to small especially when hard tumours are to be treated, and if small cells are used the application must be more protracted.

Dr. Althaus describes a battery he used as Medical and Surgical Electricity, p. 634 and 636.
consisting of fifteen modified Daniell cells made of vulcanite because it is lighter than porcelain. Instead of a porous cell being used, the copper of the pole was perforated and the holes filled up with leather, which is easily penetrated by moisture. The zinc is then immersed in water, the copper vessel being filled with a solution of sulphate of copper, and in order to prevent the liquids from spilling when the battery is carried about they are mixed with sawdust, so that a dry pile which is still very effective is produced. Every two or three months it should be taken to pieces, the zinc cleaned and a fresh solution of sulphate of copper substituted.

Perhaps the best battery for electrolysis is the zinc-carbon battery with dichromate of potash and dilute sulphuric acid.

In all operations with batteries the strength of the current ought to be measured by the galvanoscope and definitely known. Dr. de Watteville recommends the milliampere as a useful unit.

A de Watteville - Medical Electricity 2nd Ed. p. 67.
with which to graduate a galvanoscope.

He also says: "It is useless to attempt to dissolve solid tumours of a malignant character; the only hopeful plan is to insert numerous large needles along their base so as to separate the whole diseased mass from the healthy underlying tissue, and leave the ulcer to granulate and skin over. Powerful currents and long-continued applications are necessary for the purpose. The advantage of the plan is that it avoids the complications attending a knife operation and its after-treatment. Nodules of cancer growing from the cicatrix of previous removal may be conveniently treated by this method.

Electrolysis appears to have a sedative effect on the pain of cancer and deserves a more extensive trial in this respect than it has hitherto had."

In most cases a constant current of from twenty to thirty cells of the Fournaise

*Medical Electricity*, 2nd Ed., p. 201.
battery applied twice or three times a day, for five minutes at a time, with the anode upon the seat of pain and the cathode applied centrally, will give marked relief. I think in every case possible it ought to be tried before commencing the administration of Morphine, Chloral +.

In electrolysis both poles may be made to operate simultaneously, or only the negative pole the current being completed by placing the positive connected with an ordinary sponge electrode on some indifferent part.

It is best to begin in the first operation with a small number of cells and short séances.

Sometimes a number of séances are necessary in other cases one is sufficient. Intervals of one two or three days and even much longer are required to secure the full after-effects of the treatment. A steady uninterrupted current is required.
19. Aletheus recommends that if a case of malignant disease is treated by this plan it should have one thoroughly energetic and long application under chloroform or ether so as to destroy the connexion of the tumour with the subjacent parts. Fifteen or twenty needles may be required, according to the size of the tumour and they should all be alternately connected with the positive and negative pole. For a large seiriusus about two hours will be required. Short and frequently repeated more gentle applications of the electricity do not do much good in malignant disease except to relieve pain. If zinc needles be used the caustic action is obtained in addition to the electrolytic which is an advantage.

In this paper I have allowed various authorities to speak at considerable length and have said little myself because

"Private letter"
they have had great experience of this method and none, but I hope to give it at no very distant day a careful and interested trial.

I cannot conclude better than in the enthusiastic words of Melpo Beard and Rockwell—"Electrolysis is not only a very important branch of electro-surgery but in its scientific and practical relations, and in its application to disease it is one of the most fascinating studies to which the human mind can be brought and is therefore worthy of and must everywhere receive the systematic attention of the medical profession."
Description of a New Regulator.

Admirable as our Medical batteries are, there is room for their improvement both as regards portability and price. Probably it is on this latter account that the generality of medical practitioners are not provided with the batteries and necessary appliances. If they could be procured more easily, they would be used more frequently, and both our knowledge of electro-therapeutics and our patients' interests would be advanced.

"In medical batteries the elements are so arranged by the manufacturer that their rearrangement is beyond the control of the medical man and we are always compelled to use two separate batteries for electro-therapy and the galvanic current" 1; now it was my aim to place the arrangement and rearrangement of the elements within the practitioner's control, and thus

1 Electricity in Medicine & Surgery - G.V. Poore MD. P. 19.
to enable him to accomplish with the aid of a single battery all the work which is usually performed by two. In a battery composed of small elements the size of the plates may be practically increased by uniting all the generating plates together, and all the collecting plates together.

Meyer and Meltzer have supplied a battery with small plates for the galvanic cautery and écraseur. It consists of twenty-seven pairs of zinc and carbon plates each plate having a superficial area of three inches by one and a half. All the zinc plates are connected together and all the carbon plates together and the exciting fluid is a solution of bichromate of potash to which sulphuric acid has been added. It is necessary to keep the fluid constantly in motion, and this has been accomplished by a simple contrivance by means of which the elements can be made to rock to and fro in

the cells. Such a battery would do for medical purposes also if the coupling of the elements could be readily altered. To accomplish this I have designed a New Regulator. The Diagram, page 28 shows it constructed for a battery of fifty cells. A is a disc of some insulating material which, instead of having one circle of metallic buttons as is usual, in this case is provided with two.

Each generating plate is connected by wire with the under surface of one of the buttons of the external circle and each collecting plate in the same way with one of the buttons of the internal circle. (Vide, Diagram D, p. 29).

All the buttons of the external circle therefore are negative and the internal positive.

The alteration in the coupling is done upon the surface with switches.

The alternate buttons (distinguished in the Diagram A by a double outline, thus ☺), are each provided with two switches.

When the elements are to be arranged in series, Diagram 13, for electro-therapy
the switches must be turned diagonally as indicated by lines drawn upon the Regulator.

When, on the other hand, the elements are to be arranged for the galvanic cautery the switches should be placed so as to form two being lines as in C page 28.

The large central switch regulates the strength of the current by including few or many cells within the circuit according to the requirements of the case.

When the elements are arranged as in B and more cells are about to be included in the circuit some of the switches of the inner circle should first be turned longitudinally so that the central switch may pass along to its new position without breaking the circuit and causing an unpleasant shock, or the free extremity of the central switch might be made broad enough to come into contact with the next button before leaving the other as in Smith's double collector.

As the combined electromotive force of a number of cells arranged in series is equal to the electromotive force of the weakest of the series multiplied by the number used
in a battery where the first ten cells are used much more frequently than the others, we ought to be able to omit them and select the cells which are in a more perfect condition. To accomplish this the wire (a) would be disconnected from the under surface of the first negative button and connected up to the eleventh.

The commutator is omitted from the diagram for the sake of simplicity.

A page 29 is a drawing of one of the small switchets.

The switches of those cells not in use for the time being should be turned aside to prevent wasteful action.

The advantages of the Regulator are twofold viz that it will enable one battery to fulfill all purposes, and that the strength of the current can be increased so gradually as by a single cell at a time.

Though no doubt clumsy it is yet I believe an attempt to move in a useful direction, and I hope will soon be superseded by something which will answer the purpose better.
A NEW REGULATOR.