vertigo, and there was no homolateral weakness of the limbs or muscular inco-ordination.

On January 18th the use of the tube was discontinued, the discharge having ceased. It was thought that the tube might be obstructing the sinus, and the latter was kept open by fine forceps during the next two days. Between January 20th and 29th, apart from a quick pulse and a moderate pyrexia, there were all the indications of excellent progress. The eye changes disappeared except the nystagmus, incontinence ceased, and the appetite was fully restored. The mind was clear and animated. On January 31st a sudden relapse occurred, and the patient became rapidly comatose again. The tube was reinserted, but for several days she remained in a moribund condition, and could not be induced to swallow more than an occasional teaspoonful of water. Hiccup was a prominent symptom at this stage.

After these critical days had passed rapid improvement set in. The pulse and temperature remained normal and progress was uninterrupted. The tube drained freely and was left in for a fortnight, until it could no longer be inserted.

During the whole of this period the tube was taken out for cleaning twice daily. It remained, however, stitched to the skin all the time, so that there was no uncertainty in reintroducing it to the proper depth. The girl was able to get up on February 19th and returned home on February 25th. Since then she has made unremitting progress. The nystagmus disappeared in a week or two. Now, at the end of April, she is in vigorous health and entirely free from any ill effects of her serious illness.

CONCLUSIONS

The conclusions to be drawn from this case are:

1. That brain abscess may develop insidiously, and that the first intimation may be incipient coma.

2. That a hypodermic syringe may discover pus when other means fail.

3. That drainage should be continued as long as possible; for this purpose a very small tube may be adequate, the pus escaping alongside it rather than through it.

THE TECHNIQUE OF SURGICAL DIATHERMY

DESCRIBING A NEW ELECTRODE

BY

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The electric current employed in diathermy treatment and for surgical operations is of the nature of a high-frequency current. D'Arsonval (1895) showed that an alternating electric current, making and breaking about 15 times per second, would produce clonic contraction of isolated muscle preparations when tested *in vitro*. When the frequency of the current was increased 20 to 30 times per second tonic spasm was observed. The severity of the muscular contraction was augmented as the frequency was increased up to 300 cycles per second. Beyond this optimum the response of such muscle preparations to electrical stimuli diminished, and at about 10,000 times per second muscular spasm ceased and heat was developed. Electric currents which oscillate at 10,000 times per second are known as high-frequency currents; they have an entirely separate physiological action on tissues, as they cause heating, in contrast to lower frequency currents, which cause muscular contraction.

HIGH-FREQUENCY CURRENTS IN DIATHERMY

High-frequency electrical currents which are employed in diathermy or for surgical operations are obtained by means of coils and condensers. The main alternating current supply of 100 to 250 volts, and frequency of 50 to 60 cycles per second, is connected to the primary coil of a transformer; by this means a high voltage alternating current is developed in the secondary coil, which is connected to a series of condensers storing up the electrical charge until the voltage is sufficiently high to cause discharge through a spark-gap. The condensers are immediately recharged, and the process is repeated. With modern diathermy apparatus these oscillations are continuously maintained. The oscillating high-frequency current is taken up by a resonance coil of low resistance, and a second circuit is connected to the patient, which, when properly applied, produces the effects of diathermy. In place of the spark-gap, thermionic valves, three-electrode valves, or grid valves may be employed; these give a smoother current, which is perfectly continuous, but have the disadvantage that they are fragile and costly; further, they cannot carry a very heavy load of current. By such methods it is possible to obtain a high-frequency current of 3,000,000 cycles per second. Currents of electricity travel at a constant speed of 300,000 kilometres per second, but the nature of the wave-length transmitted varies with the frequency. Thus, a wave-length of 300 metres corresponds to a frequency of 1,000,000 cycles per second. The nature of the vibration of an oscillating current may be similar to the motion of a vibrating violin string, or it may be a series of undulating waves of uniform magnitude. The former are called damped oscillations, and the latter undamped oscillations. The thermionic valve apparatus emits a continuous flow of undamped oscillations; the apparatus containing spark-gaps produces damped oscillations. Each type of high-frequency current, differing in wave-length, causes variable reactions when applied to living tissue. The biological action of high-frequency current depends upon: (1) the intensity or amperage; (2) the tension or voltage; (3) the frequency of wave-length; (4) the nature of the oscillations; (5) the size of the electrodes; and (6) the electrical conduction of the living tissue. The amperage, voltage, and frequency directly control the intensity and dissipation of electrical energy, and therefore regulate the quantity of energy in terms of electricity or heat. As the amperage is increased the voltage and frequency diminishes; and, as a result, a heavier diffused current is generated, which is suitable for coagulation of tissues, and has greater power of penetration.

SURGICAL DIATHERMY

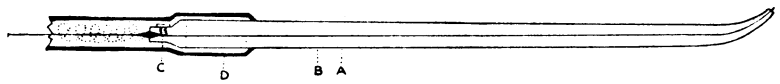
As a rule two electrodes are necessary for surgical diathermy. A large indifferent electrode is attached to a big area of the skin of the limbs or abdomen, and allows a wide path for the current to be generated to the body. This is discharged at the point of contact with the second active electrode. The size of the electrodes are directly proportional to the conduction of heat. Therefore a pin-point electrode will cause a discharge of electrical energy over a small area and result in rapid destruction of tissues by coagulation; whereas a larger plate electrode will have a generally diffused temperature effect over a wide area, which will not be sufficient to destroy tissue, but will only generate heat. The latter is the principle involved in therapeutic uses of diathermy. In order to obtain a maximum effect of deep penetration, a long wave-length current is applied by generating electricity at a high amperage, low voltage, and low frequency of damped oscillations. The maximum warmth the patient will tolerate is carried to the site of application by two large lead plates, copper foil or mesh, which are employed as the active electrodes.

Coagulation and Excision Technique

In surgical diathermy high-frequency currents are employed in two ways: (1) for the destruction of tissue by coagulation; and (2) for direct excision, similar to excision by a surgical knife. For coagulation, the active electrode is, as a rule, a small metal button or ball of varying shape and size, attached to an insulated handle and rubber-covered flex. The whole should be designed so that it can be completely sterilized. The extent and depth of coagulation is regulated by: (1) the intensity of the diathermy current; (2) the time the electrode is in contact with the tissues; and (3) the nature of the electrical conductivity of the tissues. For this purpose spark-gap diathermy apparatus is superior, as it permits a heavier load of current to be generated. This is desirable when coagulating large areas of diseased tissue. A current of relatively high amperage (1 to 20 amperes), low voltage and low frequency (under 1,000,000 cycles per second) is employed. Firm pressure should be applied, and the diseased tissue should be slowly coagulated. If too much current is employed, sparking, fulguration, and haemorrhage will result, which will rapidly cause a charred dry scab; as this is a poor conductor, it will inhibit the passage of further current; by consequence there will be only a superficial destruction of tissue, the diseased parts of which will remain within the depth of the lesion. In coagulation technique a "white reaction" should be obtained rather than a black eschar. After the coagulation operation is completed, it may at times be necessary to fulgurate the surface of a lesion, or the coagulated region may be completely excised by the cutting current and the excision technique. At first the active electrode should be firmly applied to the diseased tissue; the apparatus is then switched on with the indicator dial at the zero mark, and the current is gradually increased until "white coagulation" can be seen spreading around the margin of the electrode; the switch is then turned off and the electrode is moved, and a further area of diseased tissue is coagulated in a similar manner. If the active electrode is applied with too heavy a load of current passing through, only charring and sparking of the surface layers will result, and the deeper layers will not be heated. Similarly, sparking will occur if the active electrode is suddenly released before the apparatus is switched off. The depth of coagulation can be controlled by regulation of the intensity of the current, by the size of the active electrode, and by the time it is in contact with the tissues. Whenever it is practicable, coagulation should be continued until it can be seen that it has penetrated throughout the depth of the diseased tissue to the surface layer of the healthy tissue. Rapid coagulation, the use of small electrodes, or excessive current are to be avoided. The coagulation may be further controlled by the use of a thermo-couple embedded in a hollow needle, and in this way the temperature at any given region can be recorded by observation of the deflection of the needle of a sensitive galvanometer. Cutting tissues by means of the diathermy current involves a technique which is different from the methods of coagulation. A diathermy current of short wave-length, low amperage (100 to 200 milliamperes), higher voltage (4,000 to 8,000), and a frequency of 3,000,000 oscillations per second is usually generated. The active electrode is a fine needle or a wire loop. The object of such operations is to cut tissues cleanly with the minimum diffusion of coagulation beyond the limits of the incised area. In this way a bloodless incision is attempted, which, after suture, should heal by first intention. Many types of active cutting electrodes have been described. Many of them are too long and do not allow the depth of incision to be controlled. Others are too thick, and cause diffused coagulation.

AUTHOR'S CUTTING ELECTRODE

Recently I have designed a new type of active electrode (see Fig.) so that it could be used for accurate incision and dissection of tissue with the same safety as the surgeon's scalpel.



Diathermy knife. A, Quartz rod and capillary bore; B, Molybdenum wire; C, Screw for adjusting free end; D, Rubber tubing.

This electrode consists of a molybdenum wire which projects 2 mm. beyond a quartz rod. This quartz rod is about 9 inches long and is tapered and bent at its end; a capillary hole is bored throughout its whole length, and the molybdenum wire is threaded through the fine hole and projects for 1 to 2 mm.; this can be regulated and adjusted by a clamping screw. The molybdenum wire is connected to some copper flex, which is covered by rubber tubing throughout its whole length, and is attached to the outer wall of the terminal half-inch of the quartz rod. In this way the electrode is completely and safely insulated, and can be readily sterilized by boiling. Since fused quartz can withstand high temperature, rapid cooling, and is a good insulator, there is no danger that this electrode will be damaged or crack. The electrode can be used repeatedly, as it is rustless and is not softened or damaged by high temperature or oxidation. The length of the active end of this electrode is roughly 2 mm., and it is surrounded by the quartz capillary bored rod and therefore is well insulated.

By this means it is possible to cut and dissect tissues carefully and to operate on vascular areas, avoiding the important large blood vessels and nerves. The depth of the incision can always be controlled with the same care as with the scalpel. Pressure on the electrode should be avoided, for the incision is made by the electrical discharge from the point of the active electrode.

Operative Technique

Skin and muscle are readily incised, but fat and hard scar tissue are more difficult to deal with, as they are poor conductors of electricity. A heavier current is necessary, and at times the dissection of a mass of fat will prove difficult and laborious. The electrode should be used with a rapid light stroking movement; for if it is left in contact with tissues for long, diffuse coagulation will result. Bleeding is rarely excessive, except from the larger blood vessels, which should be clamped in the usual way, and later sealed off by applying the point of the electrode to the pressure forceps and changing over from the cutting to the coagulating diathermy current. It is advisable to ligature larger blood vessels by the usual methods. The control of the diathermy current during operations needs skill and knowledge. The current should be slowly regulated to obtain the correct cutting effect so that the coagulation does not spread further than 0.3 mm. The intensity must be regulated from time to time during the whole operation to compensate for the changes in conductivity of the various tissues—that is, skin, fatty tissue, muscle, and scar tissue. Excessive discharge of current or incorrect frequency will cause sparking, and result in diffused coagulation. Operation by the diathermy current produces a sterile and almost bloodless incision; the lymphatics are sealed off and the danger of dissemination of malignant cells or bacteria is diminished. The heat caused by the high-frequency current counteracts the surgical shock following exposure of wide areas of tissues, which are quite warm after diathermy operations.

Indications for Operation

This method of operation has been employed for:

1. The excision of areas of disease of the tongue and palate.
2. The excision of malignant disease of the breast.
3. Excision of areas of necrosis and ulceration following malignant disease.
4. Radium and *x*-ray necrosis and ulceration.
5. Excision of tissue in vascular areas, in which it is difficult to control haemorrhage by other means (bladder and brain).

The cases which have been selected for diathermy were those in which surgical operation by other means would be difficult owing to the danger of haemorrhage or the inability to dissect successfully the adherent masses of scar tissue. The operation for excision of the breast by diathermy has invariably healed by first intention. At times it has been possible to excise a mass of adherent malignant glands, even when in close proximity to the axillary vessels. Foul and sloughing malignant ulcers have been excised, and the base has been coagulated, leaving clean granulating surfaces with consequent relief of pain and discomfort. It has been possible to heal cases of *x*-ray ulcerations and radium burns in the same way, such treatment giving immediate relief of the pain associated with these lesions. After diathermy operations a solution of flavine in liquid paraffin applied once every day is a suitable dressing. On the seventh to tenth day after operation a slough separates, leaving a clean granulating surface. Healing at this stage may be accelerated by means of ultra-violet irradiation. In successful cases wide areas may be excised or destroyed by the diathermy current, and will finally heal completely without the necessity of skin graft. Diathermy operations of the tongue, tonsil, and palate cause more severe reaction; oedema is marked, and secondary haemorrhage may occur at the stage of separation of the slough. It is more difficult to obtain healing by first intention. I have attempted to dissect tonsils by means of the cutting diathermy current with the help of Mr. E. Steeler. In all, twenty cases were done. We obtained good results in eighteen cases, but in two cases secondary haemorrhage occurred nine days after operation. The destruction of enlarged tonsils by the technique of coagulation has given favourable results in adult patients. Surgical diathermy is a very useful agent for the removal and destruction of naevi, moles, and warts. The operation is rapid and bloodless, it can be performed without anaesthesia, and results in a successful healing with no unpleasant disfigurement or scar.

I am indebted to Mr. Stanford Cade and Mr. Douglas Harmer for their valuable help in giving me the opportunity to assist them at operations.

Memoranda

MEDICAL, SURGICAL, OBSTETRICAL

SUICIDAL CUT THROAT: RECOVERY

The following case of a suicidal cut throat recovering, after very severe injuries, seems of sufficient interest to publish.

On January 19th, 1931, in answer to an urgent call to the receiving ward at the West Middlesex Hospital, I found a well-nourished man, aged 30, sitting fully dressed, with a loose scarf bandage draped around his neck, and his head slightly flexed and rotated to the left. On examination I found the patient almost aphonic, with a circular cut in the neck 5 inches in length, extending from about 1 inch to the right of the mid-line, to 4 inches to the left of the mid-line, at the level of the upper border of the thyroid cartilage. There was comparatively little bleeding, although the cut extended through all soft tissues, including the infrahyoid group of muscles, the thyrohyoid membrane, the tip of the epiglottis, and the lateral walls of the pharynx, back to the vertebrae. There was abundant discharge of mucus. Temperature 97°, pulse 130, respirations 24.

I learned that this was a suicidal cut, inflicted with an ordinary razor in a moment of financial anxiety. I ordered a hypodermic injection of morphine 1/4 grain to be given statim. After consultation with the medical superintendent, Dr. J. B. Cook, we decided against any attempt at surgical repair. Warm saline dressings were applied to the neck, and rectal glucose and coffee salines were given six-hourly: also a hypodermic injection of adrenaline co. 1 in 1,000, with atrop. sulph. 1/200 grain, and strychnine hydrochlor. 1/100 grain.

On January 22nd the patient started taking sips of water and diluted milk by mouth; the rectal salines were gradually discontinued, and by the 25th he was taking an ordinary fluid diet and the neck wound was healing up rapidly. On February 17th the patient started getting up; and, except for an attack of influenza which developed on the 22nd, he made an uninterrupted recovery. He was bright, and quite normal mentally, during the whole of his stay in hospital, and was discharged cured on March 19th.

I have to thank the medical superintendent for allowing me to publish these notes.

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TREATMENT OF PERNICIOUS ANAEMIA

The following brief history of a case of pernicious anaemia, which I have had under my observation for nearly three years, and now appears to be cured, may be of some interest from the point of view of treatment.

I first saw the patient, a man aged 54, on July 24th, 1928. He was then complaining of shortness of breath and weakness. His heart was dilated, auscultation revealing a mitral systolic murmur, and there was some oedema of both legs; he was very pale, and at first I thought of aortic disease. He gave a history of not feeling well for a year, and of having weakness in the right arm and leg. The knee-jerk on the right side was very feeble, and the hand-grip on the same side was weak. Examination of a blood film showed a typical picture of pernicious anaemia, with the exception that there were very few nucleated red cells. I was at the time unable to make a blood count, but the haemoglobin was 60 per cent. There were some petechiae scattered over the chest and back.

I prescribed half a pound of raw liver daily, and 5 minims of liquor arsenicalis and 10 grains of ferri et ammon. cit. to be taken three times a day. The patient responded fairly quickly, so that on September 11th the haemoglobin was 80 per cent., and on October 6th 90 per cent. The dose of liquor arsenicalis had been increased to 8 minims. He ceased attending in the early part of October.

He again appeared in June, 1929. His condition had deteriorated, and his haemoglobin was only 60 per cent. He had acquired a distaste for raw liver, and had not been taking it very regularly, I think. I put him on liver extract, in full doses, and the arsenic mixture as before. On July 20th a blood count showed 1,800,000 red cells per c.mm., and the haemoglobin was 75 per cent. Instead of the arsenic mixture dilute hydrochloric acid was given in 30-minim doses three times a day, with tincture of nux vomica and gentian. On October 17th the red cell count was 1,250,000 and the haemoglobin 60 per cent. On October 21st the haemoglobin had gone up to 80 per cent. He was now taking raw liver as much as possible, and the extract only at intervals.

He did not attend again until April 19th, 1930. His condition was then so grave that I suggested treatment in a hospital, with a view to transfusion of blood, but he would not agree to this. He was extremely weak and dyspnoeic. His right leg had again become weak. A blood count showed that the red cells were down to 950,000 per c.mm., and the haemoglobin was 50 per cent. Throughout his illness he had an extremely high colour index. His appetite was very poor, and he found it impossible to take raw liver on account of the nausea and loathing it produced. He had been receiving the equivalent of 6 ounces of liver, as liver extract, daily. I now gave him 1 drachm of glycerin of pepsin, with 30 minims of dilute hydrochloric acid (later increased to 40 minims), and 10 minims of tincture of nux vomica, three