I introduced my drainage from below at the end of the operation, and probably on account of faulty disposition this led to the only complication encountered in the after-treatment, for a small haematoma formed in the dead space between the two pairs of flaps and came away per vaginam about the fifth day, a little colicky pain preceding this event. The trouble was at an end within thirty-six hours. The margins of the upper segment of the divided vagina were now approximated by interrupted sutures, the opening in the floor of the bladder being thus closed.

By the above procedure both pairs of flaps were turned with their epithelial surfaces everted, and the attempt was made to arrange for some appreciable space to intervene between the new vaginal vault and the suture line in the bladder base. The greater the distance, within reason, between these two structures the greater the security against leakage of urine—temporary or permanent.

The bladder was closed around a tube in the usual way, care being taken to ensure that the end of the tube did not press on the repair in the bladder floor. My personal preference is for keeping the bladder dry by suprapubic suction, and this was used. After a few days of suction drainage a self-retaining urethral catheter was substituted, being retained for a week. The suprapubic wound remained dry throughout, and convalescence was uneventful except for the small incident of the haematoma. The suprapubic wound sealed immediately after removal of the tube and healed virtually per primam, but as a precautionary measure the patient was kept in bed for three weeks.

Result

The patient was re-examined seven weeks after the operation, when she said she was in excellent health and was continent. The bladder, however, was still a little irritable, and if the call to micturate was not immediately obeyed a drop or two of urine might be lost involuntarily. This was quite evidently an active incontinence resulting from a cystitis which had not completely subsided, and was not due to leakage through the fistula. Vaginal examination revealed a longer tube than I had expected, it being estimated as one and three-quarter inches to two inches in length. The vault was firmly united.

At cystoscopy the urine withdrawn from the bladder was faintly turbid, and on microscopical investigation showed a few pus cells and some scanty organisms. The usual 200 c.cm. of fluid was used for the examination without discomfort. The mucosa of the body of the bladder was of normal appearance and vascularity. The neck, trigone, and ureteric orifices showed a moderate degree of oedema, accounting for the slight bladder irritability above noted.

The operation area was the centre of chief interest. The vaginal implant formed a large shallow depression. There was not a great deal of overhang, so that every portion of its walls was in full view. The mucosa lining it was indistinguishable from bladder mucosa. It had the same sandy colour, the same individual vascular stems emerging through the membrane and breaking up into tufts. If I had not known its origin I should have regarded it as healthy vesical mucosa. There was no sign of inflammatory reaction here. At the highest point a puckered scar marked the position previously occupied by the cervix. The line of junction between the vesical and vaginal sections was very evident. It formed a perfect circle, the margins of which were everywhere prominent, but especially so in the lowest third, where they slightly overhung the subjacent trigone. Healing was complete, with no sign of stitch marks. Indigo-carmin was injected intravenously, and appeared early and copiously from each ureteric orifice.

Discussion

The advantage of the operation above described is that it uses thick healthy well-nourished flaps which can be cut to any required size. Thin ill-nourished inadequate flaps and tension are the causes of failure in so many operations for vesico-vaginal fistulae. These features appear to be completely overcome in the case reported. The operation presented no technical difficulties.

How will the vaginal mucosa behave as a constituent part of the bladder wall? This remains to be seen. It is, however, common knowledge that it stays healthy when continuously sodden with urine as in the base of a vesico-vaginal fistula. I believe that it will give no trouble, and the cystoscopic appearances above described support this view.

A shallow sacculus lying above the interureteric bar resulted from this operation. I believe it will drain perfectly. Certainly it should do so in the sitting posture.

Will this operation be applicable when the uterus has not been removed? The presence of a uterus would obviously require the provision of an outlet for menstrual and other discharges. Perhaps it may prove possible to cut the flaps so as to meet this desideratum. If not, the patient would probably be consoled for the loss of her uterus by the cure of so distressing and unsocial a condition as a vesico-vaginal fistula.

TREATMENT OF OUT-PATIENTS BY ELECTRICAL CONVULSANT THERAPY WITH A PORTABLE APPARATUS

BY

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The treatment of various kinds of mental disorder by means of artificially induced convulsions is by now so well known that there is no need to preface an article of this kind with a historical review of the work of other investigators. Furthermore, so many articles dealing with the treatment of schizophrenia with the electrical apparatus designed by Profs. Bini and Cerletti (or modifications of it) have appeared in the medical press during the last year that we do not consider it necessary even to summarize recent work on electrical convulsant therapy.

As the title of this paper suggests, its object is to give some account of a special application of the treatment carried out with a new type of apparatus. In the course of our investigations, as will become apparent later, we were able to observe several interesting clinical phenomena and to simplify the technique employed by other workers. It occurred to us that it has so far been very difficult to evaluate properly the usefulness of convulsant therapy in general, if only for the reason that, for the most part, the treatment has been carried out on mental hospital patients—i.e., patients whose mental disorder was already sufficiently advanced to require their certification or their detention as voluntary patients in a mental hospital environment. One of the great advantages of pyretotherapy in the treatment of dementia paralytica is that the treatment can be undertaken in a general hospital or a private nursing home long before the question of the certification of the patient requires consideration. This led indirectly to the use of pyretotherapy (e.g., by means of the inductotherm) in a great number of clinical conditions unconnected with G.P.I.

All experienced workers are agreed that the success to be expected in the treatment of schizophrenia depends on treating the condition early enough. By "early" we do not wish to emphasize the time factor unduly, but rather to indicate the degree of schizophrenic disintegration. It therefore seemed worth while to us to treat true

borderline cases—i.e., patients who could not, strictly speaking, be considered psychotic, or who had only one leg over the frontier, as it were. The majority of such patients are quite unsuitable for admission to mental hospitals, and do not require in-patient treatment in general hospitals; many of them, in fact, are leading, and continue to lead, a normal life in the outside world. It was with all these considerations in mind that we constructed a cheap, compact portable apparatus for use under out-patient conditions.

Source of Patients and General Procedure

The majority of the subjects treated and under treatment are patients attending the department of psychological medicine at St. Bartholomew's Hospital. Some were treated (and are being treated) in the consulting-room of one of us (E. B. S.), and others—under semi-out-patient conditions—in a private nursing home for the treatment of functional nervous disorders (Riverhead House, Riverhead, near Sevenoaks). The Barts patients received treatment once a week, the others twice. Patients are instructed to cut out the meal preceding their treatment, although they are allowed to have a cup of tea and a piece of toast. The treatment is given with the patients lying on a couch or bed; patients are made to empty their bladders immediately beforehand. They are not required to undress, and they may even retain their shoes. Naturally the collar is loosened in the case of men, and all hard articles which might dig into the patient are removed from the pockets; dentures must of course be removed. The next step is to scrub up the temporal region on both sides with ether soap, thereby removing all traces of sweat, sebum, and grease from the skin and hair. The soap is washed off with saline solution. There appears to be so little anxiety associated with electrical convulsant therapy that the patients almost invariably assist one good-humouredly to adjust the electrodes. This is in striking contrast to what occurs in cardiazol treatment. We have abandoned the use of all contact pastes, which we found to be both messy and unnecessary, although some form of contact paste is advocated by other workers. The patient then has his fit, the voltage used being determined (at least in part) by the skull A.C. resistance. On recovering full consciousness the patient is made to recline quietly on a couch for a short while—anything from half an hour to one hour. He is then perfectly able to return home by an ordinary means of conveyance or even on foot.

Apparatus

The apparatus is of small size, and is housed in a case which is finished in polished black cellulose with chrome carrying-handles. Its approximate dimensions are 14 in. long, 7 in. wide, and 5½ in. deep; weight about 20 lb. It is fitted with three-way earthed plugs, with ejector fuses in both the mains and patient's circuits. It has pilot lights indicating live mains and time switch. The patient's equivalent A.C. resistance is calibrated from 0 to 1,000 ohms and is balanced on a first-grade moving-coil galvanometer with metal rectifier. The voltage selector covers voltages from 20 to 150 by 5-volt stages. The time base covers from 0.1 to 0.5 second and operates an electronic time switch of constant accuracy. (In our first apparatus we used a motor-driven time switch, as shown in the accompanying illustration of the circuit. In that apparatus the patient's resistance was measured by means of direct current.) A push-button operates the electronic time switch and applies the shock. The channel selector switch is in front of the push-button.

The Electrodes, etc.

The electrodes consist of two plates of soft electrode metal, 5 × 4 cm., with rounded corners, with 4 ft. of insulated flex having terminal ends soldered to each plate. We found that

a 3-in. bandage of latex rubber 24 in. long, perforated so as to carry studs, is the most convenient method of holding the electrodes in position. Rectangular rubber sponges, 4 × 5 × 3 cm., placed on top of the metal electrodes, together with the latex bandage, provide a configuring even

Diagram showing the circuit used in the apparatus.

pressure to the electrodes against the head. Two layers of lint soaked in sodium chloride solution of any strength from 20% up to saturation are interposed between the head and the metal electrode.

Resistance

Primarily with a view to obtaining some idea of the voltage to apply across the skull, and in consequence to estimate dosage in terms of current and time, resistance measurements have always been made. There are many ways of measuring resistance to the passage of current, and the nature of the current to be used must be considered, as must also the nature of the resistance or conductor itself. Thus if one passes direct current, alternating current, or high-frequency current through a conductor, the resistance it will offer will vary, depending on whether it is electrolytic, has inductance, or has capacity.

Now in considering the resistance of a part of the human body we must regard it as a complex electrolytic conductor, since it consists of tissues principally bathed in NaCl solution together with a great many other ions also in solution. Previous workers have used a direct-current method to measure, presumably, the resistance offered by the electrolytic body to an alternating current! If a direct current is passed through an electrolyte, electrolysis occurs and conditions arise which tend to oppose the electrolyzing current, but since alternating current cyclically flows in one direction only for 1/100 second, when it changes polarity, direct-current electrolytic changes do not occur. Thus an electrolyte which presents considerable resistance to direct current may present virtually no resistance to alternating current. Moreover, different methods of measuring resistance by direct current will show different readings of the same electrolytic conductors, depending on the amount of electrolysis and the current flowing to make the measurement.

Fleming, Golla, and Walter, using a direct resistance-measuring current of 1 milliampere, find the patient's head resistance to be 450 to 1,200 ohms, while greater resistance than this, they say, suggests faulty electrode contact. Using a similar method, Kalinowsky finds the resistance to be 400 to 1,000 ohms, and determines which voltage is to be applied, although it is agreed that Ohm's law is not applicable and that the principal value of resistance measurement is to ensure good electrode contact. Shepley and McGregor do not state what patient's head resistance to expect, but their ohmmeter reads from 0 to 2,000 ohms, with a multiplier to 4,000 ohms.

Using a very accurate Wheatstone bridge with a current limiter to keep the patient's measuring current to not greater

than 200 microamperes direct current, which is just below the limit of sensation, we found that a patient's transtemporal inter-electrode resistance with properly applied electrodes was 4,000 ohms. With an alternating-current bridge it was 312 ohms. This is an example of the fantastic discrepancy between direct-current and alternating-current resistance measurements. On applying a voltage of 90 volts a current of 288 milliamperes was passed.

On the question of electrodes and their resistance we had interesting results: two layers of lint soaked in a 20% NaCl solution were placed between two electrodes, 4 × 5 cm. The interelectrode resistances of the pad were:

- (1) By direct-current Wheatstone bridge (electrode current: less than 200 microamperes direct current), 1,650 ohms.
- (2) By standard ohmmeter (electrode current: less than 1 milliamperes direct current), 370 ohms.
- (3) By alternating-current bridge (electrode current: less than 200 microamperes R.M.S.), 0.12 ohm.

A voltage of 2 volts R.M.S. was applied across the pad and a current of 16.6 amperes was passed. Thus Ohm's law applies to this latter measurement.

It was in view of these considerations and observations that we finally decided to incorporate an A.C. resistance circuit in our set, consisting of a resistance bridge excited by a low-voltage isolation transformer.

Time and Voltage

Although, as has already been indicated, it is possible to vary the time of the passage of the current in the shock circuit (i.e., through the patient) from one-tenth to a half of a second we have never found it necessary to exceed the minimal limit of one-tenth second. The voltages used have in our present series of cases varied from 80 to 100, the upper limit having been found necessary in the case of one patient only. In the majority of cases 90 seemed to be the voltage of choice. These findings differ from those of other workers, such as Kalinowsky, who found that the average voltage varied between 100 and 120.

Measurement of Actual Amount of Current Passed through Patient

The apparatus employed by previous workers, notably Bini and Cerletti, includes a device for measuring the actual amount of current passed through the patient's body. This in our view makes the apparatus unnecessarily bulky and expensive; and we fail to see that that measurement provides the investigator with information of any value. With our apparatus, which gives an accurate resistance reading that has a meaning, that information can be obtained by a very simple piece of mental arithmetic, being just a factor of the data already provided.

Method of Recording Cases.—We have found the following method of recording economical and convenient:

No. of Treatment	Date	Resistance (ohms)	Voltage	Fit
3	4/x/40	350	90	1

Remarks.—Good major fit. Violent struggling after cessation of true clonic phase.

Nature of Fit

All the fits so far observed have been indistinguishable from true epileptic fits—i.e., the epileptic cry (as often as not); the tonic phase accompanied by cyanosis; the clonic phase followed by major convulsions; as often as not, automatic reactions of various kinds preceding the return to full consciousness. Amnesia for the whole series of events—and for a varying degree retrograde—invariably occurs. Petit mal attacks may occur—(a) if the voltage has been insufficient; (b) if, owing to faulty adjustment, the electrodes have slipped, causing bad contact; (c) if the current-limiter in the shock circuit trips too readily. According to our experience it is very undesirable to be satisfied with one or even more minor fits,

as these leave the patient for a while disorientated as to time and place with a retrograde amnesia reaching back for several hours. Patients find this a disagreeable and frightening experience, whereas major fits are followed by no trace of anxiety. Our procedure, then, if closure of the shock circuit is followed by a petit mal attack, is to ascertain and remedy the cause, to wait for just the moment when the patient has recovered full consciousness, and to produce a major fit.

Clinical Material

So far we have treated patients (eighteen in all) showing the following conditions: (1) hebephrenia; (2) paranoid schizophrenia; (3) the schizophrenic type of depression; (4) schizophrenia simplex; (5) manic-depressive psychosis—mixed phase; (6) manic-depressive psychosis with nihilistic delusions and corresponding somatic hallucinations; (7) stuporous melancholia; (8) involutional melancholia; (9) manic-depressive psychosis, hypochondriacal type, complicated by morphinism; (10) schizoid psychopathy with acute anxiety symptoms; (11) schizophrenia with alcoholism; (12) multiple tics. Since this paper is in the nature of a preliminary communication, mainly methodological and technological in its scope and purpose, and since the greater number of the patients concerned are still under treatment, it would be out of place to expand this section. However, a few clinical observations may not be considered improper even here and now. In general, it may be said that, with very few exceptions, therapeutic results have been most striking and encouraging. To take some illustrative cases haphazard from the above-mentioned groups:

(a) *Multiple Tics.*—A girl aged 20 has had severe tics involving head, face, arms, hands, legs, together with sniffing, coughing, and teeth-grinding, since the age of 3. In addition she has always felt tense and "woolly in the head." She has had nine fits, is now symptom-free, and declares she feels easier in her mind than she has ever felt in her life.

(b) *Manic-depressive Psychosis (Mixed Phase).*—The patient is a doctor, aged 36, with a pre-psychotic temperament chronically hypomanic. The present attack had lasted for five months. After the first fit he became acutely hallucinated and agitated; he heard people talking against him in the walls, and heard his brother's voice talking from the wardrobe. After the second fit he quieted down and became rather depressed again. Two days after the third fit he was restored to his norm and was able to resume the conduct of his practice.

(c) *Paranoid Schizophrenia.*—This patient, a man aged 23, was complaining of loss of interest in work and of affection for his friends and relatives for two years. He was argumentative and aggressive, moody and chilly, and suspicious of everyone. Whilst in hospital under observation for four days he complained that the patients in the ward were plotting against him. He was given ten fits, and became completely symptom-free, friendly, and cheerful. His fiancée stated that he was so much more agreeable that he was almost unrecognizable.

(d) *Schizophrenia with Alcoholism.*—This woman patient was seen for the first time by one of us (E. B. S.) on May 1, 1940. She was resident in a private mental hospital and had been certified in October of the previous year. She was confused, hallucinated, depressed, and aggressive. She had a history of alcoholism dating back to the age of 18. The original diagnosis was chronic alcoholic hallucinosis; our diagnosis was schizophrenia with symptomatic alcoholism. The patient received in all nine fits in the consulting-room. She came for treatment as an out-patient accompanied by nurses. It had been planned for her to have the full course of treatment (i.e., twenty fits), but treatment was discontinued on August 19 for certain non-clinical reasons. On October 2 the medical superintendent wrote: "Just a note to let you know that X. has been making very good progress indeed. I am sure that this great improvement is due to the electric-shock treatment you gave her. . . . There is no evidence of any

hallucinoses now . . . her manner is much more normal, and her conversation is more coherent and reasonable. I think that she will soon be well enough to go on leave on trial."

Summary and Conclusions

A case is stated for the use of electrical convulsant therapy under out-patient conditions.

A portable apparatus suitable for such a purpose is described.

Certain modifications in technique and procedure associated with the use of this apparatus are set out, together with their advantages.

The clinical results so far obtained are regarded as encouraging, and will, it is hoped, be made the subject of a further communication.

ERYTHROMELALGIA

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In 1878 Weir Mitchell described a condition of redness and burning pain of the extremities for which he coined the name "erythromelalgia." He considered the lesion to be a rare vasomotor neurosis of the extremities. The condition has since been described and discussed by a number of observers, and in reading these descriptions one cannot help being struck by the confusion which has arisen—a confusion so great that it has led some authors to doubt whether erythromelalgia is a definite disease. This confusion no doubt has its origin in the fact that a combination of redness and pain is a frequent concomitant of many different diseases of the peripheral circulation. We believe, however, from our experience that the lesion described by Weir Mitchell does exist as a separate entity—that is, it does occur in a pure form unaccompanied by any clinical signs of peripheral vascular disease. It is undoubtedly very rare, and in the course of nine years in a busy "neurovascular" clinic we have seen but four cases.

Symptoms

The patients are usually young adults, and the condition is probably more common in women. The attacks of redness and pain are brought on by warmth, by exercise, and by the dependent position of the limb. They may occur in the hands, but are more often seen in the feet. At first the trouble is most evident in the heat of summer, but as time goes on the attacks become more severe and last longer, occurring also in the winter. The pain is described as of a burning character, limited at first to the toes or to the heel, but later involving the whole foot. It is much aggravated by warmth, as of bedclothes, by the dependent position, and by walking. It tends to get worse, and may make the patient's life a well-nigh intolerable misery: one of our patients had spent six months in bed, unable to tolerate the lightest covering on the feet.

In an attack the feet are bright red and the skin may be extremely tender to the lightest touch; the appearance of the foot is like the erythema of a burn of the first degree. We have not seen the throbbing arteries

which Weir Mitchell, perhaps with a touch of drama, added to his list of physical signs; normal pulsation is, however, present throughout the foot. The temperature of the skin is raised during the attack. Elevation of the foot above the cardiac level lessens the symptoms and causes some diminution of the colour, but does not lead to any ischaemic pallor. Urticaria factitia has been described in some cases, but was not present in any of our four patients, nor did any of them show hyperidrosis.

Pathology

The cause of erythromelalgia is unknown. Weir Mitchell regarded it as a vasomotor neurosis. Buerger (1924) states that the sympathetic system is in all probability the seat of the disease, and this view receives some support from the immediate and complete cure which has in our hands followed lumbar cord ganglionectomy. It is also significant that in the recovery phase of a Raynaud attack, which is thought by most observers to be of sympathetic origin, the extremities involved are red and painful. Lewis (1933-4) regards the condition as a "susceptible state" in which the skin of certain patients reacts to a stimulus at a point well below the threshold of a normal individual. It is a common observation that some patients who experience trouble in the winter from erythrocyanosis or pernio are apt to complain of sensitive burning feet in hot weather, but we have never seen this amount to anything more than a mild inconvenience. Collier (1898) thought that erythromelalgia was associated with nervous lesions, and considered that its presence might afford early indication of serious disease of the central nervous system. This view has, however, not been substantiated.

Differential Diagnosis

The condition which presents some superficial resemblance to erythromelalgia, and to which most of the confusion in the literature is due, is the painful rubor common to certain peripheral vascular diseases.

The Painful Rubor.—In cases of progressive obstruction of the peripheral arteries there comes a time when a reddish discoloration of the skin appears. This happens first in the digits and spreads later to the hand or foot. This rubor is of a dark brick-red colour, and is more evident in the dependent position. When the discoloured part is elevated above the level of the heart the rubor gives way to a cadaveric pallor, and the rapidity of the change in colour gives a direct measure of the degree of arterial obstruction. The earlier stages of rubor are not painful, but as the colour extends and deepens the pain begins. This pain, which is likely to become constant and severe, is a "rest pain," and is quite distinct from claudication, which is an "exertion pain." The rest pain is diminished by the dependent position, and these unfortunate patients try to gain sleep by hanging the limb over the side of the bed. Rest pain is no doubt due to tissue starvation, and it will disappear in dramatic fashion if a sympathectomy has been able to dilate a sufficient collateral supply. The condition of painful rubor is a grave one, and is to be regarded as a pre-gangrenous state.

There are many points of difference between painful rubor and the erythromelalgia of Weir Mitchell. Rubor is seen most commonly in young adult males (thromboangiitis obliterans) and in elderly men (arteriosclerosis). Pallor on elevation is not seen in erythromelalgia, and the pain in rubor is eased by the dependent position. Finally, the painful rubor is no more than a symptom of some grave underlying condition, which is always a threat to the limb and often to the life of the patient.