For one year all went well, and it was possible to reduce the extract to 20 to 30 c.cm. a week, given intramuscularly. Then a severe crisis occurred following some days of over-exertion and domestic worry. There was nausea with frequent vomiting and fatty diarrhoeic stools, and the abdominal musculature was rigid and painful to pressure. Blood pressure dropped to 70 mm. In view of the patient's very thin veins and the collapsed circulation, intravenous administration of considerable amounts of fluid could not be undertaken. Fluids (1,200 c.cm.) with 20 grammes of salt were given daily, mostly by mouth and to a small extent rectally. The patient received daily 80 c.cm. of adrenal extract (cortin and eschatin), and with eventual improvement the amount was reduced to 70 and later to 50 c.cm. a week, given intravenously. But the former condition of comparative ease could not be regained. The patient's complexion became more yellowish, with a clay-coloured tinge, and freckle-like spots appeared on the backs of the hands and on the face; but the typical Addison pigmentation was not shown, nor was there at any time pigmentation of the mucous membrane of the mouth.

The Operation and After

This was the condition until August, 1938, when a severe Addisonian crisis occurred, due immediately to the damp heat prevailing at that time in Alexandria (86°, with 95% humidity). The amount of extract was increased to 40 c.cm. daily, but the blood pressure dropped to 70 mm.

In this crisis it was decided to graft into the patient the left adrenal gland of a man who had died just previously from a cerebral tumour. The donor was 52 years of age, and belonged to the same blood group as our patient. The graft was made in the abdominal musculature on the left side, under local anaesthesia.

[Here followed in the complete paper a detailed description of the operation.]

Soon after the operation the symptoms of adrenal insufficiency reached their climax—increased somnolence, uncontrollable vomiting, frequent diarrhoeic stools, collapse of circulation, and fall of blood pressure to 60 mm., this in spite of the fact that the daily administration of extract had been increased to 80 c.cm. and that of salt to 50 grammes. Within three days of the operation, however, the condition improved, the dose of extract was reduced, and no more was given after the seventh day, and the patient declared that she felt absolutely well. She left hospital on the sixth day after the operation. During the next two months the blood pressure varied between 115 and 135 mm., the colour of the skin became lighter, and the freckle-like spots were no longer so intensely coloured. But any great exertion or excitement always produced slight somnolence and pain in the back, and during an influenza attack, when the blood pressure was lowered to 80 mm., it was necessary to give 10 to 20 c.cm. of extract for some days.

Comment

From the results of experiments on animals it seems irrelevant to the success of the operation where the grafting takes place (ovary, testis, kidney, musculature), nor does the type of transplantation (whether the organ is cut into slices or grafted as a whole) seem to be of significance. As the operation has been shown to be more likely to succeed in some species of animals than in others, it may be that in man the conditions are exceptionally unfavourable. It has been demonstrated in a great number of animal experiments (Loeb, 1930, 1937) that transplantation in general is more successful the closer the blood relationship between donor and recipient, and in respect of the adrenal gland in particular this has been recently emphasized by several workers (Ingle and Higgins, 1938; Ingle, Higgins, and Nilson, 1938). When selecting the donor the utmost the surgeon can do is to consider the blood group.

The result of the grafting operation must be largely dependent on the bodily condition of the recipient, and in Addison's disease particularly it must not be lost sight

of that the insignificant surgical procedure of grafting endangers the patient's life. Treatment by extract before, during, and after the operation has therefore undoubtedly improved the prospects of success.

In our patient the adrenal graft is able to meet the requirements of normal life, but if the demand is above normal it fails. This cannot be due to the fact that there is only one adrenal gland fully functioning, because such symptoms of insufficiency are not met with in cases in which one adrenal gland has been removed by operation. On the contrary, there is complete accordance between our observations and those on the functional behaviour of grafted adrenals in the animal (Ingle, 1937; Perla and Gottesman, 1931a, 1931b; Wyman and tum Suden, 1937).

Summary

In a severe case of Addison's disease the adrenal gland of a patient belonging to the same blood group, who had just died, was grafted into the abdominal musculature. The functional results, as observed over a period of fifteen months after operation, are excellent. A state of compensation has been produced so long as the patient lives under normal conditions. Only after special exertion or during a transitory infection, with increased demand on the adrenal gland, are slight signs of insufficiency noted.

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TREATMENT OF 100 WAR WOUNDS AND BURNS

BY

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During recent enemy activity over this country 100 wounded men have been under our care in a military hospital. The great majority were admitted within six hours of injury, unlike those described in previous articles on surgery in the present war (Cohen and Schulenberg, 1940; Brown, Dennison, Ross, and Divine, 1940).

Some 50 of our patients were airmen, both Allied and German. They were brought in within an hour or two of their injury. Excited, with nerves still keyed to the highest pitch, with heads still spinning from the swift rush earthwards, and with wounds bleeding freely from the battle, they formed a striking contrast to the Dunkirk soldiers with their grimy and inflamed wound holes often several days old.

These cases afforded an opportunity of carrying out modern treatment and, as some were in for several weeks, for observing their clinical progress. The preliminary anti-shock measures—warmth, morphine, hot fluids—were necessary in all except trivial cases. Some patients required either blood or plasma. When salines were indicated we often used the intramuscular route for injection in order to eliminate the risk of oedema of the lungs (Billimoria and Dunlop, 1940). The problem of assessing

the precedence for operation, so important with a rush of casualties, did not concern us: with small numbers coming in there was always adequate time to deal with each case separately.

Wounds of the Limbs

Wounds of the limbs constituted the greatest number of our cases, the majority being compound fractures. Complete excision of the wound layer by layer was undertaken in these cases if treatment were instituted within the first eight hours. After excision reduction was carried out, often under the x-ray screen. After eight hours we employed surgical cleansing and enlargement to facilitate drainage—that is, “débridement” in the modern sense (see Morrison, 1940a, 1940b; Mackenzie, 1940; Bailey, 1940; d’Offay, 1940).

The removal of retained foreign bodies was incidental to the general cleansing of the wound. In early cases in good condition a careful search was undertaken, especially in the neighbourhood of joints, where, owing to constant movement, it was considered there was less chance than elsewhere of a retained fragment of projectile being walled off and rendered innocuous. Preliminary radiographs were essential, especially in cases presenting an entry wound and no exit wound, with the certainty of a retained projectile. All such cases should be sent, if possible, to places where x-ray facilities exist, and should not be explored “blind” first.

The multiple minute fragments of aircraft-cannon shell peppered over the skin and in the superficial tissues were left alone. We painted the puncture holes—sometimes as many as sixty or seventy—with iodine or gentian violet without applying dressings, as Bonnin (1940) suggests. Dressings, in fact, were best left off in such cases owing to their tendency to absorb the antiseptic dyes from the skin (Fleming, 1940).

Through-and-through bullet tracks caused by accidental discharge of firearms, without retained projectile, were often encountered. If not involving bone or large vessels we left them alone. It was astonishing how often these bullets missed or pushed aside important structures. In one case a 0.45 revolver bullet, entering just below the right fibular head, traversed the anterior compartment of the lower limb and came to rest overlying the first cuneiform, whence it was easily removed without fracturing any bone or damaging any nerve.

Tracer-bullet injuries were also seen. A pilot officer had his left humeral head shattered by a tracer bullet; the wound was still smoking furiously till completely excised. In such wounds the tissues around the bullet fragments were burned as well as torn. Extensive shattering injuries caused by fragments of high explosive from the German “Channel Charlies,” with their potential risks of grave infection, were also seen.

We found the times for primary suture given by Jeffrey (1940) a useful guide. He states: “In the upper half of the body, including the arms, suture may be attempted up to twelve to fourteen hours after injury. In the lower limbs the limit should be six hours.” We did not close up any wound, however, until it was completely excised. No muscle or tendon or nerve was sutured, the only catgut introduced being to ligate main vessels. The first part of the axillary artery was successfully ligated in one case to control a wound of the third part of the vessel. It was considered that prolonged hunting for a damaged nerve in a recent wound was inadvisable. Such cases when healed were sent to a neurological centre for secondary suture.

The wounds were lightly packed with acriflavine-paraffin gauze to prevent collections of blood in the depths and to

act as drains. No wound was packed at all tightly, as it was found that tight packs elsewhere introduced into partially cleansed wounds to control haemorrhage as a first-aid measure invariably caused severe pain and inflammatory reaction and required removal in forty-eight hours.

The wounded limbs were then immobilized in plaster-of-Paris. Our technique followed well-recognized lines based on the improvements of the Winnett Orr treatment resulting from experience of surgeons in the Spanish War (Trueta, 1939; Jolly, 1940; Tudor Hart, 1939). No case was treated by Carrel-Dakin irrigation, which, though evidently still used in America (Hermann, 1940), is not employed in present war surgery. Wounds treated elsewhere, not immobilized, or inadequately immobilized on splints, were also put into plaster, with immediate cessation of discomfort, throbbing, and pain. Our plasters were skin-tight except in wounds left open and expected to ooze considerably. In these much cotton-wool was packed over the wound for the reception of discharges inside the plaster (Pannett, 1940). No “windows” were ever employed, the risk of window oedema being well known.

The patients were left undisturbed till the seventh to tenth day in soft-tissue injuries, and the fourteenth to twenty-first day in fractures, by which time the plaster had become loose and was no longer fulfilling its purpose of immobilization. Their progress was painless and afebrile. The plasters were then removed and packs and stitches taken out. A healing granulating wound covered by a variable quantity of thick pus and scabs was constantly observed, with no trace of active inflammation. The presence of dead tissue, as pointed out by Carrel and stressed in a recent paper by Riley (1940), had evidently acted as a stimulation to the proliferation of cells in the process of healing. The wounds were re-dressed, this time with merely a thin strip or wick leading into the wound cavity, easily capable of being extruded by the tissues. Superficial cutaneous irritation around some wounds yielded quickly to application of aqueous gentian violet. No septic lymphangitis or lymphadenitis was seen; no case had a secondary haemorrhage. The observation of Trueta and Barnes (1940), that immobilization in plaster minimizes lymph flow and therefore decreases the chances of absorption of bacteria and their toxic products, was confirmed.

Plaster immobilization was continued till the wound had healed completely. If not, the wounds and the limb inevitably became slightly painful and uncomfortable. Discomfort ceased at once on re-immobilization. No physiotherapeutic measures were started till the wounds had thoroughly healed.

Visceral and Facio-maxillary Wounds

Penetrating wounds of the abdomen and chest were also encountered. The importance of the “time-lag” in visceral lesions was well realized. The extensive intraperitoneal damage produced by projectiles entering through the buttock was again observed in our series. In one patient resection of four feet of small intestine in addition to suture of bladder and rectum was required, but, unlike Gordon Bell’s successful case (Gordon-Taylor, 1939), this man died. The causal factor was the initial haemorrhage from the mesenteric vessels. In another case—a through-and-through wound of the right flank—a bruise of the lateral border of the ascending colon was the only visceral lesion, and was not extensive enough to require Jolly’s (1940) reperitonizing operation.

Several facio-maxillary injuries were encountered. With a minimum of excision, displaced hard and soft tissues were sutured back as nearly as possible to the normal position, avoiding tension in the replaced structures.

Suturing was found essential, even at the expense of slight distortion, in order to control the very profuse and sometimes dangerous haemorrhage so common in these wounds.

The high frequency of abscess formation which supervenes in the lower jaw after such injuries (see Report on Maxillo-facial Injuries, 1939) rendered primary drainage advisable. In one case—a through-and-through wound shattering both superior maxillae and the nasal septum—a bilateral Caldwell-Luc operation was performed, on the advice of Major Cowper Tamplin, R.A.M.C., to facilitate drainage. The lessening of muco-purulent discharge from the traumatic facio-antral fistulae in this man (a German pilot sergeant), the evident improvement in the closure of the facial wounds, and the lessened risk of severe ectropion on the left side were gratifying. We had the co-operation of Lieut. C. L. Douglas, Army Dental Service, in the treatment of these cases, and they were transferred as soon as possible to a facio-maxillary centre.

Treatment of Burns

Fifteen burns came under our care. They were chiefly of the face and hands, of the first and second degrees, with small areas of third degree. We employed the immediate-coagulation method of combined tanning with silver nitrate 10%, tannic acid 10%, and gentian violet 1% aqueous solution, as described by Dennison (1939). Tannic acid has been used successfully, with various modifications in technique, in the present war (Cohen, 1940a; Gordon, 1940; Heggie and Heggie, 1940; Brown, Dennison, Ross, and Divine, 1940; Ross and Hulbert, 1940).

Thorough preliminary cleansing under anaesthesia was carried out first to eradicate the sepsis that is so likely to supervene and produce scarring and contractures even in burns of first and second degrees. It has been said that "wound excision as a general principle still stands as the surgeon's sheet anchor" (Max Page, 1940). Similarly, adequate preliminary cleansing is the sheet anchor of the treatment of burns.

After cleansing, the triple tan solutions were applied, and coagulation was accelerated by the use of an electric hair-drier. The tan was applied without any break in continuity over the flexor aspects of joints. A degree of splinting of the joints was therefore produced which was not considered unbeneficial, as the parts were placed temporarily in immobilization, the optimum state for healing of any wound. The supple coagulum of the triple tan proved far superior to the rigid eschar of tannic acid alone, and allowed gentle movements to take place without cracking. Movements of affected fingers were allowed from the seventh day onwards, any cracks appearing in the coagulum being filled by a reapplication of the tanning mixture. The pliability resulting from a thin application of the triple tan proved of special value in the treatment of burnt eyelids, whose essential mobility was thus maintained.

Oedema did not develop to any extent in our cases, the main factor in the oedema of burns—infection—having been controlled by the initial cleansing. What little oedema did appear cleared up on elevating the part on pillows. The absence of pain and sepsis was very noticeable. No necrosis of phalanges was seen, and there were no contracture scars. The results were uniformly satisfactory.

Chemotherapy

Chemotherapy was employed in only a few selected cases in our series of wounds and burns. Primary infections by haemolytic streptococci occur in only about 5% of cases with open wounds (Colebrook, 1940), and one of the few wounds we left accessible for investigation purposes—a penetrating abdominal wound—was sterile to

culture on admission. Infection by streptococci more commonly occurs in hospital. The plaster immobilization technique minimizes this, for plaster cases militate against the ingress of haemolytic streptococci from the nasopharynx and hands of dressers (Hare, 1940).

Dealing with very recent wounds sustained in aerial combat and in an area where the soil is relatively "clean," we did not consider chemotherapy in any form an essential part of treatment. We employed sulphapyridine prophylactically—its most effective use, according to Buttle (1940)—in several large wounds in which complete wound toilet had not been possible and in which projectile fragments and devitalized muscle were still *in situ*. The dosage was two tablets (each 0.5 gramme) by mouth four-hourly for twenty-four hours, followed by 0.5 gramme four-hourly for the next forty-eight hours. The local application of sulphanilamide powder was not tried. None of our cases showed any streptococcal infection.

Sulphapyridine was given in massive doses in the one case which grew a culture of anaerobic organisms. This was a bomb-fragment injury of the right forearm, with broken ulna and sloughing flexor muscles, that reached us second-hand in an infected state. The benefit of chemotherapy was not noticeable, and amputation was eventually necessary.

All our cases had antitetanic serum either on or before admission, and no case of tetanus was seen.

Anaesthesia

Pentothal sodium followed by nitrous-oxide-and-oxygen administered by Boyle's apparatus has been used in almost all cases. The average British soldier has a phenomenal appetite for all anaesthetics. It was found that an average of 6 to 8 c.cm. of 5% solution was necessary for induction, and a satisfactory state of anaesthesia could not be obtained with less than 16 to 18 c.cm. This anaesthetic lasted for about twenty to thirty minutes, and the patient was round in under an hour. Some cases required about 30 c.cm. for half an hour's anaesthesia. These cases were not round for about two hours, and were drowsy for the remaining twenty-four hours. This confirms the findings of R. H. Moore (1940). When gas-and-oxygen was used as a supplement a smooth anaesthesia with good relaxation and a rapid recovery was obtained. For facial burns and injuries we used pentothal. It proved an ideal anaesthetic for all cases in which a clear airway could be maintained.

The R.A.F. fighter pilots were often brought into hospital in a highly excited state, and it took a great deal of gentle coaxing to persuade some of them to accept even a prick in the arm; any question of inhalation anaesthesia would have raised strong objections. It is now our custom to prescribe omnopon 1/3 grain and scopolamine 1/150 grain one hour beforehand. Phenobarbitone, 1 grain twice daily, is also prescribed for several days afterwards. Many patients have expressed the view that in the future they will not so much mind being wounded if they know that they will have such a pleasant anaesthetic.

In a few cases it was found necessary to operate before the patient had recovered from his shock, in order to arrest haemorrhage or, as in one case, to remove a burning tracer bullet. In these cases pentothal administered slowly gave satisfactory results. As in many instances the patient was already receiving intravenous saline, the pentothal sodium was added to it in the ward, and the patient fell asleep without even knowing that the administration of the anaesthetic had begun. The Army pattern transfusion set was used, 1 gramme of pentothal being added to 200 c.cm. of glucose-saline. The solution was run in at about 120 drops a minute until unconscious-

ness was produced, and then continued at about 40 drops a minute for the duration of the operation, the rate being increased or reduced according to the individual circumstances.

Severely shocked patients were not touched at the end of the operation, but when circumstances permitted were left on the table for several hours. We considered that lifting a gravely ill patient on and off the table, rolling him to put on bandages, and putting him into bed would have been almost certain to tip the balance in the wrong direction.

Local anaesthetics were never used in this series. Several cases admitted second-hand after having had wounds excised and explored for foreign bodies under local anaesthetics were found to be painful and infected. This unfavourable condition had been caused or aggravated in some measure by the insertion of a local anaesthetic into tissues potentially infected and certainly devitalized.

Summary and Conclusions

100 wounds caused by the projectiles of warfare, the majority of them recent, have been treated.

Excision in early cases, and débridement in later cases, followed by adequate immobilization in plaster-of-Paris, have been successfully employed.

Efficient immobilization lessens the incidence of infection in wounds and materially aids its resolution when once it has set in.

Chemotherapy is not necessary as a routine in the treatment of early wounds occurring in areas where the soil is not heavily contaminated with anaerobic organisms. Its best use is as a prophylactic agent in large wounds which it has not been possible to clean completely. We agree with the suggestion of a Field Ambulance officer, Lieut. E. S. Watson, R.A.M.C., that it should be employed as a first-aid measure at the same time as anti-tetanic serum is given to wounded men for whom adequate surgical excision may not be available for many hours.

The silver-nitrate-tannic-acid-gentian-violet treatment of burns again proved successful. We endorse the defence of tannic acid by Park (1940) and the opinions expressed in Cohen's (1940b) summary.

Pentothal intravenously has proved a safe and satisfactory agent for routine use in war surgery.

The use of local anaesthesia in the treatment of war wounds is strongly deprecated.

We wish to thank Major H. G. Hobson, R.A.M.C., for invaluable aid and criticism, and for permission to record our findings. We are also indebted to Lieut. W. Carton Winterbottom, R.A.M.C., who co-operated with us in the administration of many of the anaesthetics in these cases.

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A SIMPLE METHOD OF ESTIMATING PROTHROMBIN IN CAPILLARY BLOOD

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The estimation of the prothrombin content of the blood is recognized as a necessary step in the investigation of the haemorrhagic states in general, and it is of particular value in cases of obstructive jaundice prior to operation and in haemorrhagic diseases of the newborn. The method described by Quick (1938) is usually employed. This entails the withdrawal of 4.5 c.cm. of blood either from a vein, which may be difficult to locate in obese or collapsed adult patients, or from the anterior fontanelle in infants, a procedure which the clinician may be unwilling to undertake in view of the haemorrhagic tendency.

If the prothrombin in capillary blood could be estimated in a simple and satisfactory manner the scope and application of such an investigation would obviously be extended. The following method, employing capillary whole blood and snake venom as a source of thrombokinase, can be performed in a few minutes. We have carried out this test on a large series of normal persons, newborn infants, and patients with obstructive jaundice and liver damage, and have found that it gives results comparable to those obtained by Quick's and other methods.

Method and Materials

A standard white-blood-cell-counting pipette is used to measure the various ingredients. It is better to have a number of such pipettes, but if only one is employed it must be cleaned thoroughly with saline after measuring each ingredient. A solution of crystalline sodium oxalate (13.4 grammes per litre) is drawn up into the pipette, and a quantity equal to one division of the pipette is blown into a clean watch-glass. The skin is punctured so that the blood flows freely without squeezing. In infants the heel is the most suitable site. Blood is drawn up to the ninth division and then transferred to the watch-glass. Thorough mixing of blood and oxalate solution is effected by means of a small glass stirring-rod. The snake venom used is Russell-viper venom, supplied by Burroughs Wellcome and Co. under the name of stypven. The solution is prepared by adding 1 c.cm. of distilled water to 0.1 mg. of the venom in dry form. A freshly prepared solution is best, as the efficacy of the venom in solution decreases after a few days. Stypven solution and a solution of anhydrous calcium chloride (2.775 grammes per litre) are in turn sucked up into the pipette to the tenth division and are mixed with the oxalated blood in the watch-glass. Following the addition of the calcium chloride solution, visible fibrin formation usually occurs within twenty-five to thirty-five seconds as timed with a stop-watch. The change is best seen against a white background. The test is repeated on a normal person at the same time and under the same environmental conditions,