SURGICAL PROCEDURES IN GENERAL PRACTICE

This is one of a series of articles contributed by invitation

TREATMENT OF WOUNDS—I

BY

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The aim of wound treatment is the restoration of perfect function: to attain this end the wound must be made to heal in the shortest time, with the least alteration in its structures by the processes of repair.

The Process of Repair

The ideal progress of a wound is, or should be, seen in the healing of a surgical incision. An operation wound differs in several particulars from the majority of accidental wounds: first, it is executed with sharp instruments, used in their cutting plane only, and the damage to tissues along its margin is therefore slight; secondly, there is no loss of substance; thirdly, haemorrhage has not been allowed to take place; and, fourthly, infection is absent or minimal. After suture the first change that takes place in such a wound is the outpouring of fluid between the apposed cut surfaces. Into this fluid and between these surfaces phagocytes wander, and proceed to engulf and remove damaged cells—in the case of a clean wound to a depth of a few cells only. The fixed connective-tissue cells of the part multiply and bridge the gap, and on the surface the epithelial cells do the same. After four days the epithelial wound if linear is covered with fresh cells, and the deeper parts are bridged by new connective tissue. After ten days the wound is mechanically very nearly as strong as the normal parts on each side of it, but the newly united tissues are more cellular and vascular. By the end of six weeks mature connective tissue has replaced the fibroblasts and repair may be looked upon as complete.

In traumatic surgery an imperfect result may be due to the nature of the wound alone, the process of healing having proceeded normally, or to permanent interference with the function of the structures in the neighbourhood of the wound due to delayed or imperfect healing. In the first case there has been actual loss of substance which cannot be replaced, and the resulting disability will depend upon the extent and importance of the tissue lost. We can do nothing to mitigate or to prevent this loss. In the second case repair has been by second intention—that is, it has passed through an intermediate stage of granulation. Granulation tissue is not in itself vicious. It is Nature's method of dealing with a dead space, the putty she puts into imperfections before finishing off. Granulation tissue must therefore be expected where the loss of substance has been too great for the tissues to be approximated by suture; where approximation, though possible, has been imperfectly performed; or where it has been broken down later by haemorrhage or infection. The evil of granulation tissue is that it is finally replaced by a fibrous tissue which contracts to approximate the margins of the defect it originally filled. Its purpose is to bind, fix, and repair; its vice that this fixity destroys movement. The skin over a granulated scar is thin, fixed, prone to break down with friction, and liable to keloid or even malignant changes later; muscles are weakened in proportion to the gap in their fibres, and bound to each other by adhesions; tendons become fixed

to their neighbours and their sheaths; nerves regenerate poorly if at all.

If our ideal is to be the approximation of healthy tissues without infection we must, in each case that presents itself, assess both the mechanical and bacteriological condition of the wound. From one point of view wounds may be classified as punctured, incised, lacerated, crushed, or complicated by injury to bones, joints, or nerves. From the other they fall into the categories of clean or infected. The two are not really independent, for wound infection depends not alone upon the entry of bacteria but on the presence of dead or damaged tissues upon which they can thrive and establish a foothold. In general, clean-cut wounds are more likely to be bacteriologically clean than lacerated ones, but this is by no means always the case; among the most dangerous are the small punctures caused in hospital work by infected needles.

Contamination and Infection

The progress of a wound infection may be divided into two somewhat arbitrary stages—contamination and infection. In the first stage the bacteria which have been carried in by the agent inflicting the wound lie on its surface—in bits of dirt, clothing, or metal fragments—or in small groups in the blood clot. They are a local contamination and have not yet started to multiply or invade. They can, at this stage, be removed by a thorough mechanical cleansing, leaving the tissues round them uninfected. In the second stage the bacteria, profiting by the supply of culture medium available to them in the dead matter around, in blood clot, lymph, and damaged muscle, have multiplied and started to invade the tissues of the host. They can now be removed only by the protective reaction of the living cells, or by some wide excision which necessitates the removal of healthy tissues, and involves the risk that it may injure the defence wall without including in its scope all the invaders. For practical purposes the stage of contamination may be looked upon as lasting for twelve hours before it passes into that of infection. It must be remembered that where the organisms introduced are few, the available pabulum scanty, and the tissues around healthy, infection may never establish a foothold.

An estimation of the probable degree of infection is the first step in deciding upon the treatment of any wound. This will take into consideration the nature of the instrument, the state of the patient's skin and clothes, and the appearance of the wound, and will be no more than a working guess based upon experience, but a guess upon which treatment must be decided. If the wound is clean it should be sewn up completely; if infected, it should be drained. When there is any doubt undue pessimism is safer than mistaken optimism.

First-Aid Measures

These should be of the simplest character and confined to absolute essentials—the arrest of haemorrhage and the protection of the part from infection and further damage. They are only necessary when some complication is urgent and when the interval in time or space before permanent treatment can be undertaken is appreciable.

Haemorrhage can usually be arrested by local pressure—the application of a first-aid dressing with a firm bandage over it. Under the conditions implied by first-aid, when the dressings are from a stock packet sterilized some time previously and there are no facilities for boiling instruments or adequate preparation of hands, opening the wound or packing its depths should be avoided. Should this seem essential for life-saving, the packing gauze, if possible, should be wrung out of an antiseptic. For severe haemorrhage from a limb a tourniquet provides a certain method of arrest, one far safer than packing under doubtful conditions. A tourniquet should not be left on the arm longer than half an hour if it can be avoided, and in no case longer than an hour; in the leg these times may be doubled. In the arm the dangers of a tourniquet are not alone those of tissue necrosis following prolonged ischaemia; paralysis of some of the nerves, usually temporary but occasionally persisting as a partial weakness, is to be feared even after a short application of any band of a rigid type. Here it is safer to use the cuff of a sphygmomanometer.

Tincture of iodine is universally painted over wounds as a first-aid measure. That this practice should be retained in ambulance classes is probably wise; the use of iodine discourages meddlesome exploration, re-sterilizes dressings which have often been de-sterilized in application, and brings a visible and pungent reminder of the value of antiseptics. When a really sterile dressing can be applied with careful technique iodine is better omitted. In a fresh wound it is extremely painful, and to one whose nerves have been upset by a recent accident very distressing, while its sterilizing action is limited to the skin and the dressings and does not extend appreciably to the depths of the wound, the proteins of which are coagulated by the alcohol. When haemorrhage has been arrested and a clean dressing applied the part should be fixed on a splint or otherwise protected from avoidable movement.

General Treatment

As soon as the patient reaches a place where adequate treatment can be instituted—his house or the doctor's, a nursing home or hospital—a more careful study of him and his injury must be made. We must ascertain as far as possible the extent of the wound, the degree of contamination, and the structures that have been injured. This examination may mean gently lifting up the flaps of the wound with forceps and cautious probing, but any forcible separation of the parts, anything that may hurt the patient or restart the haemorrhage, should be postponed till an anaesthetic has been given. At this stage a careful search will be made for nerve and tendon injuries and for fracture of neighbouring bones. Such a survey will allow us to decide whether the general condition of the patient demands treatment for shock or whether we may proceed to repair the wound at once; whether an anaesthetic is necessary, and if so of what nature; what structures are certainly damaged and need repair; and if infection is to be feared, particularly infection by some of the more dangerous organisms.

It is rarely that treatment for shock is essential before the wound can be repaired, and then only if it appears reasonably certain that active haemorrhage plays no part in the shock. Because of the difference outlined above between contamination and infection it is really important that the surgical toilet of the wound shall be delayed as little as possible and that bacteria should not be allowed to establish a hold. The treatment of shock by warmth

and the administration of fluids can in most cases be carried on while the wound is being repaired. If necessary a local anaesthetic can be given.

Preventive Therapy

While infection may be present and is to be feared in any wound, there are three organisms whose presence can often be anticipated and whose ravages can be forestalled—the bacillus of tetanus, the bacillus of gas gangrene, and the haemolytic streptococcus. The bacilli of tetanus and gas gangrene are both found in the alimentary flora of farmyard animals, and therefore in stables and on all manured land, on the surface of roads, and in the clothing of those who work in gardens or with horses or cattle. Either bacillus may gain entry to wounds incurred in such surroundings or by people in these occupations; but whereas the tetanus bacillus will establish itself wherever anaerobic conditions are found, the *Cl. welchii* rarely gains a foothold except in the presence of grossly devitalized tissues. A prophylactic dose of 1,000 English units of antitetanic serum (2 English units correspond to 1 U.S.A. unit) should be given in all cases of road or farm accidents, and indeed in every case of a lacerated wound where soiling is at all possible; a prophylactic dose of 4,000 units of anti-gas-gangrene serum should be given in addition where soiling and laceration coexist.*

Infections with virulent strains of haemolytic streptococci are rarely encountered, except in wounds inflicted in hospital practice. In pricks or scratches incurred during necropsies, or while operating on or dressing septic cases, they may almost be anticipated, and are notoriously dangerous and even fatal. In such cases a prophylactic dose of sulphanilamide should be given.

Anaesthesia

The question of anaesthesia demands little discussion. Trivial wounds, and occasionally larger ones in phlegmatic adults, may be stitched without anaesthesia. If the patient has not to make a journey afterwards a preliminary injection of morphine may be given to allay apprehension. In most cases a general anaesthetic will be found advisable, since it leaves the surgeon free to extend his procedures in time or space, and it is almost essential if a tourniquet is to be applied or haemorrhage is anticipated. Local anaesthesia is particularly applicable to wounds below the knee and elbow. The method of local infiltration is not really suitable for the repair of wounds, and some form of nerve block will be preferred. Fortunately the median, ulnar, and radial nerves at the elbow and wrist, and the internal and external popliteal and long saphenous nerves at the knee, run in easily identified anatomical sites, and may be blocked by injection with 1 per cent. novocain. Local anaesthesia is indicated when the wound is part of an injury that includes fractures of the ribs, since pulmonary complications may follow general anaesthesia, however carefully administered.

Operative Treatment

The aim of the surgeon is to suture healthy, uninfected tissues as accurately as possible. When the wound has been inflicted with a clean sharp instrument, the tissues on its surfaces are undamaged, and the edges of skin and deep layers clean-cut, the wound may be sewn up completely after gentle irrigation with a harmless antiseptic,

* Many surgeons now give a mixed tetanus and gas-gangrene antitoxin in all road and industrial accidents: this is prophylactic against infection by *Cl. tetani*, *Cl. welchii*, and *Vibrio septique*.

such as 1 in 1,000 acriflavine, and the arrest of all bleeding and oozing points. Such an apparently clean wound almost necessarily contains organisms; but these, if small in number and of low virulence, will be exterminated by the healthy tissues around them if no circumstances favourable to them, such as the accumulation of exudate or the presence of foreign material, are allowed to appear. Dead spaces must be eliminated, so the wound must be sutured to its depth; it is not sufficient to approximate the skin. For the deep sutures catgut of small calibre should be used, but used sparingly. Size 00 is usually sufficient, and the sizes larger than 1 are seldom needed, being bulky and irritating to the tissues rather than strong. For the skin unabsorbable sutures of horse-hair or fine silkworm gut are best. An ideal material is the suture of 00 ophthalmic silkworm gut, which is supplied by most firms in sterile tubes for plastic work, on fine eyeless cutting needles. These sutures can be inserted almost painlessly without anaesthesia and leave no visible scar when removed. All stitches in deep structures or skin must be interrupted to allow any fluid accumulating to escape between them, and beyond this precaution drainage is unnecessary in the clean type of case under discussion. If, on the other hand, the wound is lacerated and soiled it must be trimmed and cleansed before it can be sutured, and even then it should not be closed completely unless the excision has been wide and early; usually drainage of some kind must be allowed.

Such a wound is first opened freely and its depths inspected. Loose blood clot, dirt, and fragments of clothing are removed, and the cavity is lightly sponged out with gauze swabs. If bleeding from a vessel of some size is then encountered it must be stopped; otherwise the arrest of haemorrhage should be left till obviously damaged tissues have been excised. Excision is carried out methodically and carefully from the deeper to the more superficial layers. The torn surface of muscle should be trimmed with scissors to the depth of a few millimetres. Vessels and nerve trunks must of course be left, and can only be cleansed in so far as swabbing with an antiseptic will do it. In most lacerated wounds the subcutaneous layer appears to be most soiled and must be methodically trimmed, care being taken, however, to remove only as much as is badly damaged, and not to interfere with the blood supply of the skin flaps. Skin should be removed very sparingly, the bruised edge alone of the flaps being cut away with a sharp knife.

Haemorrhage should be arrested, where possible, by ligation of the bleeding point. After the excision of bruised tissue the point of emergence of the jet of blood from the clean surface should be seen comparatively easily, and the point can be picked up with artery forceps and ligatured. If excision has been done under a tourniquet the vessels appear as the band is loosened. Blind diving for bleeding points that cannot clearly be seen is to be deprecated, for arteries and nerves usually run together, and the nerve may be seized with, or instead of, the vessel. Ligation of large masses of tissue should also be avoided, as being liable to lead later to sepsis. While the actual bleeding point should be picked up and tied, under the conditions of poor light, inadequate assistance, and inefficient anaesthesia in which wounds often have to be treated such a course may be unwise. Bleeding may continue, and its source appear to lie deep in an interosseous space or near some important structure, where the operator is unwilling to adventure under the circumstances prevailing. Here packing offers an alternative method of arrest, and one that is immediately effective,

though ultimately far less certain than ligation. In the type of case being discussed a packed wound inadequately excised is almost certain to become infected to some degree, and secondary haemorrhage, demanding ligation of the main artery to the part at a distance, is very likely to follow at any time in the ensuing ten days. When a wound has been packed to arrest bleeding the pack should be removed two or three days later, a second pack being ready for immediate insertion should the bleeding restart.

Drainage and Delayed Primary Suture

A wound lacerated and soiled enough to require excision can rarely be sutured up completely. In most cases a small drain, preferably a length of corrugated rubber or a strip cut from a surgical glove, should be put down to its depth and brought out between two stitches. The drain can be removed as soon as lessened discharge and normality of temperature and pulse show that there is no infection in the depth of the wound; if it comes out within forty-eight hours the cosmetic result will be that of an undrained wound without its risks. In small wounds a very satisfactory temporary drain can be made by a wisp of six to ten strands of silkworm gut laid side by side, some or all of which can be removed as the wound clears up.

If the excision has been incomplete or if the wound has been grossly contaminated, and in all cases of large and dirty lacerations repaired later than twelve hours after infliction, it is better to pack the wound at first, or at most to close it in part only. The method of "delayed primary suture," used with success in the war, is particularly applicable to these dangerous cases. The wound is excised, and after haemorrhage has been arrested it is carefully packed with strips of gauze soaked in 1 in 1,000 acriflavine, care being taken that all recesses are filled and that no pockets remain in which serum can accumulate. The abortion of infection is judged by the general condition of the patient, the state of his temperature and pulse, the absence of pain, and the normal appearance of the parts around the dressing. If these indications are satisfactory the packing is removed after two or three days under general anaesthesia, and if the wound appears healthy its sides are brought together over a small drain with catgut mattress sutures for the deeper parts and interrupted silkworm-gut stitches for the skin.

After suture the wound is dressed with sterile gauze and wool and bandaged firmly enough to keep the deep layers apposed and discourage oozing. The injured part must be kept immobilized for at any rate the first week after suture. This may imply rest in bed, confinement to the house, a sling, or, in many cases, a splint. Rest is essential to prevent effusion, aid repair, and assist the tissues to overcome infection. It is far better overdone than omitted. For these reasons a splint is often advisable to immobilize the whole of an involved limb segment and, in some cases, to maintain a position which relaxes the sutured planes.

(To be continued)

The Medical Society of Evian is organizing a second congress on renal insufficiency, which will take place at Evian from September 21 to 24, under the presidency of Professor F. Rathery. Titles of papers to be read at the congress should be sent to the secretaries, Dr. F. P. Merklen and Dr. M. Derot, before July 15. All communications or inquiries should be addressed to the Secrétariat du Congrès, 138, Avenue des Champs-Élysées, Paris, 8ème.