WAR WOUNDS AND AIR RAID CASUALTIES

The following is one of a series of lectures on the Treatment of War Wounds and Air Raid Casualties recently delivered at the British Postgraduate Medical School

INJURIES OF THE LOWER LIMB—II

BY

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Fractured Femur

In 1917 Martin and Petrie made some valuable observations with regard to infection of bones due to gunshot wounds. Their conclusions can be briefly summarized as follows:

1. From the surface of a divided or fractured bone exposed to infection bacteria may penetrate to deeper parts.

2. In an untreated fracture penetration is apparently unlimited.

3. If the dead bone on the surface of the fracture is removed early penetration is much reduced, and may not occur at all.

4. Penetration, particularly of anaerobes, is greatly increased by reduction of the circulation through the injured bone.

5. Penetration is increased by obstruction to drainage either of the bone or of the soft parts.

6. The order of frequency and power of penetration of the bacteria found is: (a) streptococcus, (b) staphylococcus, (c) anaerobes, (d) *B. coli*.

7. The rate of penetration is at its maximum during the first few days.

8. Bruising—an invariable accompaniment of projectile fracture—does not appear to facilitate penetration if the surface layer of debris is removed and drainage established.

9. In a septic fissure growth of bacteria is progressive and may lead to infection of a distant part—for example, a joint. Dissemination of infection throughout a bone takes place by penetration from the walls. Little beyond the consideration of these findings in relation to thigh wounds will be necessary to understand why gunshot wounds of the thigh were a menace during the war.

Efficient drainage was invariably made difficult by the laceration of the muscles in addition. Many patients arrived at the operative centre in a condition of shock, owing to the extent of the wound or multiple wounds. The employment of the Thomas splint as a first-aid measure in these cases is to be encouraged.

The treatment of a gunshot wound of the thigh with fracture of the femur consists of: (1) The operative treatment of the wound and fracture, which has been described. Anti-shock treatment before operation will generally be necessary. (2) Reduction. (3) Immobilization.

REDUCTION AND IMMOBILIZATION

This is almost invariably realized when the "operation" is over, or at least it is facilitated. Often it consists in immobilizing the limb in the physiologically correct position: in any case, prolonged extension always gives the result desired. In post-war surgery it was not osteotomy for angulation that was necessary, but sequestrectomy for necrosed bone or grafting for non-union. Gradual reduction by weight extension is always desirable; and before discussing the technique it is not out of place to point out that any method of forcible reduc-

tion by stripping periosteum, the use of large bone-holding forceps, and internal fixation by chandlery-bolts, screws, plates, etc., is likely to be followed by disastrous complications.

British surgeons employed Thomas's splints, when possible, and a weight or fixed extension applied to the skin by adhesive strapping or a non-irritating glue. Laced boots and plaster gaiters had a trial. Transfixion nails and metallic loops—the latter passing between the tendo Achillis and tendons at the back of the ankle—were employed by the Italians and French. In fact, skeletal traction was first advised by an Italian physician. The British method produced reduction and caused no complication, unless it was over-traction in some cases; but frequent soiling of the plaster was inevitable and constant renewals became necessary. Apparatus around the ankle became more popular, and the footpiece glued to the foot, devised by Sinclair, had many advantages. The "glue" consists of 50 parts ordinary glue, 50 parts water, 2 parts glycerin, 2 parts calcium chloride, and 1 part thymol. The mixture is sterilized. It can be used for extension bands by applying gauze strips after painting the skin with glue, or to fix a wooden footpiece to the skin. This is mentioned in some detail, for many surgeons doubt the advisability, and possibility, of using Steinmann's pins or Kirschner's wires, which are familiar to all now, in every case of gunshot wounds of thigh or leg. That they would be used extensively there is little doubt, but with what success cannot be foretold.

SPLINTAGE

During the great war the standard splint for large flesh wounds of the thigh, with or without fracture of the femur, was the Thomas. It is often convenient to bend the side irons at the level of the fracture or the knee. In theory this does away with the exact method of extension, but as a means of fixing the fracture and accessibility for dressing it has no superior. Fixed extension will be used in transport, and in some cases in hospital. Weight extension can be employed by one of the two recognized methods. Slings are probably better fixed by large safety-pins than by the simple clip, which is inclined to slip. The latest clip is not likely to be available in large quantity. In certain cases of multiple wounds the splint is used only as a supporting trough. The Hodgen splint is still used by some surgeons.

In severe injuries the limb can be slung from an over-bed beam, after the original method, described as the Balkan beam. In hospitals away from the line apparatus to sling the Thomas splint, such as beams with pulleys or Pearson's fracture bed, is available. The latter can be used in a number of ways, with or without a mattress; the limb can be extended without splinting, if necessary, and the back of the limb can be dressed from below.

Fractured Leg

Treatment for wounds of the leg is on the same lines as that of the femur. Plaster-of-Paris is to be avoided during early treatment, but may be suitable in slight cases after a few weeks. In the early stages the extent of swelling subsequent to the operative treatment cannot be

gauged. It is likely that skeletal traction will be used by pin traction through the os calcis, particularly as it has met with such success in open fractures during the last twenty years. Over-traction by too great a weight will lead to separation of the fragments, which is to be avoided. The non-union of the tibia seen after the last war necessitated many bone grafts, and their number will be multiplied unless thought is given to this matter when skeletal traction is employed.

The question of secondary suture of leg wounds does not apply as in open fractures due to road accidents. Braun's frame is the ideal for these fractures rather than Thomas's splint. It is in frequent use now, and everyone who may be called upon to do this work should become familiar with it.

Injuries of the Foot

Conservative treatment should be employed as far as possible. Incisions on the sole of the foot may be necessary, but should be avoided. Amputation of toes that are only adherent or are gangrenous may be required. Those through the middle of the foot at the site of a wound are not likely to succeed, as infection spreads up the tendon sheaths. For urgent surgery an amputation through the lower third of the leg is advocated for severe injuries of the foot. This may be a useful stump, and if reamputation is necessary later the standard leg amputation with a five-inch to seven-inch leg stump is possible.

Injuries of the Knee-joint

A punctured wound such as that due to a bullet or a small shell fragment, causing haemarthrosis only, is rare, but responds well to treatment. There is a synovial wound only in this case. More common and serious wounds are as follows:

1. *Small or Moderate-sized Wounds with Fracture of the Knee involving the Joint, with the Missile in situ.*—These produce a dangerous condition, owing to the presence in the joint of septic particles of clothing, earth, etc., and owing to the existence of fissures more or less prolonged into the shaft of femur or tibia, whence arises a formidable osteomyelitis (Fig. 3). Unless there is intervention, death ensues in two-thirds of the cases from gas gangrene or articular septicaemia.

2. *Fractures of the Bones forming the Knee-joint due to Penetration of a Condyle.*—These fractures are often followed by acute septic arthritis. If the patient is not carried off by acute septicaemia he is liable to suppurative arthritis, to deep diffuse cellulitis of the thigh, and to secondary haemorrhage from the popliteal vessels. In short, if intervention is not practised at once, amputation soon becomes necessary, and only too often it is unable to save the patient's life. This is exemplified by numerous specimens in the war collection.

3. *Destruction of the Knee.*—Complete crushing of the joint is usually accompanied by fissures extending the length of the tibia and femur. Often the vessels and nerves are damaged. Shock is considerable. Gangrene quickly develops, with the formation of gas and fetid sloughs, if not true gas gangrene.

THERAPEUTIC MEASURES

In short, apart from the first type of injury, wounds of the knee are of extreme gravity if they are left untreated in the first few hours. It is necessary to act at once, and to be beforehand in dealing with whatever may be happening. The measures available are:

1. Immobilization with or without aspiration. This is suitable for the first type. Repeated aspiration may be required.
2. More usually, in the first type, primary excision of the wound or edges of skin, underlying tissues, and synovial membrane is made—the joint is washed out by some—and this joint lining is then sutured, but the overlying structures are left open. Immobilization is essential, and subsequent aspiration may be employed.
3. Arthrotomy, with or without excision of the wound. This treatment differs in no way in its application or technique from that of civil practice.

FIG. 3.—Lower half of femur removed by amputation for streptococcal arthritis of knee seventeen days after injury. Longitudinal section of bone, with fissure opened out to show continuity of pus from fracture to articular cartilage. A, Fracture. A', Fissure extending to joint. Fig. 3 is reproduced from the *British Journal of Surgery* (1917, 5, No. 18), by kind permission of the editor and of the publishers.

4. Posterior drainage is unsatisfactory.
5. Arthrotomy followed by active movement. This originated in Belgium: in British hands it was not a success.
6. Primary excision of the knee is not practised by British surgeons for suppurative conditions.
7. Amputation is required in gross disorganization as a primary measure, in suppurative arthritis, before or during septicaemia, and in severe leg injuries extending into the knee-joint.

Primary amputation is indicated if the condyles and shaft of the femur are split up and there are fragments as high up as the middle of the bone, because the risks of infection with so much loss of substance are considerable. The prognosis of most of these amputations is always grave. Pre-operative transfusion is valuable and the mortality is lower in the primary amputations than in those where delay has been incurred.

The conclusions are, therefore: (a) for articular bullet wounds employ simple immobilization with aspiration or primary excision; (b) for foreign bodies in the joint, arthrotomy and immediate extraction; (c) for fractured patella, excision; (d) for extensive injury, especially with vascular injury, amputation. After all operations on the knee the first dressing should be delayed and the temptation to insert a drainage tube be avoided. No one with a wound of the knee (except the simple perforating bullet wound) ought to be evacuated without surgical exploration. If there has been an arthrotomy, evacuation should be delayed until the twelfth day. For the transfer, the limb should be immobilized, preferably in a posterior half-gutter plaster or an interrupted plaster. It is better if the journey should be of less than twelve hours' duration.

Ankle-joint Wounds.—These are often so extensive that amputation is indicated. When the fracture is limited to one bone treatment on the principles advocated may be carried out. Excision of the astragalus when it is in pieces may help towards joint drainage.

Vessels and Nerves

I have made little mention of injuries of these important structures, chiefly because others are dealing with them. It is pertinent to point out that sciatic nerve-sutures are often required in post-war surgery, but little vascular surgery is required at that date. All wounds of muscle and bone complicated by vascular injury must be classed as grave if a large blood vessel is injured. Secondary haemorrhage is seen far more frequently than in civil practice owing to suppuration. In the thigh and calf (from the posterior tibial) it is serious, and often necessitates amputation. Penetrating wounds of the gluteal region are liable to secondary haemorrhage. This appears to be less common if the wound is opened up as a primary measure. If it occurs when no operative measures have been undertaken and there is an entry and exit wound, the operator should have no hesitation in joining the two wounds. Ligation of the internal iliac is to be avoided.

Amputations.—These are also dealt with elsewhere, though I have frequently mentioned these operations. Amputation of the middle or lower third of the thigh is required only too often: the operator will be in doubt as to the advisability of closing such wounds. In primary operations six silk-worm-gut sutures will often form an excellent closure and save pain in dressing. As a secondary measure this is often unwise. In preference to the guillotine operation, skin flaps may be cut and stitched back. Carrel's tubes may be placed over the muscular mass for a few days, and then the skin flaps freed and allowed to drop over the end of the stump.

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EXPERIMENTAL METHOD IN THE CONQUEST OF DISEASE

SIR EDWARD MELLANBY'S LECTURE

The thirteenth Stephen Paget Memorial Lecture was delivered under the auspices of the Research Defence Society on June 13 by Sir EDWARD MELLANBY, who took as his subject the experimental method in the conquest of disease. Lord LAMINGTON was in the chair.

Sir Edward Mellanby said it was now possible to count the blessings they and their fellow-men had secured as a result of the wide adoption of experimental science and offer up thanks for their good fortune in being allowed to use this method.

"It is my usual habit to pass down Whitehall on the top of a bus at 9.45 each morning. Whatever may have been my daydreams up to this point, I am suddenly brought to life by seeing in a shop window [the premises of one of the anti-vivisection societies] models of some of my own rachitic dogs exposed to the public view. I realize then that I have not always spent my days in an office, and I remember that it is just because it is possible to see these models of deformed dogs that it is difficult to see the same kind of deformities in children throughout the country. In the memory of many of us stunted children with bandy legs were so common as either to pass unnoticed or be a source of amusement. If we saw them now we would be angry, because we would realize they were the products of ignorance or negligence. Many women are still paying the toll of this disease either by their own death in childbirth or by that of their babies. As the present generation of girls become mothers it is certain that this particular disability will greatly diminish."

The lecturer proceeded to define the terms "experimental method" and "experiment," pointing out that there was still a good deal of confusion in the minds of some people as to the difference between experiment and observation. An experiment consisted essentially of changing a condition or conditions by active interference, whereby any effect produced by these changes could be tested. He discussed the parts played by the experimental and the observational method in obtaining information about the working of the body, taking as an example a human disease—Bell's palsy—where the lesion seemed so simple and superficial that the observational method ought to be most effective. Here a problem of long standing was only settled by the experimental method, whereby Bell showed that the condition was essentially a paralysis of the seventh nerve, and further that the seventh nerve was the motor nerve of certain muscles of the face and not of other facial muscles. If all the clinical conditions encountered by the physician were as simple as Bell's palsy the need for animal experiments would be greatly reduced. Usually the physician only recognized what he was looking at because of the knowledge brought to him by the experimenter, who, by simplifying his experimentally produced conditions and analysing their effect, had been able to teach the clinician the functions of each structure and what happened when that structure was absent or abnormal.

Reliability of Experiment

One of the fundamental properties of the experimental method which had to be recognized was that a particular experiment always recorded the absolute truth. The words "good" and "bad" in connexion with an experiment had no meaning at all, except in so far as they reflected the goodness or badness of the experimenter. An experiment might be a bad one for many reasons, but these had nothing to do with the changes of the reacting material of the actual experiment.

"It is this sense of certainty and reliability of the experimental method, throwing as it does the complete onus of the work on to the experimenter, which gives such great intellectual satisfaction to the investigator and puts him on his