THE TREATMENT OF SEPTIC GUNSHOT FRACTURES OF THE FEMUR AND OTHER LONG BONES.

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Compound fracture of the femur in its upper part has been fairly common as the result of bullet wounds during the South African campaign. In a good many cases the wounds have been septic and often the comminution of bone very great. These septic fractures have a high mortality, and as regards their treatment considerable difference of opinion exists.

In the course of the campaign, and particularly in the early part of it, I had under my care a large number of these cases, and could also watch the treatment of other medical officers under similar circumstances. A great source of error amongst many of us, especially in the earlier cases treated, was to regard them from the same standpoint as compound comminuted fractures of the femur seen in civil practice, the results of accidents. The two conditions are essentially different, and the last certainly the more serious. In a compound fracture produced by an accident in civil life, the force being usually from without inwards and of a crushing character, the bruising of muscles and the injury to the vessels is considerably more serious than in those compound fractures produced by bullets, in which the damage is from within, the splintering of bone causing the chief damage to vessels; in addition, although the extravasation of blood may be great there is not such wholesale damage to tissue. This point is worthy of note because it influences the question of immediate amputation. Often, in civil cases, the damage is so great that it is evident the limb will be of little use even if the patient escapes gangrene and other complications.

In my opinion, however great the comminution of bone in a gunshot wound, provided the man survives, it is nearly always possible to obtain a limb of some use, with the proviso that not more than three inches of the bone are actually driven out or removed, which first rarely occurs in gunshot wounds. That men have recovered from septic compound gunshot fractures of the thigh with a flail leg is true, but in many cases this is due
to the removal by the medical officer of large pieces of bone which, being felt loose and separated, have been removed to allay the suppuration, i.e., as the cause of it. I have seen operators insert long forceps into a wound and remove pieces of bone of large size which I subsequently examined and found still covered with periosteum, but which felt to the finger in the wound to be quite loose and separate from the shaft. I have done this myself. I have come to the conclusion that the removal of any pieces of bone at an early stage, unless very far removed from the shaft, is a mistake and usually unnecessary. It is marvellous how these pieces will weld together in time, also how few necrose, and although one feels with the finger bare bone, apparently denuded of periosteum and quite separated, in time, after only slight loss of its substance, it will become united with other pieces often in a similar condition.

Amputation above the middle third of the thigh in cases which are septic and have been so over a week is almost invariably fatal. Two alternations are advocated if amputation is essential: (1) Amputations within forty-eight hours of reception of wound. This, on the field or even in a field hospital, is a very serious undertaking and should, as a rule, only be undertaken if there were grave fear of gangrene or for a few other critical conditions. The fact alone of the wound commencing to be septic would hardly justify amputation on the field (that is, whilst still with a bearer company or convoy). (2) To wait until the wounds are healthy, until the patient is in the best of health possible, in the best surroundings, and then under these conditions to amputate.

In both these alternatives the risk is very great and the mortality high. These septic gunshot fractures if energetically and properly treated do remarkably well, and there should be but few cases in which amputation is ultimately necessary. To give an example of the worst type of case: A trooper was admitted to hospital with a gunshot wound of the upper part of the right thigh. He had been dressed once on the field, by a friend, I believe, and once subsequently at an out-station. When admitted the wound was a week old, suppurating profusely, and stinking. Under an anaesthetic the upper part of the femur, including the great trochanter, was found to be shattered, the splintering being longitudinal as well as transverse in direction, the bone being powdered in parts and loose pieces lying about in the neighbouring muscles.
The upper part of the femur, in fact, was in four or five pieces, with the part immediately where the bullet had struck either powdered or in fragments varying in size from a pea to a walnut, and extending longitudinally over two and a half inches. In addition, the wound was suppurating profusely. The man's temperature ranged between 101° and 103°. This apparently was a hopeless case; edema and redness extended well up the buttock, and it appeared highly probable that suppuration would shortly extend to the pelvis and abdomen up the intermuscular layers of tissue.

One need not here describe his particular treatment, which was very much on the lines described further on. The high temperature continued with very little remission for three weeks or more, operations were frequent, the patient wasted extremely, and the amount of pain involved in his treatment very great; the question of amputation was mooted to give him "his only chance." The discharge was extremely profuse and extension of suppuration occurred in all directions, requiring frequent and free incisions. The treatment was maintained, and at the end of a month the temperature began to range lower, the fracture showed signs of uniting, the discharge became thinner and less foul, though still profuse. Practically no bone was removed throughout. The man made a good recovery and ultimately got off with about two inches shortening, and, I believe, a small sinus.

As to the treatment of these cases: On admission to hospital, the case being found to be septic, an anaesthetic should be given as soon as possible, and the wound carefully explored with the finger (the surgeon operating must be the surgeon who carries out the subsequent dressings, the practice of one surgeon operating and another surgeon subsequently attending to the case is unfair both to the patient and to the surgeon in charge of him). Loose pieces of bone lying in muscle and with tissue separating them from the shaft should be removed at once; pieces of bone lying near the shaft with no intervening tissue should be left (it is not always possible to discover with the finger that these have lost their blood supply, i.e., are denuded of periosteum, and unless they are very small they should be given a chance). The exact position of the loose fragments should be felt and remembered, as this often gives a clue to subsequent increase of suppuration.
A longitudinal incision, at least three inches in length, should be made at the back of the thigh down to the fractured portion of bone, and carried round the bone, establishing communication with one of the original wounds. One large, or better two (half an inch in diameter), indiarubber tubes should be passed through from the front or laterally to the posterior incision (if there is a large cavity in the bone pass the tubes through it if possible). Wash out thoroughly with warm (1 in 40) carbolic solution—temperature 116° F. The posterior incision should always be made in these cases, it is impossible to secure good drainage without it. Generally it will be found necessary to enlarge the point of entrance or exit of the bullet. All cavities felt by the finger likely to allow pus to accumulate should be connected with the posterior incision either by drainage tube or by incising intervening tissue. Copious dressings should be applied. An X-ray photograph should be taken generally within the first twenty-four hours, if possible. If the bullet is still in the body, and has been localised about the neighbourhood of the fracture, it should be removed. If, however, it is lying at all away from the septic area and is doing no harm, it is bad practice to incise the healthy tissue in order to remove it; the probabilities are that the fresh wound will also become septic. Care should be taken in drawing conclusions from the X-ray photograph as to the positions of the fragments of bone as regards one another and with regard to the shaft. These skias-grams are very deceptive, much depending on the angle at which taken. Most erroneous ideas of the nature of the fracture may be drawn from them. Further reference to X-ray pictures is made at the end of this article.

In the subsequent treatment, splints, as a rule, are not required; they give great additional pain in dressing and should be avoided as much as possible. Even an extension is rarely necessary, the exception being usually when there is no comminution. Shortening through muscular contraction is the rarer the greater the comminution. “Jumping” of the muscles is rare with comminution. It must be borne in mind that the condition of the patient is so serious that saving his life must be the first consideration, saving the leg the second, whilst the question of shortening must be relegated to the background. In badly comminuted fractures of the thigh, it will be found that if the leg is laid in position between sand-bags, that there is very little tendency to shortening after
the first forty-eight hours. If splints are discarded, dressings are more easily applied; it is easier to irrigate the wound, there is less pain, since the splint often presses on the wound or its neighbourhood, no splint sores (these are usually impossible to prevent when splints have to be taken down once or twice a day, and when the patient is wasted and septic), no pain from taking off the splint, and continuous irrigation will be possible, whereas with a splint it is impossible.

Difficulty will occur at first in using the bed-pan, but mechanical extension from the foot, during its use, minimises the pain, and it is astounding how quickly the patient gets callous to the leg being handled and moved. It is well not to be too sympathetic with these patients. Prolonged fever, weakness and pain tends to make them highly hysterical, and unless great firmness is shown both by the nurse and medical officer it will be found impossible to carry out the treatment properly, and almost certainly a fatal termination will ensue. In the worst cases irrigation twice a day will be found to be quite inadequate. It will make no appreciable difference in the amount of suppuration, the rapidity of the extension into surrounding tissues, or impair appreciably the general condition of the patient by diminishing septic absorption. It only remains in these cases to contrive some form of apparatus which will allow continuous irrigation to be carried on for many hours, or throughout the day.

From the results of cases treated energetically in this manner, I consider that its adoption gives the best results, and in many cases offers the only chance of life to the patient. If efficiently performed it will allay the most virulent forms of suppuration. For its efficiency, intelligent co-operation on the part of the nurse or orderly is required, patience on the part of the medical officer, attendant and patient. Time after time it will be found that the irrigating fluid has been sucked up the back of the patient, and that the whole bedding is soaked, and artful contrivances must be improvised to prevent it, the carrying out of which will depend largely on the ability of the nurse. For example, I have irrigated successfully thighs with wounds as high as the folds of the buttock without, after the first trial or two, any water escaping into the bed.

The best antiseptic to use is half a drachm of tincture of iodine to one pint of hot water (temperature 116° F.). To maintain the
water at a high temperature is the most important consideration. The rate of flow should be three pints to the hour at least, and so contrived that the fluid reaches every possible part of the bone and surrounding cavities, two irrigators being used if one is not sufficient. Preliminary rapid irrigation should be done every day and the wound explored with the finger at the same time, if the patient can stand it (the patient will often become tolerant of this in a day or two), if not, under an anaesthetic every second or third day. The duration of the irrigation each day depends greatly on the patient and the nature of the fracture. Some cases will suffer no inconvenience from it, and in fact like it, others after one hour or so at the onset of treatment will complain of pain usually from the nozzle of the irrigator in the wound. It is best then to discontinue the irrigation for a time, gradually lengthening the period each day.

The treatment must not be given up because no immediate diminution of temperature takes place. The temperature may keep as high as previously for seven, ten, or even fourteen days, and even, as in the case of a septic fracture of the humerus under my own care, until after some union has taken place. A more important point is whether the surrounding oedema and redness are diminishing, stationary, or extending, or, as in very septic cases further sloughing of the muscles takes place, whether pus is still "eating out" pockets in the tissues, and whether the wound is markedly less foetid. The temperature is only a small consideration at first as to the effectiveness of the treatment. The best arrangement for carrying out continuous irrigation in fractures of the thigh is to slope the bed by placing hernia blocks under the upper end and allowing the water to flow into a pail at the foot. The other method of allowing the water to run through a hole in the bedding into a pail beneath is only possible in fractures of one bone of the leg, not the thigh, because of the pain produced at the seat of fracture by having practically no support under it, and by the difficulty in keeping the water out of the bed. In the first method, the patient is placed with a ring air-pillow under the buttocks and jaconet is fixed by strapping across the tips of the buttocks and carried down to just above the posterior wound. A mackintosh sheet passes from the foot of the bed up over the ring pillow. The slope of the bed is made about one foot in six or more. Padding is placed under the leg between the pillow
and the fracture, beneath the mackintosh, and so arranged that the leg lies evenly on the mackintosh and with no antero-posterior bend at the seat of fracture. Laterally the mackintosh is carried over the sound leg on one side and over sand-bags on the other, forming a trough sloping down to the foot of the bed. A cradle can be placed over all and the other leg and body kept warm with blankets, one of which can be carried over the cradle.

Patients bear the actual treatment extremely well. There is no exhaustion or collapse, and it is quite possible, if necessary, to keep the irrigation going continuously. I have done this in a gunshot fracture of the fibula in which the septic process was most intense, whole masses of muscle sloughing in a few hours, and had an excellent result; but I have not done it in femur or humerus cases, finding six to twelve hours in the twenty-four sufficient. The actual preparation of the patient for the process is generally at first accompanied with pain, but as there are no splints to take down, the actual movement is limited to placing the mackintosh, &c., into position. Pain, from digital exploration, which, as before mentioned, should be done daily if possible, gradually diminishes as the patient gets accustomed to it. The larger the irrigator used the better. It can be easily suspended from a screen. An orderly must attend to it every fifteen or twenty minutes to insure the temperature of the water being maintained. The rate of flow can be controlled by a stopcock, or if that is not available, by string tied round the tubing. The end of the glass nozzle in lateral wounds must be inserted into the wound, but if on the upper surface, the nozzle can be fixed with tapes so that the point is immediately over the wound. It is best, however, to insert the nozzle and alter the position from time to time. The whole wound should be covered with lint dipped in a solution of 1 in 20 carbolic acid, a hole being made through it for the nozzle of the irrigator. I consider on the whole that it is better to remove the drainage tubes before irrigation, as they often prevent the fluid diffusing over the tissues, conducting it straight through; however, if removal causes much pain they can be left in situ.

The use of hot-water baths is of course mechanically impracticable as regards fractured femur cases, and also generally in fracture of the tibia. In fractures of the humerus as well, especially of the upper end, it is impracticable; even if practicable it is not to be preferred, as the current of water properly directed gives
better results in cleaning up the wound and in preventing extension of suppuration.

In exploring septic wounds to discover fresh tracts of suppuration great care should be exercised. Indiscriminate incisions into healthy tissue through the old wound will render that tissue septic, and it is common to see, instead of improvement, a still higher temperature within forty-eight hours. Increase of temperature in the patient with a septic fracture is by no means a positive sign of extension of suppuration in the soft tissues. I have frequently myself on the strength of a rise in temperature explored a wound and made incisions in neighbouring tissue, especially in slightly oedematous parts, expecting to find pus and have found the tissue quite sound. The signs of extension of suppuration in this class of case are very uncertain, oedema, perhaps redness plus a rise in temperature are the most certain indications, but by no means infallible. For example, I had a case of septic gunshot fracture of the thigh about the junction of the middle and upper third, the patient had a fairly high temperature, gradually descending after about ten days' irrigation. On the fourteenth day the temperature rose for no apparent reason to 103°F., on the sixteenth day oedema and some redness appeared in the upper part of the popliteal space, four inches from the wound, with apparently healthy intervening tissue; next day the part was markedly swollen. Mr. Makins then saw the case and advised waiting a short time, and then, if the symptoms did not abate, exploring the swelling. I ultimately incised and found absolutely nothing to account for the signs. The patient's temperature gradually descended and he ultimately recovered. Probably the true cause of the rise in temperature was an increase in the suppuration about the fracture and some retention of the pus which ultimately was washed away unnoticed in the continuous irrigation.

I have neither seen nor heard of secondary hæmorrhage occurring in cases treated by continuous irrigation, although I have seen several in ordinary septic cases not so treated. I do not infer that this is a proof that secondary hæmorrhage cannot or does not occur in continuous irrigation, but maintain that the process certainly does not tend to increase the liability to sudden hæmorrhage; however, although I have not seen it occur, it is wiser to have a special orderly over the patient whilst irrigation is going on. Treatment by continuous irrigation has been prac-
tised in septic conditions for several years now, but its systematic use in these dangerous cases of gunshot fracture has, so far as I know, not been very frequently attempted. You have in this class of case a condition in which amputation is generally impossible on account of the debilitated state of the patient, so that the alternative is to strive by every possible means to prevent the extension and continuation of septic processes. Theoretically, continuous irrigation presents the greatest possibilities, and I think from my own experience it will be found practically to be the most efficient means of treatment. The main point is not to be soon disheartened by the difficulties in carrying it out, they are more apparent than real, and can be overcome; also to remember that it is the life of the patient that has to be saved and that, under the circumstances, questions of treatment for shortening, &c., must be disregarded, if the man's condition is critical, as it is generally in these cases.

As regards subsequent shortening in these cases, it may be said that it varies considerably in degree within limits. Measurements should be taken two or three times a week. If, in a particular case, it is at all excessive, that is, two inches or more, a skiagram should be taken to ascertain whether the fragments are overlapping or forming an angle with one another. With care, this should rarely happen with much comminuted fractures. To place the leg in splints or use an extension because there is shortening alone, without first ascertaining its actual cause, is bad practice. Shortening will take place in these cases, without either overlapping or angular union, and in this class an extension is likely to do more harm than good, delaying, if not preventing, union, besides considerably interfering with the treatment of the septic condition. Should there be overlapping or an angular position of the fragments, the treatment must depend almost entirely on the septic condition of the wound, and also on the bone fractured. For instance, considerable shortening of the humerus can occur without much subsequent inconvenience to the patient, and consequently that condition may be left without treatment, if by doing so the chances of saving the limb are at all improved. If it is found by X-rays that there is overlapping in a case of fractured femur, splints and extension may be tried for a time; however, if the patient gradually goes down hill, and suppuration extends, the splint or extension or both must be dis-
carded and the shortening must take its chance. Whenever shortening is more than two and a half inches, some or the greater part of it is due generally to overlapping produced by muscular spasm; an extension applied for forty-eight hours will usually overcome this, and the extension can then be discarded. Shortening to the extent of four inches or more, if permanent, is generally the result of bad treatment or want of care on the part of some one. Such shortening, if discovered early enough, can almost always be considerably reduced.