healed by first intention, a little moisture from sero-pus being not sufficient to interfere with this process or delay it.

CASE III.

Pte. E., wounded July 4th, 1916. Amputated in uppermost third of thigh August 4th. The thigh was massive, and the patient was fat. The stump was very short. A large cauliflower granulation covered the end of the bone. This was surrounded by a broad band of cicatricial healing, and beyond this there were retracted and fleshy soft tissues.

On November 30th an incision was made along lines separating the skin and the cicatrix and the whole cicatrix and the granulation mass dissected off in one piece. On separating the cauliflower granulations a ring sequester was struck, and this was separated also. The skin and subcutaneous tissues were freely dissected up to allow of sufficient flap area to cover so large an exposed area and the protruding bone. This was accomplished, and two sets of button-sutures were put in. The skin edges were closely sutured as for a clean operation, and two small drainage tubes were put in at opposite angles in the wound.

The whole of these extensive edges healed by first intention, except the drainage tube openings, which united by second intention. The button-sutures were removed on the twelfth day, two days after the last of the skin stitches.

On the thirteenth day, all the edges having been firmly united, the temperature rose, there was much pain, and fluctuation appeared at the outer angle of the stump. So securely were the edges united even over this area that neither a sinus forceps nor a sharp probe was able to penetrate the cicatrix, and the abscess had to be opened along the line of union by a sharp-pointed bistoury in the ordinary way.

After three days this abscess evacuated, and the whole was securely united on the twentieth day. The man says his stump is lengthened, which is true. It is lengthened by the thickness of the skin and subcutaneous tissues covering the end of the bone.

CASE IV.

Pte. W. Amputated through lowest third of thigh. On arrival at hospital the end of the bone covered by granulations protruded about $\frac{1}{2}$ in. beyond the epithelial margin of new skin, and the band of new cicatrix was about $\frac{1}{2}$ in. wide. The skin and soft tissues were much retracted.

On November 11th, two elliptical incisions were made in front and at back of the protruding bone, and about two inches of bone was dissected out and removed. Similar treatment to the above was followed. This stump suppurated badly. The temperature was high, the pain was considerable, and the stump swelled considerably, putting much tension on all the sutures, so much so that the buttons of the button-sutures were half buried in the skin. Pus welled out from between the skin stitches and from the drainage tube openings. But the button-sutures stood the test, and the edges united by the second intention. The two tube-openings and one central point where a small tube had been put on the fourth day showed granulation points of the size of split peas for several days longer, and then healed over on the twentieth day, and he left for a week's leave on the twenty-first day.

In the absence of button-sutures all the above cases would have hopelessly broken down, and the last state would have been worse than the first—the bone shorter, the granulating surfaces greater, and convalescence much protracted.

There are two factors that favour union in this method of reamputation. One is the increase in general vascularity that follows primary amputation. The largest vessels atrophy, but the small ones dilate. This dilatation of the numerous small blood vessels makes provision for a more general blood supply throughout the operation area, and guarantees a higher vitality. The pressure of the buttons is therefore of little or no consequence.

The other factor is that the skin and muscular tissues have already contracted to their maximum. There is little fear, therefore, of a further contraction when the attachments that have followed the primary amputation are disturbed by the reamputation. Shorter flaps will therefore suffice, and the "pull" over the end of the bone exerted against the button-sutures is less than one would suppose.

A consideration of these points would lead one to suggest:

1. Early reamputation and the saving of weeks of painful and tedious healing.
2. The control of bony proliferation, the avoidance of spurs, and the protection of the bone-end from infection, by careful technique in the treatment of the periosteum.
3. The covering of the end of the bone with muscle fascia and skin in such a way as to (a) approach the normal heel as a model and (b) provide for the most distant muscle attachments possible.
4. The use of button-sutures in every case of primary and secondary amputation where the flaps are large and the skin is stitched, in order to (a) keep severed muscles and tendons as nearly as possible

in apposition, (b) give immunity from the results of suppuration if it occur, (c) prevent haemorrhage between the flaps, (d) give the minimum area of flaps and the maximum length of stump where shortness is a locomotive disability.

A METHOD OF FLAPLESS AMPUTATION, WITH SUBCUTANEOUS DIVISION OF THE BONE AT A HIGHER LEVEL.

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THE guillotine method of amputation as practised during the present war conveys at the first glance an impression of brutal simplicity which carries one back to the primitive ages. Nevertheless, it is probable that this method is one of the most valuable innovations the war has brought forth, and that for certain conditions it is the Omega as well as the Alpha of the subject of amputation. Its introducer, Captain Fitzmaurice Kelly,¹ is to be congratulated on his clear vision and courage. The main advantage gained by the method is that it exposes to infection the absolute minimum of raw surface.

The method is, however, attended by certain disadvantages and inconveniences. In some cases the skin eventually succeeds in spreading over and covering the exposed end of the bone. But even in these rare and favourable cases the bone is adherent to the skin. In the majority of cases the exposed end of the bone undergoes necrosis, owing to a simple acute osteomyelitis extending a little up the medullary canal. After the separation of the necrosed fragment a really good stump might conceivably result. But in point of fact the end of the bone always becomes adherent to the skin. Two cases recently under my care presented very similar conditions, and may be taken as typical. A bare necrosed piece of bone, still continuous with the living portion of the bone, projected from a raw, granulating surface corresponding to the original section of the limb. This surface was much smaller than the original cross-section owing to the spread of epithelium over the end of the stump and the contraction which always accompanies this process. In the neighbourhood of the bone this layer of granulation tissue becomes calcified or ossified almost up to its free surface, and adhesion of the bone to the skin is the inevitable result. Thus, in nearly all cases of guillotine amputation a secondary operation is imperative. The object of this paper is to suggest the trial of a method which, while retaining all the important advantages of the guillotine method, will obviate the necessity of a secondary operation. It is also, I think, the best way of doing the secondary amputation in cases previously submitted to the Kelly method, and with such cases I propose first to deal.

Secondary Amputation Following the Kelly Amputation.

In such cases it is necessary (a) to remove such a length of bone that an adequate covering of soft tissue is provided for what remains. (b) To excise the calcified granulations, which do not afford a suitable bed for the spreading epithelium. If calcified granulated tissues are allowed to remain, it is certain that ultimately the skin will be adherent to the end of the bone. (c) To do what is necessary with minimum exposure of fresh raw surfaces, since all these cases are necessarily accompanied by sepsis.

It is obvious that a formal flap amputation is unnecessarily extravagant and that it fails to fulfil the third requirement of a minimum exposure of fresh raw surface. This method, therefore, need not further be considered.

In the first case upon which I operated I made two lateral cuts upwards through the soft tissue at the side of the stump, thus fashioning two rough flaps. The bone was sawn through at the base of these flaps and they were then brought together by a few points of suture. This operation was followed by an alarming febrile disturbance, which, however, subsided in a few days. Its ultimate result was not satisfactory, for the skin was adherent to the bone. I had omitted to observe the second requirement—namely, to remove the ossified granulation tissue

MAJOR W. A. CHAPPLE: REAMPUTATION.

FIG. 1.—Pte. K., condition when left thigh was reamputated.

FIG. 3.—Pte. W., condition when reamputated.

FIG. 2.—Pte. K., sixteen days after reamputation of left thigh.

FIG. 4.—Pte. W., four days after reamputation.

SIR WILLIAM J. COLLINS: FRAGMENT OF SHELL CASING EMBEDDED IN ORBIT.

FIG. 1.—Side view.

FIG. 2.—Front view.

FIG. 1.—Guillotine amputation of thigh, showing extreme retraction. The patient was admitted under the writer's care to the 3rd London General Hospital several weeks after the primary operation in France. A plaster extension would probably have prevented much of the retraction.

FIG. 2.—Complete healing of a flapless amputation. Note the close adhesion of the skin to the bone at the end of the stump. A secondary operation was necessary. Photographs kindly lent by Mr. Edred M. Corner, under whose care the case was admitted at the King George Hospital.

FIG. 3.—Guillotine amputation of the arm performed about six weeks before the photographs were taken. From a case under the care of Mr. Edred M. Corner.

FIG. 4.—Illustrating first stage of amputation of the thigh—the subcutaneous division of the bone.

FIG. 5.—Final stage of removal of limb. The assistant pulling strongly on the limb withdraws it from the stump almost like a cork from a bottle, the operator meantime dividing the muscular attachments to the bone.

FIG. 6.—Guillotine amputation of the thigh. Secondary amputation by the Gigli saw method. The stump nearly healed. The depressed cicatrices of the Gigli saw punctures are well shown. The stump is soundly healed with very little retraction. From a case under the author's care at the 3rd London General Hospital, Wandsworth. Drawing by Private E. Martin, R.A.M.C.

round the projecting necrotic bit of bone. Shortly afterwards I was faced by the same problem again—a guillotine amputation of the thigh about the middle, with projection of the necrotic end of the femur. It seemed feasible to minimize the exposure of raw surface by dividing the bone at the selected level by a Gigli saw. Two punctures were made at the end of the bone at the outer side of the limb, separated by about one-third of its circumference. Each of these punctures was situated four inches above the end of the stump. Through one of them a curved pair of forceps was introduced closed, and was insinuated round the bone until it was able to seize the end of the Gigli saw introduced through the other puncture. The pair of forceps was then withdrawn, bringing with it the saw. The bone was now divided, care being taken not to rasp the soft tissues. It would be possible to employ a pair of tubular guards to prevent the saw from bruising the soft tissues, but this is a refinement which is not essential. The punctures are made on the side of the limb remote from the main artery so as to avoid all risk of injury to the large vessels by the action of the saw. The end of the bone was now seized by lion forceps and with the aid of a periosteal elevator was easily separated from the soft tissues and removed. It only remained to excise the layer of calcified granulated tissue and to insert one or two sutures, making ample provision for drainage.

In this case there was only slight febrile reaction, and healing was rapid and satisfactory. The healing is now nearly complete, and the soft tissues are not adherent to the bone—in fact, the stump is very satisfactory. I venture to bring forth this method as being probably the best secondary operation for cases of guillotine amputation.

Division of the Operation into Two Stages in Exhausted Patients.

In patients exhausted by long-continued suppuration it may even be advisable to perform the little operation in two stages. The first stage is the subcutaneous division of the bone at the selected level. This operation should run an aseptic course. In a few days the ends of the marrow canal will be sealed by a layer of granulation tissue, and the isolated distal end of the bone can be removed with a minimum risk of osteomyelitis in the proximal end.

Amputation with Subcutaneous Bone Division as a Substitute for the Flapless Method.

It is evident that the method could be used for primary amputations, and I have successfully employed it on several occasions. The case now to be recorded illustrates its use.

On July 31st, 1915, I was asked by Dr. Erskine of Epping to see with him in consultation Miss X., a Red Cross nurse. Dr. Erskine informed me that when he first saw her, on July 25th, she was suffering from pain and swelling of the left thumb. Between July 21st and 25th she had been on duty each night at the hospital. On the night of July 24th she had acute pain in the thumb and felt ill, and the following morning, when Dr. Erskine was called in, the thumb was very inflamed and septic. The condition became worse and the inflammation spread to the forearm. When I saw her on July 31st there was extensive suppuration between the muscular planes of the forearm, and the patient was in a high fever and seriously ill. I judged that an attempt could safely be made to save the arm, and, after amputating the distal phalanx of the thumb, I made many free incisions of the forearm as high as the elbow and secured very free drainage. Temporary improvement occurred, but the patient again became worse, in spite of vigorous and able treatment by Dr. Erskine, and on August 7th I saw her again. In a specimen of blood taken on this date pure growth of streptococcus was obtained, and it appeared imperative, in view of this examination, to amputate the arm. This was done on August 12th through the middle of the humerus.

The amputation was performed by the method described in this paper. Two punctures, separated by one-third of the circumference of the arm, were made down to the humerus at the level selected for the saw cut. A Gigli saw was passed round the bone by the manoeuvre already described, and then the bone was divided. The soft tissues were now divided circularly at a lower level, the muscles being cut rather shorter than the skin. A few touches of the knife now sufficed to detach the muscle from the bone up to the point where it had been sawn.

The amputation wound suppurated freely; and this is not surprising in view of the infection of the blood which was known to be present. From the time of the operation the septic symptoms rapidly subsided, the temperature fell, and the patient made a good recovery.

In the healed stump the two punctured tracks made for the introduction of the saw are represented by two puckered

dimples on the skin. Evidently the band of fibrous tissues attaches the skin to the bone along the course of the tracks. This might be held as a disadvantage of the method, but I believe in reality it is an advantage, for these two bands of fibrous tissue serve during the healing of the stump to prevent retraction of the soft parts and exposure of the end of the bone. The method also has the advantage that the bone is divided as the first step in the operation. The length of the circular cuff of soft tissue required to cover it can then be precisely calculated. In the ordinary methods of amputation it is very easy to make the mistake of dividing the bone lower than was intended, especially if the assistant does not retract the soft tissues vigorously. The operator then finds that he has provided inadequate covering for the end of the bone.

I am inclined to think that this method may usefully replace the guillotine operation except in cases where extreme rapidity is required, and that in this way the necessity for secondary operation on guillotine stumps may in future be avoided.

The important object of the guillotine operation is to reduce raw surface to a minimum, and in this respect the method described in this paper is practically as advantageous. I trust, therefore, that the amputation method here described may receive a trial at the front. The situations where the method is applicable are in the thigh and the upper arm. It is possible that the method may be extended to the forearm and leg, but, owing to the presence of two bones in these situations, and to the relative thinness and easy retraction of the covering of soft tissues, the ordinary methods of amputation would seem to be preferable. The advantages of the method come out most strongly in amputations through the femur, and I believe that in this situation the method will supersede all others, not only on the grounds of simplicity, but also because the resulting stump is well-cushioned and non-retractile. In these respects I claim that the stump is perhaps better than can be obtained by any other method.

The passing of the Gigli saw round the bone may be difficult if the tissues are stiff and rigid from inflammatory infiltration. In these circumstances a suggestion of my friend Mr. Lawrie McGavin may be adopted, namely, to divide the bone subcutaneously by an Adams's saw. At the present time it is difficult to obtain efficient Gigli saws, since most of them before the war were made by an enemy firm, and some of those now upon the market do not cut hard bone very easily. In situations where the main artery lies close to the bone, the use of an Adams's saw requires care, and the rule should be to cut towards the artery and to fracture the last portion of the bone.

The skin should be retracted before the muscles are divided.

The only superiority of the flap amputation over the circular amputation is that it affords access for division of the bone at such a high level that a plentiful covering of soft parts is assured to the stump. In such a fleshy part as the thigh long flaps are necessary for this purpose, and the severity of the operation is thereby considerably increased. The method I have described is attended by the minimum of shock, haemorrhage, and division of tissue, virtues it shares with the Kelly method, while averting the necessity of any secondary operation.

REFERENCE.

¹ M. Fitzmaurice Kelly: The Flapless Amputation. *British Journal of Surgery*, April 16th, p. 676.

THE library of the College of Physicians of Philadelphia at the end of 1916 contained over 115,000 bound volumes, and nearly as many unbound theses and pamphlets. A considerable falling off was noted in 1915 in the number of books published in the French and German languages, and in Great Britain. During 1916 there was a relative increase in the case of Great Britain and a greater diminution in German publications. This, as is pointed out, is not to be taken as an indication of the number of books published. One of the features of the library are study-rooms, where a Fellow engaged in some particular research can work in peace and leave the books he is using from day to day. The popularity of these rooms is increasing. The librarian, Mr. C. P. Fisher, laments the difficulty of excluding dust from his stacks and shelves. The dust contains a large percentage of soot, which cannot be removed entirely even with a high-power vacuum cleaner. It is thought that electric lighting, combined with forced ventilation, and windows as nearly air-tight as possible, will afford a remedy.