THREE CASES OF FRACTURE IN THE NEIGHBOURHOOD OF JOINTS TREATED BY PLATING.*

[WITH SPECIAL PLATE.]

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THE three cases which form the subject of this paper will be related in some detail, because they serve to illustrate certain controversial points both as regards the treatment of fractures in the neighbourhood of joints and the employment of internal splintage in cases of compound fracture.

CASE I.

The first case is that of a domestic servant (J. D., aged 18), who was admitted to the Royal Infirmary on July 29th, 1913, and dismissed on September 3rd following. I am indebted to Professor Marnoch, under whose care she was, for permission to publish the case. On July 29th the patient fell off her bicycle on to her right elbow and sustained a severe compound fracture near the elbow-joint. The broken end of the shaft of the humerus pierced the skin on the posterior surface of the arm. The wound was ragged, about three-quarters of an inch long, and there was a smaller wound of the "burst" type. There was a considerable amount of swelling near the joint. The bone was replaced and the wound dressed with cyanide gauze. An internal angular splint was applied until the swelling should have subsided. The *x-ray* plates taken the day after the accident (Figs. 1 and 2) showed that there was a T-shaped fracture of the humerus with the upright part extending into the elbow-joint. The lower fragments had been displaced upwards and forwards. The amount of shortening was an inch and three-quarters. The patient's temperature remained normal, the swelling subsided, and the wounds healed.

On August 9th, eleven days after the accident, an attempt was made to reduce the fracture under a general anaesthetic, but no diminution of the shortening could be produced. The site of the fracture was therefore exposed through the middle line of the triceps, the scars of the wounds being enclosed in the skin incision, which was $4\frac{1}{2}$ in. long. It was necessary on two occasions to feel with a finger in the wound for the lower fragments. These could not be seen, as they had been forced well into the brachialis anticus muscle, which intervened between the three parts of the broken bone. By means of a Lane's bone-holding forceps applied during partial flexion of the forearm, combined with its forcible extension downwards, the lower fragments were with great difficulty brought out of the wound. They were seen to have been largely denuded of periosteum on their posterior surfaces. The triangular plate seen in Fig. 4 was secured to them. It will be remembered that the lower end of the humerus has a peculiar shape, the bone being much curved, and that whereas the condylar portions are relatively thick, the bone which separates the olecranon fossa from the coronoid fossa is very thin. The plate used is the only plate readily procurable which meets the needs of this particular case. To have fixed the plate to the lower end of the humerus first, and later to the fragments, would have been difficult, if not impossible. In the first place, because the lower fragments could not be maintained in the correct position and close up to the plate with a sufficient degree of firmness to allow of the screws being properly inserted, and secondly, because it would have been difficult to ascertain the correct position of the upper part of the plate on the shaft of the bone so as to make sure that the screw holes in the lower parts would be situated over the thicker portions of the fragments. While the lower fragments were being fixed, the shaft

of the humerus projected backwards beyond the upper part of the plate. After their fixation the lower end of the shaft was brought in front and placed in the angle formed by the plate and the fragments, and then backward extension was made until the plate was in apposition with the back portion of the lower end of the shaft, thus bringing all three pieces of bone into correct alignment. The strain on the screws in the lower fragments during this manoeuvre was considerable, but there seemed to be no other way of obtaining correct alignment. The upper screw was placed in position, and then the middle screw, which it will be seen passed through both the shaft and the lower and outer fragment. The periosteum was intact over the posterior portion of the shaft, and the plate was placed over it. The triceps aponeurosis was sutured with catgut and the skin closed with silkworm gut. An external angular splint was applied and the arm bound to the chest. The operation took two hours to perform.

Gentle passive movement of the elbow-joint was commenced on the third day and continued every other day without producing pain. The wound healed by first intention. The *x-ray* photographs taken on August 12th and 13th (Figs. 3 and 4) show the position of the fragments in antero-posterior and lateral views. It will be seen in Fig. 3 that there is a small piece of bone left free in front of the humerus, possibly it is in the brachialis anticus muscle. Gentle massage and passive movements with occasional active movements were continued until the patient left the infirmary, three and a half weeks after operation. At this time the biceps and triceps were acting well, the movements of flexion and extension at

the elbow-joints were well performed, but were stiff, especially in complete extension. Pronation and supination were perfect. The circumference of the arm at the site of the transverse portion of the fracture was one inch greater than on the sound side at the same level.

Seven and a half weeks after the operation movements of flexion and extension were gently carried out under chloroform. The movements were accompanied by considerable cracking of adhesions, especially near the lower end of

the scar, where the aponeurosis of the triceps was adherent to the skin. A certain amount of swelling appeared after this, especially towards the back of the joint, and the skin became discoloured. There was much pain in the arm for three days. There was no evidence of sepsis. On November 7th, thirteen weeks after the operation, and for no other reason than that the arm was still swollen, the plate was removed. It was found to be covered at the back with a layer of granulation tissue, the upper screw was slightly loose, but had to be rotated before it could be withdrawn. The three other screws were quite firm. The fragments had apparently united in good position. The scar tissue between the skin and the triceps muscle was freed and the wound closed. This wound healed by first intention. An *x-ray* photograph taken on November 18th (fourteen weeks and two days after the plating), seen in Fig. 5, showed that there was a curious and interesting buttress of bone extending from just below the transverse portion of the fracture to a point some 3 in. higher up the shaft. The small fragment of bone before mentioned is hidden by the lower part of this new formation. The site of the transverse portion of the fracture has apparently yielded very slightly, so that the lower fragments are a trifle more flexed than immediately after the operation. Skiagrams were taken on subsequent dates up to seven and a half months after operation, with a view to observing any changes that might occur. There was a certain amount of diffuseness of outline, especially of the lower fragments; the buttress of bone became denser and the central cavity smaller. It seems to me that the probable explanation of the buttress of bone is that at the time of the accident a layer of osteogenetic cells on the surface of the bone was carried forwards with the periosteum into or towards the brachialis anticus muscle. The severity of the blow probably drove the lower fragments upwards and forwards—that is to say, the displacement was caused by the blow and not by subsequent muscular action, and the osteogenetic layer and periosteum were forcibly stripped off the shaft. The osteogenetic

DESCRIPTION OF SPECIAL PLATE.

Fig. 1.—Case I: One day after accident.

Fig. 2.—Case I: One day after accident.

Fig. 3.—Case I: Three days after operation.

Fig. 4.—Case I: Three days after operation.

Fig. 5.—Case I: Fourteen weeks after operation.

Fig. 6.—Case II: Eighteen months after operation.

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FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

cells then produced new bone. The diffuseness of outline is possibly due to the absence of periosteum on the posterior aspect of the lower part of the bone, there being no membrane left which definitely limited the production of bone in this situation. This case illustrates very well the importance of x-ray examination long after operation. Looking only at the plates taken shortly after operation one would be inclined to say that the result is good.

On January 16th, 1914, nearly twenty-two weeks after the operation, the condition of the arm was as follows: It was the same length and diameter as its fellow. The biceps and triceps acted strongly and freely. The lower part of the triceps was adherent to the skin. Flexion and extension were performed freely and without pain. The movement of extreme flexion was 5 degrees of arc less on the injured side, and the movement of extension was 40 degrees less. The exact cause of limitation was not clear. The uninjured arm has 150 degrees of arc as its full complement of flexion and extension, and on the injured side 105 degrees were present, the chief loss being in full extension, as already mentioned. Pronation and supination were perfect. The joint did not grate or crack when moved, except in extreme extension. There was no "rheumatism." This is the condition now, seven and a half months after operation. Probably arrangements will be made for a course of Tallerman baths, and, later on, perhaps movements of the joint under chloroform will be carried out, but at the present time it is too early to say whether the ultimate result will be better or worse than at present.

CASE II.

The second case was sent to me by Dr. Gibb. A single woman, aged 48, on July 30th, 1912, was getting over a three-foot fence, when she tripped forwards and caught her right foot in some heather, sustaining a compound fracture of both bones of the leg at the same level—namely, 2 in. above the ankle-joint.

The fracture was put in splints by the local medical man, and the patient conveyed to a nursing home, a distance of about 18 miles, without further injury to the leg. There was a clean-cut wound, half an inch long, on the outer side of

the leg, leading to the fracture of the fibula. The ankle-joint was swollen and boggy to palpation. The patient stated that there had been some earth removed from the wound, and two small pieces were visible.

An hour after admission, under a general anaesthetic, the leg was thoroughly cleansed and the skin disinfected. An incision 3 in. long was made down to the bone on the inner side over the site of the tibial fracture and the edges of the wound clipped to the edges of a slit cut in a piece of sterilized linen. The periosteum was stripped up with the rest of the tissues, and the two tibial fragments were united by a Lane's plate. Almost exact apposition of the fragments was obtained and the screws held firmly without any undue strain on the bone. The skin was closed with silk worm gut; otherwise the Lane technique was followed exactly, and the operation itself was one of great ease. It was noticed that when the wound was closed the lower part of the internal saphenous vein crossed the lower part of the plate obliquely. The vein was not ligatured, because it was thought advisable to interfere with the circulation as little as possible. The limb was placed on a moulded back splint with footpiece and two side splints were buckled on. The splints were swung from a cradle. The patient received a single dose of tetanus antitoxin.

The wounds healed by first intention, and the stitches were removed on the eighth day. On the ninth day there was considerable redness and swelling of the limb near the ankle, with oedema of the skin, but there was no rise of temperature and no throbbing or pain. A diagnosis of thrombosis of the internal saphenous vein was made, and on the succeeding day it was possible to palpate the vein as a firm cord in the leg nearly as far as the knee. There was no antitoxin rash and no pain or swelling in the small joints of the hands or feet. The wounds did not suppurate. The patient left the home and returned to her flat on the fourteenth day.

Care was taken during the entire transit to keep the splints swung from the cradle so that there was no jarring of the limb. At the end of the third week the splint was removed and the patient moved the ankle-joint. A "Croft" plaster-of-Paris splint was then applied, and daily massage commenced, the region of the plate and thrombosed vein being carefully avoided. On the twenty-sixth day the patient got up on crutches. Six and a half weeks from the operation the Croft splint was discarded and a crêpe Velpeau bandage worn; the patient at this time began to bear a little weight on the limb.

Three and a half weeks later, having acquired plenty of confidence and being able to walk without assistance, she slipped and fell, receiving a severe blow from a fender on the middle of the shin of the fractured leg, but no serious harm resulted. Twelve weeks from the time of the accident the patient was walking without a limp, and was instructed to do the ordinary exercises for flat-foot. These she has continued to do ever since, although four months after the accident the arch of the foot on the injured side was equal to that on the sound side, and was as quickly restored on movement. At this time the scar was sound, the swelling of the foot very slight, the size and tone of the muscles of the leg equal to those on the sound side, and the patient could wear ordinary boots without inconvenience.

The condition eighteen months after the accident was as follows: There was slight swelling of the outer aspect of the foot towards evening. This swelling is absent in the morning. There was a slight pulpy swelling in the line of the peroneal tendons at the back of the fibula. This condition is much more marked on the sound limb, and could therefore hardly be ascribed to the accident. The scar of the operation was only

visible on close inspection. It was supple and freely movable. The plate was not definitely palpable. The internal saphenous vein could be felt here and there below the knee. Dorsal flexion of the foot was about two degrees greater on the right or injured side than on the left, whereas ventral flexion was some three degrees less, and was not performed so strongly or so rapidly as on the left side. Eversion and inversion on the injured side were slightly less than on the sound side, but

the difference was scarcely measurable. The patient was able to raise herself on her toes with the heels together twenty times consecutively without effort, and to perform the exercise of outward rolling of the foot. She walked ten miles at a stretch during September, 1913, and noticed that the foot did not swell after this exertion. There was no perceptible difference in size or tone between the muscles of the two legs. There was no pain and no "rheumatism" in wet and cold weather. Dr. Philip took another pair of x-ray photographs (Figs. 6 and 7). One of these shows that the upper part of the plate is possibly covered by callus, but in the absence of an oblique view this is uncertain. There is possibly some rarefying osteitis of the lower fragment, but we have no x-ray photograph of the sound limb taken at the same time, or with a tube having an equal degree of hardness, for exact comparison. A portion only of the line of fracture is visible, and the fracture of the fibula is not seen.

CASE III.

The third case is that of a male, aged 29, who was sent in to Professor Marnoch. Professor Marnoch was on the point of leaving for a holiday, and very kindly passed the case on to me. The accident occurred in this way: Two motor cyclists travelling towards each other at a relative speed of sixty-five miles an hour collided. The foot-rest of the oncoming machine caught the patient's left leg just above the ankle. The patient was knocked off and lay with the injured leg in a pool of water for one hour. His left thumb was partially torn off and there was also a severe lacerated wound over the left patella. The other cyclist sustained a severe fracture of the lower end of the left femur.

Dr. Cran, of Banchoy, and Dr. Davidson, of Torphins, brought the injured man to Aberdeen, and eight hours from the time of the accident operation was performed. The left thumb was amputated through the proximal

DESCRIPTION OF SPECIAL PLATE.

Fig. 7.—Case II: Eighteen months after operation.

Fig. 8.—Case III: Nineteen days after first operation, taken through aluminium splints. Magnification $\times \frac{1}{3}$.

Fig. 9.—Case III: Nineteen days after first operation, taken through aluminium splints. Magnification $\times \frac{1}{3}$.

Fig. 10.—Case III: Eight months after first operation.

Fig. 11.—Case III: Nine months after osteotomy and eighteen months after accident.

Fig. 12.—Case III: Nine months after osteotomy and eighteen months after accident.

phalanx and the flexor tendon sutured to the dorsal expansion. The wound over the patella contained some blades of grass, which were removed, the skin sutured and the wound drained. There was a severe compound comminuted fracture of the left tibia and a simple comminuted fracture of the left fibula at the same level, namely, about an inch and a half above the ankle-joint. Under a general anaesthetic the edges of the skin were excised over the tibial fracture and the tissues pared down to the bone. The incision was prolonged upwards. It was then seen that the periosteum was destroyed over the tibia, and some of it that was left was black with mud. It was therefore removed. There were several small fragments of bone also discoloured with mud, and about three teaspoonfuls of bone pulp mixed with mud. All these were removed and the wound swabbed out with hydrogen peroxide. It was then clear that the anterior tibial artery and vein had been severed. The posterior tibial was intact. The exact extent of the fracture was not discovered until later on. Removal of the bone pulp and mud left an irregular gap in the tibia 1½ in. long in front, 2 in. long in the medullary portion, and extending nearly the whole thickness of the tibia, so that the shaft could only be made to touch the lower fragments at the posterior surface of the bone. Part of the largest tibial fragment had been split off, so that the fracture extended into the ankle-joint, which was full of blood. These two pieces were pinned together with the nail seen in Fig. 1, and then, the foot being held well forwards and the toes pressed upwards, a Lane's femur plate nearly four inches long was used to bridge the gap between the shaft and the larger of the lower fragments. The two middle screw holes were left without screws because there was no bone underneath them. The plate held firm, and the chief lower fragment touched the shaft at its posterior border. The fracture of the fibula did not communicate directly with the wound, so it was left alone. The wound was sewn up and a small tube placed at the bottom of the gap in the tibia. The wounds were dressed, the limb placed on a moulded back splint with footpiece, and two side splints strapped on and the splints swung from a cradle. The patient received 20 c.cm. of tetanus antitoxin.

The temperature was highest on the third day, when it was 101.8° F. On the fifth and sixth days there was a severe urticarial rash, but no pain in the smaller joints of the hands and feet. The patient took food well. The tube was removed on the tenth day, and the stitches also. The scar stretched and gave way in the middle, but was covered with epithelium on the twenty-second day. On the eighteenth day an aluminium splint, carefully moulded to the curves of the limb, and padded with a thin quilted pad, was fitted in the place of the splint used at first, and two aluminium side splints were strapped in place. This system rendered it safe to move the patient to the electrical room, and the x-ray photographs (Figs. 8 and 9) were taken through these splints by Dr. Levack. They showed that there were some five pieces of bone left in the lower part of the tibia and five in the fracture of the fibula. Both these fractures extended into the ankle-joint, so that indirectly the fibular fracture communicated with the septic portion of the wound. The most important fact, however, appeared to be that the lower largest fragment of tibia was tilted at an angle to the shaft, the fragment being rotated on a transverse axis with its upper portion forwards. When the corresponding outline of a normal bone is compared with the x-ray plate, the amount of rotation is found to be 23 degrees of arc. The probable explanation of this tilting is that the fragment did not move when the foot was held up in its correct position. Its small size and the fact that the curves on the patient's right or normal tibia are more marked than in most cases led to the fixation being made in a faulty position.

On the twenty-first day the skin sloughed over the plate. On the twenty-third day Professor Marnoch, in consultation, expressed the opinion that it was inadvisable to do anything further at that time, as this would involve disturbing the plate and it might not be possible to obtain a firm hold again. He considered that it might take some time for the gap in the bone to close up.

At the end of the sixth week the patient was anaesthetized, and the ankle-joint moved as freely as possible. The plate was then removed. It was necessary to unscrew the screws, although they were slightly loose. The pin was also removed. It was found that the bones had just united. The granulations where the plate had been were scraped away, the wound partly closed and drained,

and the moulded splint was reapplied. At the end of the ninth week a "Croft's" splint was applied, daily massage instituted, and the patient got up on crutches. X-ray plates, taken thirteen weeks from the time of the accident and seven weeks from the removal of the plate, showed that consolidation was proceeding. There was a small bridge of bone between the shaft of the fibula and one of its fragments (see also Fig. 10). At this time a small sinus existed where the tube had been. Towards the end of the fourth month the patient was able to walk with the aid of two sticks.

At the end of the fifth month the sinus had healed, the dent in the bone where the gap had been was smaller, and the shortening was only a quarter of an inch. The movements of the ankle-joint were limited, but devoid of creaking or grating. The leg muscles were much wasted and their tone was bad. The patient was advised to wear a leather wedge on the inner side of the sole of the boot, and to walk with the toes turned in. At the end of the seventh month the leg was very painful during the day and at night. The joint scarcely moved.

At the end of the eighth month the joint began to yield a creaking sensation when examined, but was not swollen. There was a tender spot on the bone, on the inner side just above the joint, so that the patient could not sleep when the leg was turned on that side. There was considerable swelling of the ankle at night. Fig. 10 shows the condition in lateral view. In consultation with Dr. Smart, who was attending the patient, it was agreed to continue massage and movement of the joint by a skilled masseuse.

Up till now massage had been done by the patient and by friends. The masseuse moved the joint thoroughly and this resulted in a great effusion of blood into it. The leg became so painful that the patient was unable to walk on it. It was clear that something more radical would have to be done. The choice lay between osteotomy at the site of the fracture with rectification of the lower fragments and arthroplasty. The latter operation would have consisted in this case in opening the ankle-joint from in front, removing the front portion of the lower end of the tibia with its articular cartilage, and in rounding off the surface of bone so as to make a new ankle-joint in the correct position. A portion of deep fascia from the thigh would then have been inserted so as to separate the joint surfaces. This proceeding, although of undoubted use in many cases, seemed to me to offer nothing radical as regards restoring the line of action of the muscles, and further it would have involved the risk of opening the ankle-joint and perhaps the production of more adhesions. In choosing osteotomy it seemed that the spicules of bone near the fibular fracture could be dealt with at the same time and the condition of this part of the leg ascertained with respect to any interference with the action of the peroneal muscles that might be present. It was recognized that the operation would be one of considerable difficulty. A moulded aluminium splint was carefully shaped to the sound leg with the foot held in a position of extreme dorsiflexion, and padded with a thin quilted pad.

One week less than ten months from the accident the patient was anaesthetized and the adhesions in the ankle-joint broken down. The sites of the fractures were exposed, and the bridge of bone and projecting spike attached to the fibula removed. They lay under the tendon of the peroneus longus. The tibia was divided at the site of fracture, the bone being found to be dense and devoid of medullary cavity. An attempt was made to rectify the position of the lower fragment, but this was found to be impossible until the fibula had also been divided, and when the correct position of the foot had been secured in this way the ends of the fibula did not come into proper alignment, the lower fragment being tilted forwards and inwards. The tibial and fibular fragments were plated to the shaft, this being difficult to do on account of their small size and the proximity of the ankle-joint. The wounds were closed and dressed, and the limb splinted and swung from a cradle. The operation took three hours and a quarter to perform, and it was followed by severe pain lasting for three days. The highest temperature recorded was 99.4° F.

The wounds healed by first intention. Massage and passive movements were carried out daily, commencing on the third day. The plates had been so firmly fixed that there was no great risk in doing this; but, in view of the risk of rarefying osteitis supervening or of sequestration of any of the original fragments present at the time of the accident, it was considered advisable to remove the plates. This was done at the end of the

seventh week under a general anaesthetic, the opportunity being taken to move the ankle-joint freely before removing them. There was no cracking of adhesions when this was done. The screws were found to be quite firm, and the fractures were found to have united. The limb was again placed on the moulded splint until the wounds were healed, and on the tenth day a Croft's splint was applied. Massage and active movements were carried out from the seventh day. A piece of the old scar tissue from the original wound at the time of the accident sloughed immediately over the tendon of the tibialis anticus, and this has resulted in a slightly adherent scar. The patient had a course of Tallerman baths to the limb for three weeks, but I regret to say I have no note of the dates. This treatment resulted in considerable softening of the scars, and seemed, if anything, to improve the condition.

He was allowed to stand on both legs ten weeks after the osteotomy, and soon began to walk. From this time onwards there has been a steady improvement, which is a striking contrast to his progress after the original setting of the fracture. The condition nine and a half months after the osteotomy, or eighteen months after the accident, is as follows: There is occasionally slight pain on the outer side of the foot, and he has a tired feeling in the ankle if he walks any distance. There is a slight limp, but the patient can walk without any limp if he tries to do so. He is able to walk six miles at a stretch, he can cycle and "dance every dance," but the ankle is painful if he walks on uneven ground or if he forcibly inverts the foot. The circumference round the malleoli at 5 p.m. is 11 in., as compared with 9½ in. on the sound side. The swelling is much less in the morning. The shortening is half an inch. All the scars are supple and non-adherent except in the one place mentioned—namely, over the tendon of the tibialis anticus. This is improving. The patient's right or sound foot is abnormal as regards movements, there being less dorsiflexion than is usual. Comparing the two sides: The right or sound side has dorsiflexion 4 degrees of arc and of plantar flexion 47 degrees of arc, or 51 degrees in all. The left has dorsal 5 degrees, or 1 degree more than on the sound side, and of plantar 5 degrees, or 42 degrees less than on the sound side. Eversion and inversion on the injured side are about two-thirds of the extent of those on the sound side, and they seem to compensate very largely for the loss of plantar flexion. There is no flat-foot. The maximum circumference of the leg on the sound side is 14 in., and on the injured side 13½ in., the tone of the muscles being about equal. The thigh muscles are equal on the two sides. The patient has therefore recovered with ½ in. of shortening, ½ in. of wasting, and considerable diminution in plantar flexion. This does not seem to inconvenience him, but in view of the risk of arthritis being set up, I am at present advising against moving the joint under chloroform. The x-ray plates (Figs. 11 and 12) show that there is bone deposited between the lower ends of the tibia and fibula. There is otherwise no callus formation. The gap in the tibia is smaller and the various fragments seem to have consolidated well.

There are some interesting points about these three cases. In the first place the question arose as to whether operative interference was advisable or not, and if it was, whether plating should be carried out at the same time or the fracture merely set. In the first case, that of T-shaped fracture into the elbow-joint, reduction could not be effected by ordinary means, and even through an open wound was difficult to perform, probably because of the violence of the original blow. There was no element of sepsis after the wound had healed. If the fracture had been left and later the fragments resected, the brachialis anticus would probably by then have been caught in the callus and perhaps only freed with difficulty. The fracture extended further up the arm than the majority of such fractures. Resection would have resulted in about 2 in. of shortening, and probably a flail-like joint. In the second case, where there was a transverse fracture of both bones 2 in. above the ankle-joint, there was sepsis of the fibular fracture, but possibly no sepsis of the tibial one. With care such a fracture could have been treated without plating, and a good position of the bones secured, but the performance of massage and movements would have required great care. By plating such a fracture one obtains a rigid result from the start, and there is much less anxiety as regards the likelihood of displacement occurring when the splints are changed or massage and

movement employed. The plate was placed as far away from the septic focus as possible, and that is one reason why it was not placed on the outer surface of the tibia. Lane¹ says, "It is unwise to place a steel plate directly beneath the skin incision, and wherever possible it is well to bury the plate beneath muscle rather than immediately under the skin." It seems to me that the latter proceeding might make the operation one of difficulty in certain cases of fracture in the lower third of the leg. It might possibly lead to an adherent scar between the skin and the tibialis anticus. The fixation of the plate might have to be abandoned in some cases owing to the difficulty of inserting the screws while the muscles are retracted. The inner side is much more accessible, no muscle or tendon is interfered with and the tissues are about ½ in. thick over the bone. The chief risks seem to be that the plate may be jarred by a direct blow, or that the tissues over it may slough. In the present case neither of these things has happened; the patient wears boots and the scar is often subjected to pressure.

In the third case, according to general opinion, operation was indicated, but plating was strongly contraindicated. Walton,² however, is in favour of plating early as against waiting until sepsis has disappeared, on the ground that sepsis is unlikely to be increased by the operation; whereas by waiting the opportunity of obtaining exact apposition of the fragments may be lost owing to the changes which occur in the bones and surrounding tissues. A case in some respects similar to the present one is recorded by Negus.³ Tetanus, however, supervened, and, though the patient's life was spared, he lost his leg. Hey Groves⁴ mentions a case similar to mine in which, by means of a sliding splint, an extension of 10 lb. weight was maintained on the foot while the wound healed and the bones united, but vicious union resulted, and the patient was crippled for life. The foot was saved, but the ankle-joint became stiff. The amount of shortening, if any, is not mentioned.

Personally I doubt if the foot in Case III would have been saved without the use of a plate. The extreme severity of the injury and the flail-like condition at the site of fracture would have made it exceedingly difficult to control the foot and leg by means of external splints alone. Hackenbruch's fracture clamp apparatus was not in use at that time. It would have suited the case well enough provided there had been no swelling of the limb after its application. It would have required considerable care in use, and perhaps the plaster would have had to be frequently changed under general anaesthesia, which in some cases is contraindicated. My great regret, however, in this case is that I was deceived by the apparent correct position of the lower fragments at the time of the first operation. To have recognized that their actual position was incorrect would have saved the patient some months of great pain and disability. The error arose chiefly from the abnormal curve of the bone as seen on the sound side, and from the small size and fixity of the largest of the tibial fragments, combined with the fact that the foot came into good position.

In all three cases the patients were anxious and willing to assist their own cures in every possible way. This largely accounts for the result in Case III. The patient was a man of sound physique who carried out all instructions to the letter, and often at the cost of much pain.

The chief points about the technique of plating are so well known that they need not be mentioned. Before the Lane technique came in an ordinary bradawl and screwdriver were often used with complete success. The tedious nature of many of these operations is partly due to the use of long-handled instruments, which, though it may secure the greatest degree of asepsis in the greatest number of cases, often makes the operation more difficult. The actual mechanical difficulties are apt to be greater than those which arise in carpentry, because of the difficulty of holding the fragments firmly without any give while the screw holes are bored and the screws inserted. It is essential to have the holes the right size for the screws, neither too tight nor too loose, and it is advisable to test the drills and screws on a piece of bone beforehand. The screwdriver should fit the slot of the screw properly, and be less in width than the diameter of the head of the screw. To have to stop or alter the operation on

account of difficulties arising under these headings argues a lack of prearrangement and practice. There are two common causes of failure to get the screws to hold well, and I mention them because they are not as well known as the others. One is that the hole in the plate is not strictly concentric with the hole in the bone; in this case the screw enters with difficulty, and if much strain is thrown on it it may break off. The other common cause is that the screw is tightened too much; in this case it acts as a cutter, and removes the thread in the bone. This makes it loose just as if the hole had been too large from the start, and though the hold may be useful against movements in the plane of the plate, it is useless against movements in the direction of the axis of the screw. In these ways useful positions may be sacrificed, and in a difficult case no others may be obtainable. Again, if the screw is over-tightened much strain is thrown on the bone, pressure atrophy occurs and the screw quickly works loose. This probably in part explains those cases in which, apart from sepsis, the screws, though tight at the conclusion of the operation, are found to be loose when the plate is removed. To estimate by the feel of the screwdriver that the correct position has been attained and the correct degree of tightening ensured is an art that comes most readily to those who are used to working in hard wood, bone, and ivory. Hey Groves¹ mentions that Lambotte pointed out that the hold obtained in the bone by the thread of a screw used for metal work has a distinct advantage over the hold obtained by the thread of a screw used for wood. The tap-screw suggested by O'Neill Sherman² is a simple way of employing the metal work screw. I show to-night a section through each kind of screw cut from a bone after inserting the screws, and you see the advantage of the metal work thread as regards the hold obtained. One small point may be mentioned as its use is not generally known. To steady the shaft of a bone lying fully exposed in the wound one can place it under a broad band made of flexible sheet metal. This sometimes enables drilling and screwing to be done with great ease in an otherwise difficult case. For the sake of speed and accuracy some kind of geared drill is used. Some of those on the market do not allow of the point being kept steady while the handle is turned. By massing the chief weight one-third of the distance along from the handle to the point and by having the handle relatively heavy and arranged vertically, the instrument can be made to conform to the laws of dynamics and the point of the drill is steadied. Most will agree that the small fly-screw so often present in these instruments may catch in the tissues in a difficult case and so prevent the drill from revolving.

As to the use of splints. It seems to be agreed that external splints are necessary, certainly in difficult cases or where the screws do not hold well. They impede massage and movement, and their removal and reapplication twice a day is apt to be tedious. It seems to me that a better result is obtained by using a moulded splint thinly padded than by using a straight splint thickly padded. In the case of the leg, diminution of pain and muscular spasm, and greater ease in nursing are obtained by swinging the splint, which is shaped so that the leg is slightly flexed at the knee. In the case of a compound fracture the dressing is done without letting down the limb, so that any movements due to pain are at once taken up by the swing, and the site of fracture is not jarred. The patient can also turn partly on his side to sleep without risk of the thigh rotating relatively to the leg in the sleeve of strapping or bandage. There seems to be less after-stiffness of the knee when the joint is kept bent than when it is kept on a straight splint. In an aseptic case, after the stitches have been removed, the "Croft" or "Bavarian" splint has so many advantages that its use is becoming general. The ease with which it is made and the simplicity of its removal and reapplication make its use ideal in these cases when massage is employed or x-ray photographs have to be taken.

In conclusion, I must thank you for having given me such a patient hearing during the reading of a somewhat technical paper.

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NOTE ON HAEMOSTASIS BY APPLICATION OF LIVING TISSUE.

BY

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MANY years ago, acting on a hint obtained from Magendie's *Physiologie*, I showed that it is very easy to arrest bleeding from bone by the use of an aseptic plastic wax which can adhere to the cancellous spaces and to their walls. This method is now, I believe, in general use.

On the other hand, it is difficult to stop bleeding and haemorrhagic oozing from soft tissues except by the employment of a ligature, or pressure with a gauze tampon, or by irrigation with hot liquid (110° F. to 115° F.). For a long time I employed amadou for this purpose in experimental investigations where a sepsis was not required, and with good results, as it adhered well to the bleeding point. To obtain, however, the same result in aseptic operations is not so simple. The factors which had to be obtained were:

1. Asepticity.
2. Adhesiveness.
3. Thrombokinesis.

In view of my personal experience of the work of the late Dr. Wooldridge, it occurred to me that probably the best material would be living vascular tissue—that from the (injured) surface of a cut fragment of muscle, in all probability, thrombokinetical processes would most readily start; not merely on account of the plasma and plasmatic corpuscles of the tissue, but also the thrombokinetical by-products in the effused blood and the development of so-called blood platelets.

Such a fragment of the animal's own muscle offered all these advantages, and also asepticity. I was rather surprised to find that the necessary factor of adherence was also satisfied in a very remarkable degree.

If the bleeding point—for example, from the cut surface of the brain, liver, or any soft tissue—be gently pressed with gauze, and this instantly replaced by a piece of living muscle, and pressure again applied from fifteen to twenty seconds, it will be found that the muscle fragment closely adheres to the tissue it is applied to.

Such adhesion is necessarily limited by the pressure at which the blood is escaping from the bleeding point. By direct experiment on divided arteries (including the aorta) in the cat and dog, I found that a muscle haemostasis would resist as much as 60 to 80 mm. Hg blood pressure.

Further histological investigation of the exceedingly thin viscous layer occupying the plane of contact of the two masses of tissue shows that it contains blood platelets, fibrin fibrils, etc., in a considerable degree, and within a short space of time (five to ten minutes) of commencing the preparation.

To estimate the degree of active thrombokinesis I also tested the utility of the muscle after it had been boiled for five minutes at 100° C. Such boiled tissue had a very poor haemostatic effect. It seemed as if this was partly owing to the great loss of adhesiveness which is caused by the heat coagulation completely altering the physical surface of the muscle tissue.

Of other tissues I have only exhaustively tried fascia fully, and with the result that it has not proved satisfactory. It has not the factor of adhesiveness sufficiently well marked, though it can be employed where it is not convenient to take a piece of muscle. When experimental research had shown the remarkably rapid haemostatic effect of living tissue I used it freely in operations—above all, where it was necessary and convenient to leave a resting plug or tampon in a wound. Where an operation has been performed in two stages, I have occasionally had the opportunity of examining the isolated muscle tissue, and found it firmly attached and "organized." In no instance has any ill effect followed its employment.

At a meeting of the Society for the Study of Inebriety, to be held in the rooms of the Medical Society of London, Chandos Street, Cavendish Square, on Tuesday, July 14th, at 4 p.m., a discussion on "Proposed Legislation for Inebriates" will be opened by Dr. J. W. Astley Cooper, Resident Physician of the Ghyllwood Sanatorium and Retreat for Inebriate Patients.