Operation.—The wound was excised and necrotic tibia gouged away until bleeding cancellous bone was laid bare. The joint was then fully drained by lateral and posterior incisions and covered Carrel's tubes inserted as described above.

Second day. Temperature 103°, pulse 118. Tongue foul and dry. Dressed; covered tubes removed and replaced by uncovered ones. All the anterior part of the joint was sealed off by well-formed adhesions.

Fourth day. Temperature 97.6°, pulse 112. Tongue cleaner and somewhat moist. Feeling somewhat better. All anterior tubes removed, but the lateral ones left *in situ*.

Sixth day. Temperature 99°, pulse 100. Tongue fairly moist. Could take his food fairly well. General appearance much improved. Dressed, and lateral tubes removed completely. Anterior part of joint entirely obliterated.

From this time onwards the patient made an uninterrupted convalescence, and at the end of the six weeks the temperature was practically normal and all the wounds were healed save for a small sinus in the original wound going down to the front of the tibia and to a small patch of bare bone.

During the entire period of healing tubes were applied to the granulating surface of the incision and also placed in the posterior incisions down to, but not into, the joint.

CASE 8.—Private P. Wounded Oct. 9th. Multiple shell wounds. Oct. 10th: Operation in casualty clearing station. Right leg amputated just below the middle; left knee widely opened by a large U-shaped incision, the flap so formed including the patella. No attempt had been made to close the incision, so that five days later, when the patient was admitted, it was about four and a half inches long and two and a half wide. Almost the whole of the trochlear and adjacent part of the condylar surfaces of the femur were exposed. The sides of the incision were stinking and gassy and sloughing extensively. The sub-crural pouch was exuding pus in large quantity. The amputation stump was the seat of a severe cellulitis and extensive tracking along the fascial planes. The patient was in poor condition, thin and pale.

On the chance that the posterior part of the joint was not infected, no posterior incisions were made. Carrel's tubes were passed upwards into the sub-crural pouch, and backwards under cover of the lateral ligaments as far as possible. They were also laid over the entire extent of the wound.

Oct. 18th: Sub-crural pouch completely sealed off and the wound rapidly cleaning. Oct. 26th: Anterior wound perfectly clean; practically no pus formation. Oct. 28th: Lateral tubes not replaced; some oedema and tenderness in the popliteal space. Small incision made into same; pus found. Considerable tracking in stump. Temperature since admission had ranged to 102° F.

Nov. 18th: Patient has been going rapidly downhill the last fortnight, and taking his food very badly the last few days. Tenderness in popliteal space more marked. Some pus coming from behind, under cover of the lateral ligaments. Temperature falling and pulse-rate rising.

Operation.—Posterior drainage instituted and Carrel's tubes pushed backwards under cover of the lateral ligaments and into the posterior incisions.

Nov. 24th: General condition rapidly improving. Anterior wound entirely free from pus since last operation. Tubes removed entirely from under cover of the lateral ligaments, but still placed in posterior incisions down to the joint capsule.

From this time onwards the patient made an uninterrupted convalescence save for a small abscess which formed on the upper part of the calf, deep to the gastrocnemius, and was opened.

Jan. 20th, 1917: Discharged to England completely healed, with firm bony ankylosis. Has had a normal temperature for nearly a month.

Note by Surgeon-General Sir GEORGE H. MAKINS, A.M.S.

The contribution by Captain Campbell and Major Woollenden was read at a meeting of the Etaples Medical Society in November, 1916. Since that period a much more complete and energetic method of treatment has been adopted at the casualty clearing stations which has done much to reduce the number of cases of suppurative arthritis in the general hospitals. None the less, early radical intervention has by no means eliminated this most dangerous consequence of gunshot wounds of the knee-joint, and the paper is most valuable in showing, as it does, what may be effected by scrupulous care and judgment in saving the limbs and lives of patients in whom severe infection has occurred. The general principles enforced are those which should dominate the treatment of any suppurating articulation, while to them are added a wealth of details as to the practical treatment of both the external coverings and the joint cavity itself. Of these the most important are the rules for the regularisation of a method ensuring the drainage and sterilisation of the posterior extensions of the synovial cavity, and the cases quoted amply demonstrate the utility of the system devised. A second series of 69 cases treated in an identical manner by Captain Gill in a neighbouring unit furnished equally good results.

IRRIGATION AND SUCTION DRAINAGE FOR TREATMENT OF CERTAIN WAR WOUNDS.

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It is generally recognised that the Carrel method of treatment is sound in that it furnishes an excellent means of irrigation in the case of septic wounds. In wounds of a cavernous type where a large retentive septic space is present and where counter-drainage is anatomically impossible I have adopted the use of a suction apparatus to surmount the difficulty of drainage, at the same time using Carrel's tubes for irrigation. The suction apparatus is on the principle of the Sprengel pump, as advocated by Cathcart some years ago in bladder cases. Having noticed its success in one case and considerable improvement in another now under treatment, I would suggest that this method could be given a more extensive trial in similar cases. The two cases I refer to are as follows:—

CASE 1.—Capt. —. Compound fracture, comminuted, tibia and fibula. Some loss of bony substance. Operation April 28th. Portion of bare tibia cut away to allow of correct position. Extensive area of upper and lower tibial fragments bare of periosteum, medullary cavities filled with pus. Much inflammation in leg. Wound contents, 1 oz. of pus. Five weeks later the wound healed, with the exception of a small sinus. There is much less necrosis of bone than was expected—one small sequestrum. Normal temperature maintained.

CASE 2.—Lieutenant —. Compound fracture of tibia; $2\frac{1}{2}$ inches of tibial substance was shot away, leaving only the posterior wall of tibia. Wound content at beginning of

Illustrates apparatus (applied to Case 2). 1, Irrigation solution; w, water reservoir; T, Carrel's tubes; C, clip for patient; C¹, clip for temporarily stopping suction.

treatment 9 drachms of pus. Microscopic field count, staphylococci and streptococci, 30. Eight days later the wound content was 6 drachms. Microscopic field (mainly staphylococci) 5 per field. The wound now has a healthy appearance. Normal temperature maintained.

The irrigation fluid chiefly used was Dakin's solution, occasionally normal saline or sterile water, on an average 12 times in 24 hours. The clips are near the patient so that he himself may attend to the apparatus day or night. The wound is surrounded by vaseline-impregnated lint (sterile). The suction tube has no sharp edge and has a lateral hole $\frac{1}{4}$ inch distant from its termination, which hole lies on the bottom of the wound. The clip on the suction

tube allows the wound to remain filled with fluid for any chosen period, thus forming a temporary bath for the wound.

In my opinion the Carrel tubes are the best means of irrigation, as the sides of the wound are gently sprayed at each time of irrigation. The wound can be thoroughly cleansed at each time of douching, thus allowing the fluid to act in a cleaner medium at each application. The frequent cleansing prevents accumulation of pus, dilutes any pus that may be present in any small recesses, and so diminishes local absorption and local toxic effect of the wound discharge on bare bone, thus minimising necrosis of the bone. The infected walls have no chance of becoming dry, and therefore the outflow of bactericidal lymph is maintained and repair is hastened. The danger of infection spreading is also reduced. The patient takes an interest in his wound, and can do most of his own nursing. The wound is covered by a single layer of sterile gauze. I consider it inadvisable to use the apparatus if any vessel is exposed in the wound.

THERMALGIA (CAUSALGIA).

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(Report to the Medical Research Committee.)

THIS most distressing condition was described first by Weir Mitchell¹ as occurring in the American Civil War, and since that time has borne the somewhat misleading name causalgia, derived from the Greek, *καυσός*=heat + *άλγος*=pain, on account of the intense burning pain which is its most characteristic and urgent symptom.

The name causalgia has probably prevented the condition being more widely recognised, and since it is liable to be misleading I suggest the substitution of the more obvious name thermalgia.

The two factors which provide the great differences between gunshot and civil injuries of nerves—namely, the frequency of partial division and the excessive formation of scar tissue in the former—are sufficient to explain its commoner occurrence in military practice. Nevertheless it is not easy, at first sight, to understand why its appearance is practically limited to injuries of the median and sciatic nerves. To attempt to solve this problem and decide upon the most beneficial treatment it is advantageous to follow the subject from three points of view.

A. Clinical.

From the study of a large number of cases it is clear that thermalgia, as generally described, is only an extreme type of many median and sciatic injuries, and to determine the etiology it is necessary to investigate all cases in which pain is the predominant and constant symptom. The following cases illustrate the fact that the associated signs and symptoms of painful median and sciatic injuries vary very considerably.

CASE 1.—Patient was wounded by a machine-gun bullet on August 9th, 1916, the missile passing obliquely through the right thigh behind the femur, about $\frac{3}{4}$ inches above the condyles, and he immediately lost all voluntary control over the foot and toes. The wound rapidly healed without suppuration. Five days after the injury he began to suffer in the foot from pain, which persisted constantly until operation. The pain was of a "stabbing" character and of maximum intensity in the heel and sole. The pain got progressively worse, until when I first saw him, early in October, it was intolerable, and he had scarcely slept for a fortnight. Warmth or the slightest movement increased the pain, and the only thing which gave the least relief was a cold, wet application. The skin of the sole and around the heel was thin, smooth, and erythematous. Perspiration was excessive from the sole and the slightest pressure in this region caused extreme pain. There was marked paresis of all the muscles distal to the knee. No loss of any form of sensibility was to be discovered, but pressure on the posterior tibial nerve caused a "shock" to strike down into the heel.

At the operation on Oct. 18th, performed by Captain W. R. Douglas, it was found that a few of the inner fibres of the internal popliteal nerve had been divided and a small detached piece was projecting. There was a moderate amount of perineural fibrosis and, when this had been dissected off, the nerve was seen to be considerably swollen at the site of the injury.

During the next few days he suffered from a throbbing pain in the foot, but it was not so severe or constant as formerly. On Nov. 1st the pain was decidedly better, the excessive sweating had diminished, and the sole was much less tender. On Nov. 8th he was able to extend the ankle easily without pain and the sole was no longer sore or erythematous. The tenderness of the posterior tibial nerve gradually subsided.

He was given ionisation daily, which appeared to accelerate the return of power and relieve the slight occasional attacks of pain, so that by the end of January he was able to get about, and had merely

some paresis of the deep calf muscles and a little discomfort when his full weight was placed on the foot.

CASE 2.—Patient was wounded on Sept. 14th, 1916, by a rifle bullet, which passed transversely through the upper part of the left thigh behind the femur. There was immediate loss of power distal to the knee. The wound healed in one month without suppuration. Within a few days of receiving the wound he began to suffer from a "throbbing" pain in the foot, which became more severe and was always increased by heat or the least movement, as when he laughed or coughed. He obtained some relief by keeping the leg absolutely still with the knee partially flexed.

When seen on Nov. 1st he obviously had severe pain in the sole of the foot, but it did not appear so agonising as in the previous case. The skin of the sole was not noticeably different from that on the sound side and there was no abnormal sweating. No objective sensory symptoms were present, but pressure on the sole caused a "battery sensation in the foot," and pressure on the sciatic (distal to the lesion) or posterior tibial nerves caused an intense, sharp, local pain, which later shot down into the foot. There was no tenderness of the anterior tibial nerve. There was no voluntary contraction of any muscle except a slight movement in the tibialis anticus and extensor longus hallucis.

At the operation, performed by Captain W. R. Douglas on Nov. 15th, a small intraneural scar was found on the inner side of the sciatic nerve, which was densely adherent to adjacent muscles anteriorly and internally. During the process of clearing the perineural scar and freeing the nerve a large blood clot was found encapsuled in fibrous tissue. The nerve was wrapped in fat, and a piece of undamaged muscle sutured over it.

The pain ceased, except for an occasional minor attack, within three days. Voluntary movement and power steadily improved in the extensors of the ankle and toes, but by the middle of February there was no return of contraction in the superficial or deep calf muscles. He was treated daily with ionisation from early in January. In April there was practically a return of full power in all the muscles, and he was quite free from pain even after walking.

CASE 3.—Patient was wounded on Sept. 27th, 1916, by a piece of shrapnel, which transversely pierced the right thigh behind the femur. The wound suppurated for some weeks and was irrigated daily through drainage-tubes. As soon as the wound began to heal he suffered from severe and persistent pain in the foot, and states that for several weeks the foot was bathed in sweat.

When seen early in January, 1917, he still complained of constant pain in the foot. He was extremely emotional, and on this account it was very difficult to make a satisfactory examination. No loss of sensibility could be discovered, but there was marked tenderness to the slightest pressure on the sole and dorsum of the foot, and the skin of the former was hyperæmic, smooth, and thin. On palpation the sciatic and posterior tibial nerves were very tender. There was marked paresis of all the muscles distal to the knee-joint, possibly in part due to the induction of pain on movement.

At the operation on Jan. 6th, 1917, performed by Mr. Stocks, dense adhesions were found on the anterior and inner aspects of the sciatic nerve, and, on freeing these, a few of the inner fibres were seen to have been divided. After neurolysis the nerve was wrapped in fat and protected by uninjured muscle.

On Jan. 25th the pain was definitely better, and, although the patient was still very emotional, he stated it was gradually diminishing. There was only slight tenderness of the sole, and voluntary power had much improved. It is interesting to note that at this time all the muscles responded briskly to faradism and normally to galvanism.

On Feb. 28th the pain had almost disappeared, and there was no tenderness of the sole of the foot, although the posterior tibial nerve was still painful on pressure. The muscles had practically regained their normal power.

CASE 4.—Patient was injured on Oct. 8th, 1916, by a piece of shrapnel, which penetrated the inner part of the left upper arm without damaging the humerus. Severe pain commenced in the hand in five hours, and was continuous up to the time of operation.

When seen on Nov. 4th he was obviously in terrible pain. He kept the elbow flexed and the wrist acutely flexed in order to obtain slight relief, apparently from relaxation of the nerve. He described the pain as of a "throbbing" character, worst in the centre of the palm, and said it became intolerable on the slightest movement (or even the prospect of movement) or if the elbow or wrist were passively extended. A splint was quite unbearable. In the median area there was dissociated sensory loss of the compression type,² as shown in Fig. 1. The most trivial pressure on the distal part of the palm or affected fingers and thumb induced acute pain. Pressure over the median nerve in the forearm caused a pain to shoot down into the fingers. The skin of the median area was dry and scaly.

In this case the pain was not relieved by cold applications. The severity of the pain rendered it impossible to test the motor power, but he assured me that he had not been able to flex the thumb and first two fingers since the infliction of the wound.

At the operation on Nov. 7th, performed by Captain J. Morley, the median nerve was found to be more than half divided and recent scar tissue was discovered between the severed ends and around the nerve in this region. About $\frac{1}{4}$ inches of the nerve was excised and the ends sutured.

He was completely free from pain on recovering from the anæsthetic, and it is of interest to note that when I tested sensation on Nov. 22nd the dissociation was then found to be that of complete division. (Fig. 2.)

CASE 5.—Patient was wounded on July 7th, 1916, by an explosive bullet, which obliquely traversed the middle of the left forearm, the exit wound being situated in the middle of the anterior aspect. There was only very slight suppuration, but the entrance wound broke down several times. A few days after the injury persistent spasm of the thenar muscles developed (Fig. 3), and about the same time he began to suffer from severe pain "like a battery" in the first three fingers.

When examined on Nov. 13th it was possible to overcome the thenar spasm by massage, but it immediately recurred. There was paresis of the flexor longus pollicis and the flexor sublimis digitorum. The thenar muscles responded to faradism, but not so briskly as on the sound side. The sensory loss is represented in Fig. 4. The skin of the anæsthetic area was dry and scaly. The pain was not much relieved by cold.

At the operation, performed on Nov. 15th by Captain W. R. Douglas, two-thirds of the median nerve was found to be severed on the inner side and the undivided fibres were embedded in scar tissue. The latter