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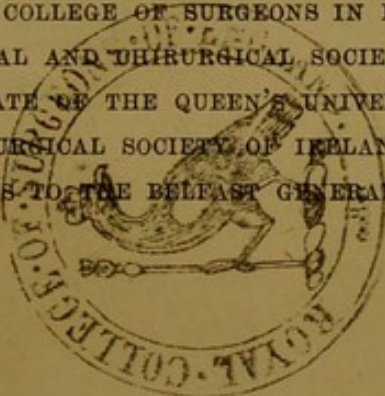


DR. WILLIAM MAC CORMAC,
Amputation through the Knee Joint.

ON
AMPUTATION
THROUGH
THE KNEE-JOINT.

BY
WILLIAM MAC CORMAC, M.A., M.D., M.R.I.A.;

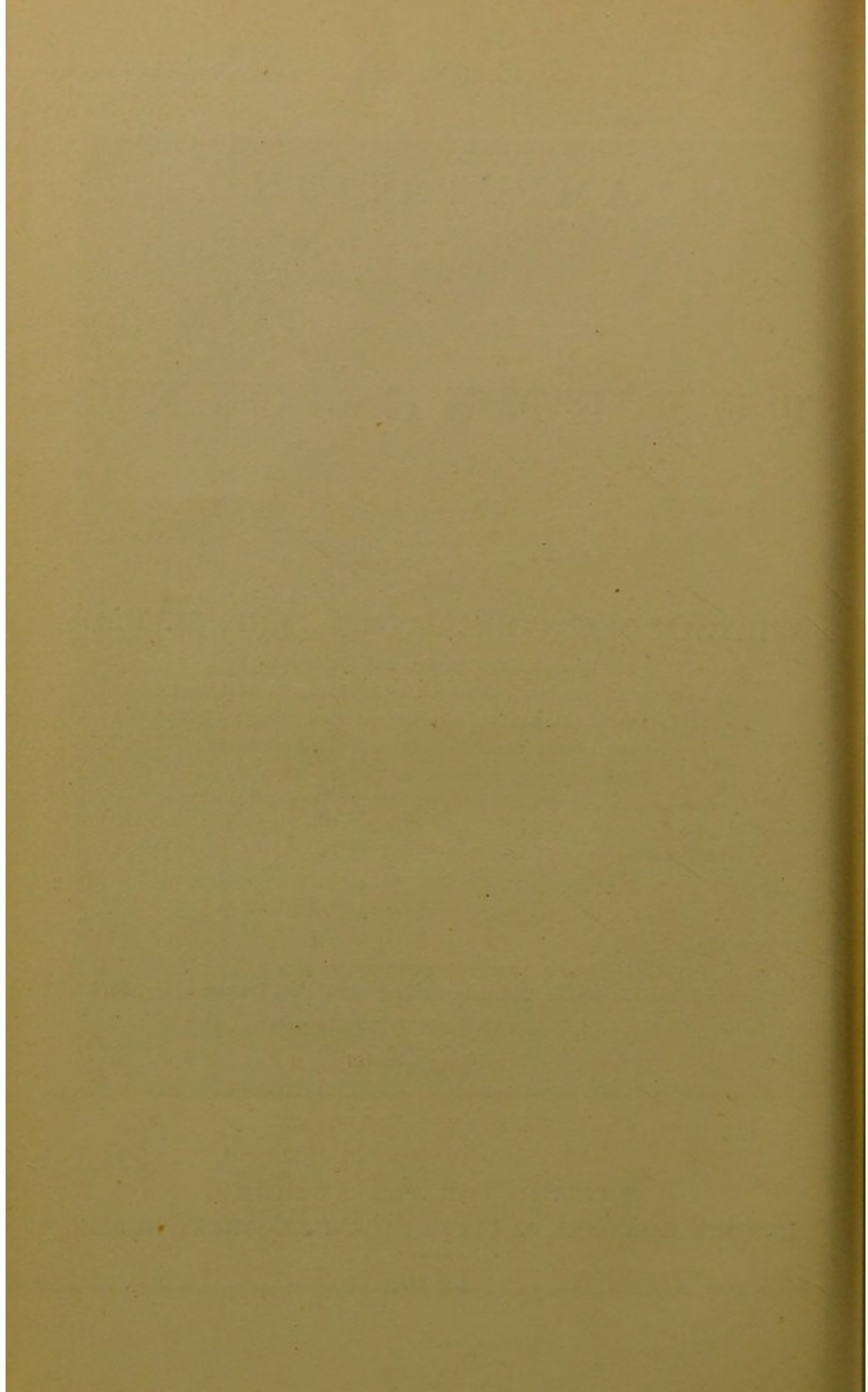
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BY JOHN FALCONER, 53, UPPER SACKVILLE-STREET, DUBLIN.

1870.



ON
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AMPUTATION through the knee-joint, or, more correctly speaking, disarticulation, is an operation of very ancient date—the oldest authors allude to it. Indeed, it would naturally suggest itself as a ready mode whereby to remove a diseased or injured limb. That remarkable surgeon, Fabricius Hildanus, to whom are attributed many great surgical achievements, is alleged to have performed this amputation in 1632, and he speaks of it as an acknowledged procedure amongst contemporary surgeons. Hoin of Dijon, about 1764, performed the operation, by means of a long posterior flap, similar to that more recently recommended by Mr. Syme. J. L. Petit amputated after a similar fashion on two occasions, once, it is said, disarticulating because there was no saw at hand wherewith to divide the bone.

Blandin, who followed Hoin's plan, recommended a counter opening at the base of the long posterior muscular flap for the escape of pus. He mentions as a serious objection that the portion of the soleus muscle, which helps to form the flap, always mortifies.

Brasdor especially extols the operation in an elaborate memoir, published in the Transactions of the French Academy of Surgery, where, amongst other matters, he points out how the circular, or transverse operation as Brasdor named it, may be modified by taking more skin from the front of the limb, according to the seat

and extent of the injury or disease. He thus indicated, in short, the modern form of the operation.

To Velpeau, however, is conceded the claim of having introduced amputation through the joint into modern surgery. In 1829, he published a memoir enthusiastically commending it, citing fourteen cases, out of which there were thirteen cures. His subsequent experience led him to modify the sanguine expectations he had at first framed respecting disarticulation at the knee, but he maintained to the last the excellence of the operation. Malgaigne expresses the opinion, in his *Manual of Operative Surgery*, "that the operation has been too lightly abandoned, that it possesses every advantage over amputation in the continuity of the shaft of the femur, especially that of leaving the patient freedom in, and command over, the motions of the hip-joint." More recently still American surgeons have devoted much attention to this subject, notably Drs. Smith, Markoe, and Brinton. In our own country, Mr. T. Holmes and Mr. Pollock of St. George's Hospital, and several others, have recognized the merits of this form of surgical procedure. Mr. Samuel Lane was the first, I believe, to perform the operation in England, which he accomplished most successfully in 1857. Before this it had been done in the Glasgow Infirmary in 1847. I do not know to whom in Ireland is to be attributed the first disarticulation of the knee-joint. Amputation close to the joint is not infrequent.

Amongst the advantages which Dr. Markoe, in one of his valuable contributions, claims for disarticulation at the knee are:—

1. The useful character of the resulting stump.
2. The small shock attending the operation.
3. The lessened section of the tissues.
4. The non-exposure of the muscular interspaces and diminished risk of suppuration in the thigh.
5. The comparatively few vessels requiring ligature.
6. The attachments of the thigh muscles being mainly preserved.
7. The absence of muscular retraction.
8. The diminished risk of osteomyelitis and exfoliation, from the femur not being sawn across.

And here it may be mentioned that under the term "amputation at the knee," two different operations have often been confounded, operations different in character, and likely to differ, as will afterwards be shown, in their results. These are, true disarticulation of the joint, without interference with the articular surfaces

of the femur or patella, and amputation through the condyles of the femur, removing more or less of that bone, and, generally speaking, removing the patella also.

Of the latter form are Syme's amputation at the knee, and Mr. Carden's modification of it. Deploring the great fatality of thigh amputations, estimated by him at from 50 to 70 per cent., Mr. Syme re-introduced Hoin's operation, recommending the femur to be sawn through the condyles in order to avoid the many risks which he attributed to dividing the medullary canal. The long posterior flap made of the whole of the calf was nevertheless attended by so many and so serious inconveniences that Mr. Syme felt constrained to abandon this mode of operating. Mr. Carden, of Worcester, some time after, advocated a similar operation so far as the bone is concerned, but he made a long anterior integumental flap, sufficient to cover with ease the entire of the cut condyloid surface. By this plan, which Mr. Carden, at the time of publication, had followed for many years, he achieved marked success, and Mr. Syme acknowledged the method to be a great improvement upon his own. In both these operations the patella is removed.

This form of operation, then, is very different from disarticulation at the knee where, when sound, the cartilages of incrustation on the end of the femur, and on the patella are not interfered with.

The method of amputation through the joint employed at different periods, has, as already indicated, varied much. The long posterior flap of Hoin and Blandin would never now be accepted through choice. Its weight and liability to gangrene, added to the difficulty of keeping it in situ, are sufficiently strong objections. Velpeau adopted a circular cut, four fingers breadth below the joint. This, however, is inconvenient, and leaves a cicatrix on the face of the stump. This latter, and strong objection, subsists against the otherwise excellent operation by two lateral flaps. The operation practised by M. Baudens approaches very nearly the plan now most generally accepted. This eminent French surgeon recommends an oval sweep to be made round the limb extending in front five fingers' breadth beneath the inferior border of the patella, and posteriorly three fingers' breadth below this level. Twice successfully did M. Baudens operate in this way. In one instance the cartilages were not interfered with, and the stump healed over without any exfoliation taking place; in the other the condyles had been injured by a musket ball, and required

removal. Dr. Nathan Smith successfully performed this amputation for the first time in the United States in 1824, and therefore before Velpeau. He removed the limb by forming two flaps anterior and posterior, exactly equal in size. The base of the flaps was half an inch below the line of the articulation, and their extremity corresponded to the insertion of the ligamentum patellæ. Dr. Stephen Smith in the last January number of the *American Journal of Medical Science* recommends a very ingenious form of incision, which for this and other amputations is well worthy of consideration.

Such, then, are some of the ways in which disarticulation at the knee has usually been practised heretofore. In quite recent times, in the opinion both of American and English surgeons, one plan of operation is preferable, when at all practicable, to all the rest, and that is a long anterior tegumentary flap, and a shorter posterior flap, while, when healthy, the cartilages of incrustation on the femur, and the patella should remain absolutely untouched. This was the method I myself adopted when I had occasion to perform this operation.

The points of importance in connexion with it are that the anterior flap should, at its base, be nearly or quite two-thirds of the circumference of the knee, just below the patella, and that its length should correspond to at least half its breadth. Further, that the incision to form this flap should commence and terminate on the inner and outer sides of the limb, one inch below the line of the articulation in the adult. To express this in another form, the anterior flap should commence opposite the posterior margin of one condyle of the femur, and extend across the limb about four or five inches beneath the patella to a similar position as regards the other condyle. The superior extremities of this incision should be an inch below the semilunar cartilages. This flap having been dissected up so as to include all the soft tissues in front of the knee, the flexed joint should now be opened as near the femur as possible. By this means all superfluous synovial membrane is cut off, and the semilunar cartilages are not separated from the tibia, as they might otherwise readily be, necessitating a separate dissection for their removal. The crucial and lateral ligaments are now with facility divided, the knee being still maintained flexed. When these are cut, the knife should be laid flat behind the tibia, the limb extended, and a thin posterior flap, about half the length of the anterior, rapidly formed by transfixion. Care must be taken

in so doing to avoid locking the edge of the knife against the projecting head of the fibula. The posterior flap may be made integumental merely by dissecting it up from without, as in making anterior flap, and then dividing the rest of the soft parts by a circular sweep of the knife. This is, I consider, much the better plan. Very few arteries require ligature. I have, however, always found it expedient to tie the popliteal vein. It is of the utmost importance to avoid heavy or tight dressings. These should be always very light, and any tension promptly relieved, should it take place.

Having said so much by way of introduction, which I trust may not prove too tedious, I now purpose briefly relating the particulars of four cases, in which I performed disarticulation of the knee, and of one case in which I performed Carden's amputation.

CASE I.—The first case in which I amputated through the knee was that of a man aged thirty-one, admitted under my care to the General Hospital, April 8th, 1865. For three years previously he had been suffering from pain in the left knee, more severe at night, and on putting the foot to the ground. No other symptom was complained of for two years, when some swelling appeared and the pain grew worse. Only three weeks before admission was he compelled to give up work. When I first saw him there were considerable swelling in the knee and severe pain. Appropriate treatment was ordered, under which he improved very much for a time. On May 31st serious symptoms suddenly supervened. The patient had a rigor, was very feverish, the leg became œdematous, and the joint swelled. Acute suppuration in the joint, it was soon seen, had taken place. On June the 5th a free opening was made, and a large quantity of matter flowed from the joint. On introducing a probe it passed into softened cancellated tissue of the head of the tibia, to which bone the symptoms were all along chiefly referable. Although a very hopeless operation in similar cases, the patient's general condition was such as led me to propose immediate amputation. Unfortunately he would not hear of it until June 10th, when his state was most unfavourable, but he then urged me to relieve him, were his chances of recovery never so bad, and after a consultation I did so, although some symptoms, not unlike those ushering in pyæmia, had been manifested. The patient being chloroformed I made an oval anterior flap six inches long, opened the joint and made a short posterior flap by transfixion. There

was pus in the joint. On examining the end of the femur it was found that the cartilage had been removed and replaced by granulations. No diseased or softened bone was felt, and it was decided to be better not to inflict further injury on the femur by slicing its end off. The patella was similarly affected, and it, too, was left untouched. The popliteal artery and one other vessel were secured by acupuncture needles (inserted after Simpson's third method). The wound was then drawn together by sutures, and the patient removed to bed, water dressing having been applied. As might be expected there was considerable tendency to general oozing, very difficult to check, and returning two or three times. The application of ice was had recourse to. An examination of the part removed justified the diagnosis. A pyogenic cavity was found in the cancellated structure of the head of the tibia. Around this the bone was softened and inflamed, and a round opening communicated through the centre of the external articulating facet of the tibia with the joint. It was, no doubt, in consequence of this perforation suddenly taking place that the violent inflammation all at once occurred in the joint. The day after the operation the symptoms of pyemia in its most acute form set in. Violent rigors, hot fits, and sweating of the most profuse kind, induced me to anticipate a speedily fatal result. No treatment is of much avail in acute pyemia. Large doses of opium were simply administered. I need not weary the reader by a detailed history of the case, further than to add that on dressing the stump on the third day, the anterior flap was observed to be fringed by a gangrenous border. No healthy action ever took place. No clot formed in the popliteal artery, which pulsated violently in the open sloughing wound. Fortunately the needle kept its place even under these unfavourable circumstances, showing that it does not cut the arterial coats so speedily as some have alleged. Harbinson died on June 16th, exhausted by the disease. The operation possibly hastened the fatal issue, but that even is doubtful, as for three or four days he asserted he had been greatly relieved by it. That his life would have been saved had he assented to an operation when it was first proposed to him is perhaps unlikely, but, beyond question, a better prospect of recovery would have been afforded. No general *post mortem* examination could be obtained, but I seized an opportunity of examining the stump. Unluckily the dressings had been displaced during the removal of the body to the dead-house, and the needle

on the popliteal artery was torn off with them. The muscles were dark in colour, and the popliteal vein was filled with thin greyish pus. There were two small secondary abscesses in the thigh.

CASE II.—On the 24th May, 1866, the anniversary of the Queen's birth-day, I was summoned some miles to the country, by Dr. Fulton, of Saintfield, to see a man called Quin. He was a commercial traveller of very intemperate habits, and about fifty years of age. Whilst celebrating the anniversary by firing off a small cannon for the amusement of his children its contents accidentally lodged in his left leg. The cannon was eighteen inches long, and of two inches bore. The charge consisted of six or seven ounces of powder, in addition to which he had foolishly introduced a quantity of small stones, picked off the walk in front of his door. It is supposed that the cannon swerved just before being discharged. At all events, he received the entire contents in his leg.

The result was a horrible lacerated wound, six or seven inches long, and the entire breadth of the limb. Above, it reached nearly to the tuberosity of the tibia. Both bones were extensively comminuted, and a piece of the tibia two inches long was lying loose in the centre of the wound. I thought it likely the fracture extended into the knee-joint, but could not make myself certain of its doing so. The soft parts were completely disorganized, and blackened by the proximity of the poor man to the discharge.

The question of saving the limb was not entertained, the only point to determine was where to amputate. Considering the nature of the injury both to the bone and soft parts, amputation in the leg was clearly inadmissible. The bone was probably split up into the joint, and the soft parts were so much bruised and lacerated that I thought they were not safe to furnish sound covering, and this could only be obtained from the calf. I decided on amputation near the joint by Carden's plan. Had the covering to be obtained been sufficient I would have preferred disarticulation. An operating table was extemporized, some candles provided, and the patient being chloroformed, an anterior flap was made as long as possible, down in fact to the margin of the wound. This flap was dissected up, the joint opened, the crucial and lateral ligaments were divided, as also the tissues posteriorly by cutting almost directly outwards, I then sawed a slice off the condyles. The

popliteal and the azygos articular arteries alone required ligature, unless we can reckon a small sural branch. I also passed a ligature round the popliteal vein, as the bleeding from it was not arrested by pressure, and I have no reason to believe that the ligature of a vein, however large, in a stump is hurtful. Interrupted sutures and water dressing having been applied, the patient was removed to bed. I dressed the stump on the third day. Union had taken place between the flaps on the right side, but elsewhere a very unhealthy discharge was being poured out. The thigh was mottled all over with yellow and purple patches. The conjunctivæ were yellow. The pulse was 120, and although he had slept well during the night, he continued in a somnolent state during the day. It was at this time that the sulphurous acid treatment, recommended by Professor Polli, was being tried in septic diseases. Fearing the advent of pyemia, although the patient was located in a country cottage, and not in a crowded hospital, I ordered the bisulphite of soda in thirty grain doses frequently repeated, as a prophylactic, in which capacity, this, as well as some other remedies, has been alleged to act admirably. I also ordered ample nourishment, and a moderate quantity of wine.

Next day, the 28th, there was to be seen at the edge of the anterior flap a portion, which appeared to be losing, if it had not already lost its vitality. On the 29th the pulse was 120, the tongue was clean and moist, there was a plentiful discharge of thin unhealthy pus. On examining the stump, the anterior flap was found to be fringed with a gangrenous margin half an inch deep and three inches long. This did not extend any further, but the symptoms of pyemia increased, the jaundice persisted, the breath acquired a sickening sweet odour, he had severe sweating, the belly became greatly swollen and tympanitic. The stomach rejected everything, and uncontrollable diarrhea set in. He gradually, in short, became weaker, and died on the 6th of June, a fortnight after his mishap. The double shock of the accident and operation, and above all, the man's antecedents, contributed to cause the unfortunate termination. Probably even a smaller amount of injury, or a less serious operation would have been followed by a like result.

CASE III. presents many features of interest, apart from the method of operation adopted. It is that of the young man whose photograph accompanies this paper.

William J. Allen, a tall lad, seventeen years of age, rather delicate looking, and with a very anxious cast of countenance, was admitted to hospital, under my care, in last October, with a large tumour occupying nearly two-thirds of the right tibia.

He states that some eight years ago, when only nine years old, a small swelling which has uniformly, though slowly, increased ever since, formed over the tibia. Within the last twelve months the rate of growth has been more rapid. There was never much pain, and generally no pain whatever, attending it. The tumor occupies the inner and anterior aspect of the tibia. Above, the tumor terminates four inches below the head of the bone, below it extends within five inches of the ankle. The tibia above the tumor is not quite free from enlargement, below it very much increased in size. The surface of the tumor is smooth, of bony hardness, and channelled by the superficial veins. It rises gradually up from the bone, which seems clearly to be expanded over it. On the lower and front part is an indolent superficial ulcer about three inches square. This began some fifteen months before, and has since been slowly enlarging. It is not painful, and the amount of discharge from it is very trifling. It seems to have been originally produced by the friction of the clothes against the part.

The diagnosis, though not quite simple, indicated a bony or cartilaginous benign tumor growing in the bone.

After consultation it was decided to amputate. The boy could, no doubt, walk about pretty well, there was no swelling in the foot, he complained of no pain, nevertheless his general health was beginning to suffer a little, the tumor was increasing more rapidly, and the lad himself being most anxious to have the leg cut off, I could see no advantage in delay.

The operation was performed on November 6, under chloroform. A long anterior flap, nearly down to the tumor, was first made. The incision was commenced on the inner side, three quarters of an inch below the line of the articulation, and well back near the hamstring tendons. The cut terminated at a corresponding point on the outer side of the joint. This flap was rapidly raised up, the joint opened, bisected, and a thin short posterior flap formed, after the limb had been extended, by cutting from within outwards. With the exception that it is placed just a little too low down, the line traced on the cast in the photograph represents the direction of my

incisions. This cast was taken before the limb was removed, and gives a good idea of the form and size of the tumor. I thought it would lend further interest to the picture if it were photographed at the same time as the patient upon whom the operation for its removal had been executed. At first sight it would appear that these flaps are made needlessly long. Such is not the fact, the amount of retraction is considerable, and if they were made shorter great straining would result, as the flaps often retract very much. In the present instance, by the time the popliteal and four other vessels had been tied, the patella was drawn up some two inches, and when the flaps were brought together they met at the posterior part of the stump without traction certainly, but also without the smallest redundancy. Neither on the femur nor on the patella was the cartilage interfered with. Carbolized dressings were applied to the stump after the flaps had been washed and sutured. Two days after the operation, the patient having been going on well in the interim, his pulse rose to 120, he became feverish, and complained of great pain in the stump. Fearing there had been some oozing of blood, distending the flaps, I partially slit up the dressings, through a space of some inches, at each angle, found the edges of the wound firmly adhering together, and no appearance of distension. This allayed my fears, and I did not disturb the dressing further. The pain reappeared on the fifth day, and I then removed all the dressings. The central portion corresponding to tip of the long flap had become gangrenous to the depth of three-fourths of an inch, by two inches broad. I came to the conclusion at the time that this was perhaps induced to some extent by the pressure of the bandages. A flap so long and delicate requires the very gentlest treatment. I believed, however, I had taken all needful precautions. No extension of the gangrene occurred. The slough was soon thrown off, and the condyles became partially exposed.

On December 7, a month after operation, I find the following record, which I transcribe from my note book:—"Since last report this patient has been getting on in all ways well. A superficial healthy granulating surface occupies the site of the former slough. All the rest of the wound healed by primary adhesion, and has since remained sound. It was interesting to watch the gradual process of removal of the exposed cartilage. It seemed precisely analogous to the process, only somewhat slower, which occurs when

some part of the cranium is denuded of periosteum—a layer of the skull perishes, and is disintegrated slowly, or scales of bones are thrown off. Granulations form from the sound bone beneath, press upon and absorb the dead portion, or it may be wholly surrounded by granulations, loosened, and cast off in a piece.

“I carefully watched similar changes going on in the exposed cartilage. It seemed gradually to get thinner, and around the edges, granulations springing from the surrounding parts encroached. After a time granulating points appeared through the cartilage itself, rising from the bone beneath. These points extended, and the granulating surfaces gradually fused together into one tract, and all trace of cartilage disappeared. The process is one of slow absorption and substitution. In other cases the cartilage may be thrown off in large exfoliations.” “At the present date,” the report continues, “any amount of pressure can be sustained by the condyloid surface. The patella remains quite movable, and is drawn up at least two inches above its normal situation. The lad goes daily about the hospital, and out of doors, and is, in fact, in all respects convalescent.” He left the hospital soon after. The photograph was taken in the middle of March, about four months after operation.

With a detailed account of the nature of the tumor I need not trouble my readers. The tibia was expanded over it. While above, and especially below, the bone was much hypertrophied. It was in addition two inches longer than the tibia of the other leg. The fibula, though not involved in the growth, was hypertrophied. On making a section of the bone it was found to contain a number of small and large membrane-lined cavities, varying in size from a pea to a walnut, containing bloody serum, and divided from each other by thin bony walls. In the interstices were masses of yellowish white substance, firm and elastic. In some places these were softer and opalescent. A microscopic examination showed this material to contain multitudes of cells of all sizes, spherical, oblong, caudate, fusiform, and triangular, about one twelve hundredth of an inch in diameter.

In short the microscope gave evidence of a malignant type of growth, and to the naked eye the tumor presented the appearance of medullary cancer. Yet the history of the patient's illness, the almost uniform and slow growth of the tumor during eight years, its external characteristics, and the absence of pain, would warrant a very different conclusion.

CASE IV.—To this and the next case I mean very briefly to allude. The first is that of a lad who was admitted to hospital on January 24, 1870. Ten days before admission he had a rigor followed soon after by pain, redness, and swelling in the left leg. He is a very delicate looking boy, but up to the day he took ill had been constantly at his work.

The disease was at first treated as erysipelas, from which acute periostitis and necrosis needs to be very carefully discriminated, as the only hope of saving the bone in the latter is by very early incisions.

When examined shortly after admission, the limb, from one extremity to the other, was occupied by a bag of fluctuating pus. There was great swelling about the ankle, and a superficial ulcer over each malleolus. A free incision was at once made, and matter, mixed with blood clots, evacuated to the extent of half-a-pint. On introducing a finger into the wound, it was found that the pus had been contained between the periosteum and the bone from which the former was detached, as far as the finger could reach, in the axis of the bone as well as all round it. The boy was much exhausted, and I felt certain the entire diaphysis had perished. He did not come under my care till he had been a week in hospital, and I then commenced antiseptic dressings. The disease, however, had largely implicated the ankle-joint, and it was showing symptoms of travelling upward to the knee. The discharge continued very profuse, and the pulse rose as high as 140. His condition had become desperate. As a last resort, and as affording the only prospect of saving his life, I determined, with the consent of my colleagues, to amputate on the 8th February. At this time he was so weak I feared he might not survive the shock of the operation; but it was evident, from the rapidity of his downward course, he could not survive many days if he were not relieved in some way. What I feared chiefly after operation was pyemia. I believe it is especially likely to occur in such cases as this one. For this reason, and believing the shock to be less, I determined to amputate through the joint, although the parts of which I had to form my anterior flap were somewhat œdematous. This was not only so, but in forming the flap I cut through a small abscess. The operation was performed in the usual way under chloroform. Seven vessels were secured by carbolized catgut ligatures, including the popliteal vein, and the ends cut short. He rallied well after the operation, the pulse came down, and he expressed himself as being greatly

relieved. The subsequent history is, that the anterior flap sloughed in that portion where the abscess and œdema were situated, the condyles were exposed, and the cartilage became slowly replaced by granulations. An abscess formed high up in the thigh, and his convalescence has been tedious. I trust, however, now, that he is in a fair way to a good recovery. He has been up daily and out of doors. The amount of disease, considering that it had been of only three weeks' duration, which the amputated limb displayed was remarkable. The entire shaft and lower epiphysis were necrosed, and the superior epiphysis was beginning to separate. The periosteum, which in one place had formed some new bone, was completely detached throughout. It presented a thick velvety injected surface. The ankle-joint was completely disorganized, and the cartilages of incrustation were thrown off. A similar condition existed in all the other tarsal joints, and the bones of the tarsus were softened and inflamed. The tarso-metatarsal joints were not affected, and the disease had not extended so as to implicate the knee-joint.

CASE V.—This man, although only twenty-seven, looked very much older. He had contracted syphilis nine years ago, and has suffered severely from its manifestations ever since. He was treated at different times by mercurials in many forms, and he has taken iodide of potassium in doses varying from five to sixty grains. He submitted to a protracted course of syphilization. He is marked all over with the scars of the syphilitic ulcerations, which have formed on different parts of the body. For the last two years the disease appears to have become localized in the left leg and foot, which is treble the normal size, covered with tubercular masses and large painful ulcers. The agony he has to endure caused him to have recourse to opium, and he admits taking four ounces of laudanum daily. His friends say he takes a good deal more. One of the toes has just dropped off, and the others seem on the point of doing the same thing. The poor man placed himself in hospital, under my care, and begged that the limb might be removed at any risk. The tibia had been the seat of antecedent disease, and there were small ulcers in different parts of the leg. The patient himself was very urgent that the whole leg should be removed. I therefore determined to disarticulate, and performed the operation under chloroform, on February 12, 1870. I made the flaps as in the other cases, commencing nearly two inches below the line of the articulation. Both the anterior and posterior flaps were made

rather longer than before. Notwithstanding this, the tendency to retract was great, and the soft parts would have been pulled right away from the condyles had they not been restrained. It is mentioned by several writers as one of the great recommendations of this form of operation, that retraction of the flaps does not occur. In the present instance this objectionable tendency was present in a most aggravated form, and I have noticed it, though not to the same extent, in previous instances.

The main artery and vein, and other vessels were secured with carbolized catgut ligatures, the ends of which were cut short, and carbolized oil dressings were applied. I previously inserted thick catgut stitches in the flaps, which I find do not hold a sufficiently long time.

There was no shock, and no febrile reaction took place. The patient was doing in every way well, except that the edge of the anterior flap became gangrenous—just the edge—but more than sufficient to prevent immediate union. The catgut sutures after a time gave way, and in the depths of a very unhealthy wound the popliteal artery was seen beating with all its force. This was a week after operation. Presently the situation of the vessel was covered by healthy granulations, and in another week the pulsations became weaker; but it was not for more than three weeks that they subsided so far as to dissipate all fear of secondary hemorrhage. Meanwhile, no trace of the catgut ligatures was seen. They seemed to have been covered over with the granulations, and to have become absorbed.

At the time I write the man is quite convalescent. There is still a considerable extent of granulating surface to heal, but this is contracting, and when the stump is soundly healed, I have no doubt it will prove an excellent and useful one. Both patients subsequently left hospital with the stumps progressing rapidly to complete cicatrisation.

We may now proceed to consider the value of this operation of disarticulation at the knee-joint. We find very various opinions entertained about it. I believe that, like other things human, it is far from being perfect, but the weight of evidence is strongly, I think, in its favour. With very few exceptions, we may conclude that the mode of operation here described is that which will most generally be adopted.

There is, doubtless, a latent dislike to bisect a large articulation like the knee, conversant as we are with the very serious conse-

quences which attend the most trivial injuries of it. As a matter of experience, however, the free opening of the joint in amputation is apparently followed by no special consequences such as, *a priori*, we might anticipate. Danger from this cause must be of rare occurrence. The two forms of injury, in fact, belong to different categories.

Another objection, felt strongly by some, rests in the presence of the articular cartilages, which must needs, they say, die and exfoliate, causing delayed healing, tender painful stump, and endless trouble and danger. Mr. Butcher, for instance, says in his *Operative and Conservative Surgery*, "I have no doubt whatever that in all cases the cartilaginous surface of the femur should be removed." He recommends a curved section of the bone as giving as good a surface for support as where the cartilages remain untouched. Now after disarticulation one of two things will happen, either immediate union takes place, or some portion of the anterior flap may slough, and the cartilage of incrustation become more or less exposed. This latter is certainly the more frequent result. Indeed, Dr. Brinton considers sloughing of the margin of the flaps occurs to some extent in most cases. But supposing union do occur by the first intention, the cartilages do not exfoliate, and do not give any further trouble. In the case recorded by Mr. Lane, and in other cases, there was free motion both of the patella, and of the flap, over the subjacent surfaces. Immediate union took place without exfoliation of cartilage. In all three of my cases that survived, the patella remained moveable, and in Allen's case the flap was partially moveable also. In process of time the cartilage no doubt becomes altered and absorbed, as tissues always do for which there is no longer any use, and eventually the flap and the bone may become joined by some connecting medium, but meanwhile the articular cartilage affords a smooth desirable resting place for the flap. But suppose a less fortunate issue to the operation, suppose union do not take place, that there is retraction of the flaps in consequence, and exposure of the cartilage. In that case exfoliation will occur, but not for the lapse of two or three weeks, not in short until the slough in the soft parts has been cast off, and the stump may be supposed to be granulating healthily. In the interval I consider the cartilage has served a most valuable purpose. It is an unabsorbent protective to the end of the bone, shields it from the influence of the hurtful secretions of the wound, and by the time it is exfoliated or disintegrated, the end of the

bone is covered and protected by a granulating surface. This, in my mind, is a condition which contrasts most favourably with an operation, where other conditions being alike, the bone, in place of being thoroughly protected, is divided through its cancellated structure, whose patulous porous nature is just such as to invite the entrance of the noxious discharges of the wound. I am satisfied that this condition, other things being equal, is calculated to induce pyemic poisoning.

No advantage is derived from sawing off the condyles. When healthy they should most certainly be retained. The presence of the articular cartilage does not interfere with the healing of the wound, and if primary union do not take place the safety of the patient is better secured by the presence in the wound of a cartilage-covered bone, than by an exposed surface of cancellated tissue. Dr. Stephen Smith, the latest writer on the subject, adverting to this point, remarks that "the methods of Syme and Carden, involving excision of the condyles, are extremely objectionable, as well as entirely unnecessary. The great source of disappointment which I have met with is the want of sufficient vitality in the long flap. In every instance in which I performed the operation the edge of the flap sloughed more or less. In all the cases, save that of Allen, there were doubtless constitutional causes present sufficient to account for the gangrene, still, as shown in that instance, there will be, under even favourable circumstances, an almost fatal liability to sloughing. This is due, of course, to the length, tenuity, and the inadequate arterial supply of the anterior flap.

Possibly greater care in guarding against the hemorrhage of reaction, in dressing the stump, or the abstinence from dressings of all kinds, care, in short, to prevent any pressure upon the flap either from within or from without might serve to avert this unfortunate contingency. As helping towards the same end, Mr. Pollock has pointed out how important it is not to cut a single line higher up between the anterior and posterior flaps than is absolutely necessary, and that the incision should not commence above the lower edge of the condyles of the femur. I was myself so much impressed with the necessity of this precaution that I invariably began my incision on a plane very much lower than that indicated by Mr. Pollock, namely, nearly one inch below the margin of the head of the tibia. It must also be recollected that the broader the base of the flap is made the less the risk of gangrene will prove. In judging of the results of the operations I have performed, it will

be conceded that, with the exception of Allen, it would be difficult to find more unfavourable cases.

Harbinson was suffering from long continued disease of the tibia, in which an abscess, subsequently bursting into the joint, had formed. He refused operative interference for a long time, and claimed it when too late. Pyemia, of a very acute type, though it had not declared itself at the moment of amputation, shortly after set in, and he was soon carried off. The operation did not appear in any way to shorten his career.

Acheson, a sickly strumous lad, was attacked with acute necrosis of the entire shaft of the tibia, and destructive inflammation of all the tarsal bones. An amount of damage, such as is rarely met with, took place in the short term of three weeks. When the operation was proposed he appeared to be almost in a dying state. The nurse, a most experienced woman, said "that boy, I fear, will not come back to the ward alive." Yet, though the prospects seemed so hopeless, there was not only no shock, but almost immediate relief was experienced, and he has done well. Crawford was but little better, worn out, as he was, by nine years' constant suffering, a confirmed laudanum drinker, the tissues of the limb diseased, the muscles only to be compared to living adipocere. What was to be expected in such a case after a capital operation? Yet here, too, there was complete absence of shock. In spite of the partial gangrene, in spite of the ominous beating of the popliteal artery, he was able to sit up daily a fortnight after the operation. He is now progressing to complete recovery, and will in time possess an admirable stump.

A sufficient interval has elapsed to show what Allen's stump is like. It was photographed some four months after the operation, and no graphic power is needed to describe its great length and consequent power, its broad rounded extremity, covered with thick integuments, and well calculated to sustain pressure, while the line of cicatrix is posterior and quite out of the way.

Mr. Pollock, with good reason, speaks of the stump resulting after amputation at the joint, "as most satisfactory, and the adaptation of an artificial leg as most easy." Dr. Brinton goes further when he states that "patients, surgeons, and surgical mechanics are agreed, their testimony is nearly unanimous as to the serviceability of the stump, and its fitness for the adaptation of an artificial limb."

One remarkable instance in support of these views, I may perhaps be permitted to quote:—"E. K. P., aged twenty-one,

received a shell wound of the leg at the battle of Cedar Mountains, U.S., Aug. 9th, 1862. Primary amputation at the knee was performed by Surgeon Bentley, U.S. Volunteers. The articular surface of the condyles was sawn off, the patella was left. The patient recovered without accident in four months. He has since been engaged in four battles, and on one occasion was captured, and obliged to walk fifty-four miles between sunrise and nine o'clock p.m. The stump is painless and well formed, and he can walk, or dance, mount his horse and ride, with perfect facility."

The rate of mortality attendant on amputation through the knee, as compared with amputation of the thigh, is, I think, somewhat difficult to arrive at. I question if there be a sufficient amount of material wherewith to form a correct estimate. The largest number of cases is contained in the invaluable reports issued by the United States' Surgeon-General. In Circular No. VI. Surgeon Otis records 132 cases of knee-joint amputations up to 1864, with a death-rate of 48 per cent.

In Dr. Brinton's most interesting communication, already more than once referred to, that surgeon relates that further returns have been made to the Surgeon-General's office, which raise the number of knee-joint amputations performed to 211. Of these 106, or 50.2 per cent., proved fatal. Many of these additional examples, Surgeon Otis explains, are cases of primary amputation, collected from special reports, which died before reaching hospital.

Mr. Pollock has collected forty-eight cases from various sources, operated upon in England, with thirty-six recoveries and twelve deaths, or thirty-three and a third per cent.

Dr. Markoe gives the following table, showing the results in the aggregate of American and foreign cases of amputation at the knee-joint:—

	Cases	Recoveries	Deaths	Mortality per centum
Primary amputations after accident, -	59	34	25	42.37
Secondary amputations after accident, -	37	23	14	37.83
Secondary amputations for disease, -	62	48	14	22.58
Cause and period of disease undetermined,	6	6	—	—
Total, - -	164	111	53	35.31

Mr. Pollock has had himself nine cases and one death.

So far, too, as the comparison has gone, it would appear from the cases collected by Dr. Brinton that the ratio of deaths is somewhat greater when the condyles have been removed than when they are left intact, and on reading over these cases one cannot fail to be struck with the relative frequency of death from pyemia amongst the former. Against this, however, may fairly be quoted Mr. Carden's remarkable success of thirty-one cases and five deaths.

Undoubtedly, the death-rate in this operation will contrast favourably with amputation of the thigh, forming the estimate from cases similarly circumstanced.

In the late American war, Surgeon Otis reports 1,597 completed thigh amputations, and 1,029 deaths, or 64 per cent., and in civil practice the mortality attendant on primary amputation of the thigh cannot be much less than 60 per cent. Fifty per cent., or, according to others less, is the ratio for amputation through the knee. If Dr. Markoe's rate of mortality of 22 per cent. for amputations through the knee-joint for disease be correct, this also will bear favourable comparison with pathological amputations of the thigh in civil practice.

Dr. Hamilton, in his *Military Surgery*, considers that disarticulation at the knee has proved more successful and more safe than amputation either immediately above or immediately below the joint. And Dr. Stephen Smith thinks it established that this operation is less fatal than amputation in the upper third of the leg.

I do not agree with these authorities. I would not feel myself justified in amputating at the joint, if it were practicable to do so at any point lower down. I think disarticulation should never from choice be substituted for amputation of the leg. The cases, then, to which it is applicable must prove comparatively rare. They are injuries to the knee-joint, not involving the femur, or only involving it to a slight degree, extensive disease, or severe compound fracture, involving the whole of the tibia, but without great destruction of the soft parts over the front of the limb.

In very many cases where amputation of the leg is inadmissible, the state of the parts will be such as to necessitate amputation of the thigh. Possibly this may be one of the chief reasons why amputation through the knee-joint has for lengthened periods been completely abandoned, to be from time to time revived as surgeons happen to meet with cases which appear eminently suitable for it.

Since writing the foregoing paper I have again performed disarticulation at the knee-joint with every prospect of a most satisfactory issue. It was in the case of a little girl of thirteen years

old. Six months ago, acute periostitis and necrosis of the tibia took place, and a sequestrum, comprising half the shaft of the tibia, was afterwards removed. An interval of five months passed, and no new bone was deposited. The limb became greatly deformed, and was quite useless. Finding that there was no hope of preserving a member of any use to the patient, and finding that the knee-joint was becoming involved, that there was free lateral motion in it, and some grating between the head of the tibia and the femur, I considered amputation not only expedient but necessary. Her general health, too, was beginning to give way, and the wound made to remove the necrosed tibia had never healed. The little patient being chloroformed, I first made a posterior cutaneous flap, about three inches long, and dissected it up to the level of the articulation, including in it all the subcutaneous tissues down to the muscles. I then made an anterior flap somewhat longer, opened the joint, and cut the rest of the parts by a circular sweep of the knife. The flaps were carefully formed with a scalpel, cutting at right angles to the surface, and their edges were thus quite thick. The vessels and nerves were divided transversely. Catgut ligatures, and Mr. Lister's lac dressings were employed. Although the flaps were nearly of equal length, the anterior one folded completely round the end of the femur which was not interfered with, and met the retracted posterior one an inch and a half above the end of the condyles. The cartilage on the femur was sound, that on the tibia completely disorganised.

The total absence of shock after the operation was very evident when I visited the child in the evening. Her face was perfectly tranquil, she was not suffering pain, and her appearance betrayed not the slightest indication that a serious operation, or indeed any operation at all, had been performed upon her. Ten days have now passed, and the child has continued quite well. The wound is healing admirably, and there has been no sloughing or trouble of any kind.

At the time I am revising this paper, the little patient has left hospital, just one month after the operation, having made a most rapid recovery. The stump is all but healed, and otherwise everything that can be desired. One more perfectly formed, or apparently better calculated to sustain the weight of the body on an artificial limb, I never saw after any form of operation.

I have now, therefore, had five cases of disarticulation at the knee-joint, with but one death, and that occurred in a patient who could not have survived under any circumstances.