AMPUTATION OF THE RIGHT LOWER LIMB AFTER EXCISION OF THE HIP: USE OF DAVY'S LEVER.

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RICHARD C., aged eleven years, a boy in this school, who had always been previously in good health, although of delicate appearance, came to the Infirmary on February 2nd, 1878, complaining of pain in the left ankle. There was some swelling about the joint, but no redness, nor much pain on moving it. He said he thought he had sprained it, but did not remember doing so. There was a slight graze on the right knee, which was healing and looked healthy. Fomentations were applied to the ankle.

On the next day, he had sharp feverish symptoms. His temperature was 104.4°; tongue white and furred. The case was judged to be one of acute rheumatism, and ten grains of salicine were ordered to be given every hour. On February 4th, the morning temperature was 101.3°, falling in the evening to 101°. The ankle was very red, and acutely painful. On the 5th, the left middle finger was very red and swollen; temperature at night 103°. On the 7th, he complained of pain in the right hip, thigh, and leg. On the 9th, the heart's action was tumultuous and irregular, and pain in the right ankle was complained of. The dose of salicine was increased to fifteen grains every hour, which was continued until the 12th, when, it being evident that pus had formed in the left ankle and in the metacarpo-phalangeal joint of the left middle finger, the salicine was discontinued and free incisions were made into these joints, a considerable amount of pus being evacuated. On February 16th, he had pain in the right heel and back of the right knee; he improved slightly, sleeping better, and having less pain, until the 23rd, when the right knee became painful, but the pain passed off. It returned on March 1st, and the joint swelled and became full of fluid. On March 3rd, redness and swelling were noticed below the left internal malleolus. On the 6th, an abscess, which had formed without pain just above the left elbow-joint, was opened. On the 10th, an abscess behind the left ankle-joint was opened. On March 18th, the right knee was freely incised on the inner side, and a good deal of pus let out. On the 26th, he was placed on a water-bed, there being a sore on the lower part of the sacrum; and, although great care was taken, others formed over the spines of the dorsal vertebra. On April 7th, there were petechiæ on the left arm. An abscess, which had formed about the right hip-joint, was opened, the incision being over the great trochanter; six ounces of pus were evacuated. On the 11th, an opening was made on the outer side of the right thigh, three inches above the knee. There was free discharge from all the openings in the right limb. On April 25th, a bed-sore formed on the right ankle. He was very weak and exhausted, but took nourishment and wine well.

From this date he gained somewhat in strength, and the abscesses on the left side healed; the sores on the back became cleaner, but did not heal; the discharge from the right thigh and hip were very great, and until December he continued in this state, when Mr. Johnson Smith of the Seamen's Hospital and Mr. Pink saw him, in consultation with me. The right knee was ankylosed; and, no bare bone being felt in the shaft of the femur, it was determined to try if excision of the hip would preserve the limb. Accordingly, on December 17th, Mr. Johnson Smith, Mr. Pink, and Mr. Purvis kindly assisting, Dr. Williams administered chloroform, and I made an incision about six inches long over the great trochanter, and through this removed the head and both trochanters of the femur, and gouged away the whole of the acetabulum. Some strips of lint were placed in the wound, and its edges were brought together by sutures. The limb was laid between sand-bags, and a bag, containing six pounds of shot, was attached to the leg by strips of plaster, and hung over the end of the bed to extend the limb. He slept well after the operation, under the influence of two doses of fifteen minims each of tincture of opium.

December 20th. He was put under the influence of chloroform, and the sheets were changed and the back dressed, etc. There was very great discharge of pus from the wound at the hip, and also from the inner side of the thigh. This method of dressing, under chloroform, was repeated every two days until January 21st, 1879, on which day he was so weak that it was not deemed safe to administer chloroform. Mr. Johnson Smith and Mr. Pink saw him with me on this day; and we determined that, if he were stronger on the morrow, we would amputate the limb.

On January 22nd, kindly assisted by Mr. R. Davy of the Westminster Hospital, Mr. Johnson Smith, Mr. Pink, and Mr. Bampton, the boy was anæsthetised by Dr. Williams. Mr. Davy controlled the hæmorrhage by his peculiar method. He introduced a wooden staff, about

two feet in length and three-fourths of an inch in diameter, having a bulbous extremity, into the rectum, for a distance of nine inches; and then, using the anus as a fulcrum, compressed the common iliac artery against the pelvis. I removed the limb by antero-posterior flaps, commencing in the wound made for the excision. Fifteen ligatures were applied; and so completely did Mr. Davy's instrument prevent hæmorrhage, in both anterior and posterior flaps, that we were obliged to ask him to relax his pressure in order to discover the bleeding points. The total quantity of blood lost was measured, and was only three ounces, this being mixed with pus. The acetabulum and pelvis were examined, but no bare bone could be felt. The flaps were brought together with silk sutures.

The patient was greatly exhausted after the operation, and was almost pulseless. Brandy being freely administered, he gradually rallied, and, after a dose of fifteen minims of tincture of opium, he slept for a time.

On the 23rd, he had passed a fair night, taking nourishment freely. There was a considerable discharge of serum from the outer part of the wound. On the 24th, there was much serous discharge. He was carefully lifted; the stump and back were sponged, and simple ointment on lint applied to both, and the sheets, etc., were changed. On January 25th, the purulent discharge was offensive and copious; the scrotum and left thigh were cedematous. He was dressed as yesterday. On the 26th, the stump looked rather better; tongue moist. At his own wish, he tried to eat part of a mutton-chop, which caused vomiting and slight oozing of blood from the wound. The vomiting exhausted him very much, and at night he was very weak. The voice was hoarse, and he could not clear the larynx by coughing. On the 27th, his bowels were relaxed, to check which small doses of tincture of opium were administered, and a teaspoonful of Brand's essence of beef was given every hour. On the 28th, he took the essence well; the purging was stopped. He slept fairly. There was a free discharge of pus from the stump. On the 29th, he was very weak. The side was excoriated by the discharge which ran under him. He was ordered to have as much port-wine as he could take. On the 30th, the œdema of the left limb and scrotum had increased and was extending over the abdomen. He passed very little urine. On the 31st, the pulse was hardly perceptible. There was a glazed swelling over the left groin, with slight blush. He sank gradually, and died at 5 P.M.

February 2nd. I was allowed to open the abdomen, but, the father wishing to be present, I could only make a very partial examination. The peritoneum lining the cavity of the pelvis appeared healthy, and no pus or slough appeared on incising this membrane in several places. I examined the course of the right common iliac for any sign of pressure exercised whilst controlling the hæmorrhage at the operation, but could see none; nor was any cause discovered by me, in the necessarily imperfect examination, for the œdema of the left limb. The shaft of the removed femur was atrophied, but in other respects healthy and covered by periosteum, save over a small portion, about two inches in extent, of the posterior surface, near the upper and truncated extremity of the bone.

ON THE CAUSE OF EVERSION OF THE LIMB AFTER FRACTURE OF THE NECK OF THE FEMUR.*

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FROM the time when this subject was first touched by the great master, Astley Cooper, surgical writers have, for the most part, been content to adopt the explanation which he gave. These were Cooper's words: "This state (eversion) depends upon the numerous and strong external rotatory muscles, to which very feeble antagonists are provided." So far as I am aware, no experiments had ever been instituted with the view of determining the relative strength of the muscles which rotate the thigh inwards and outwards, and it is not improbable that Cooper himself based his statement on *à priori* grounds; nevertheless, his dictum has remained an excellent working hypothesis, though its truth has been but little questioned, and still less challenged.

It will be my object to-day to show that the eversion is due solely to the force of gravity; that when the neck of the femur is broken, the limb "tumbles" on to its outer side. I shall affirm that the muscles of external rotation, though greatly superior in number, are inferior in

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† *Treatise on Dislocations and Fractures of the Joints.* Edit. vii, p. 82.

strength to those of inversion; and I shall also call special attention to the fact that, when the femur is broken below the level of the attachments of the numerous small external rotators, eversion of the limb is still the characteristic feature of the lesion.

The muscles of internal rotation are the anterior two-thirds of the *glutæus medius*, with the *tensor fasciæ femoris* and the chief part of the *glutæus minimus*. The anterior part of the *glutæus medius* has but a

DIAGM A.

scanty origin from the dorsum of the ilium, but it takes a strong attachment from the deep surface of the *fascia lata*. That there is in these few muscles an immense mass of fibres for effecting inward rotation, an observer can readily assure himself by grasping with the finger and

DIAGRAM B.

thumb the firm tissue which bellies up between the front of the iliac crest and the great trochanter when he rotates the limb inwards. The depth of the space which is occupied by this mass of fibres is shown in diagram A; the surface and the direction of some of the fibres are

shown in B. The diagrams themselves are drawn to scale from Professor Marshall's *Anatomy for Artists*. But if eversion were due to the superior strength of certain muscles, how is it that after fracture of the patella the leg is not found firmly flexed upon the thigh, for the flexors of the leg are then free of all opposition? But opposed sets of muscles are not arranged in active physical antagonism, as if struggling in a perpetual "tug of war". Were this the case, the foot would be doubled upon the front of the leg when the tendon of Achilles is ruptured; and when the wrist-extensors are paralysed in lead-poisoning, the hand would be so firmly bent upon the forearm, that the term "drop-wrist" would but feebly express the abnormal state. Now, these conditions do not obtain; and we have no right to assume that the external rotators of the thigh would act the part which has been generally ascribed to them after the neck of the femur has been broken. That the elasticity of the muscles, skin, fascia, vessels, and nerves does much in producing shortening and other deformity after fracture, I am prepared to admit; but I apprehend that we are in the habit of attributing too much influence to the special muscular contraction. Is it the experience of the surgeon that after an amputation, say of the thigh, the divided muscles have retracted so that they have hidden their ends beneath the long-cut skin? Does he not rather find the skin-flaps disappearing? Does he not trim off tendons which would otherwise hang from between the flaps? When the effects of an anæsthetic have passed off, the ends of divided muscles will quiver on being irritated, but they will not coil into energetic contraction. But supposing the small external rotators did try to roll the limb outwards after fracture of the neck of the femur, they could exert but little influence, as the great trochanter has fallen backwards and inwards towards the great sacro-sciatic notch. This condition would, however, offer improved opportunities to the muscles of inversion. It may be remarked that the special adductors are also concerned in everting the limb; then, I would ask, why do not those muscles rather draw the broken limb across the opposite thigh, and so evince their claim to their name? But the special muscular contraction plays no part in the programme. I think that it will be granted that eversion of the limb is an immediate effect of the fracture, that the eversion is to its full extent, and that the shortening of the limb is often the work of time. And if this be granted, we must seek different causes for the eversion and shortening; and so it is. The eversion is due to the action of gravity; the shortening to the elastic recoil of the skin, fascia, muscles, and other tissues.

Some time since, I had under my care an aged female, who, three months previously, had sustained an intracapsular fracture, for the repair of which nature seemed to have made no effort. As she lay in bed, the affected limb (which was considerably shortened) rested perpetually upon the whole length of its outer side; but on my instructing her, she inverted it until the foot was at right angles to the surface of the bed. She was, however, unable to keep the limb long in this position, on account of the great expenditure of muscular force necessitated, which gave her the sensation of a "cramping" in the anterior gluteal region. In this case, the characteristic and persistent eversion of the limb could not have been due to a superior force in the muscles of external rotation, or, without assistance, the patient would have been unable to roll the limb inwards, even for a moment. In my opinion, the report of these facts has considerable bearing upon the explanation of the eversion after fracture.

One can readily understand how, shortly after the receipt of an injury, the pathological condition of the parts about the seat of fracture will preclude the practicability of the patient inverting the limb, for the least disturbance of the parts distresses. But I apprehend that, could we meet with a patient just after fracturing the neck of his femur, and could we by any means induce him to take sufficient personal interest in the experiment to command contraction of the muscles of internal rotation, the limb would be found obedient to their influence. But occasionally the limb is found inverted after fracture of the neck of the femur. How can the external rotators have allowed so unorthodox a proceeding? True, Hamilton saw but one such instance; and he states that in sixty cases of fracture of the neck of the femur, Cloquet did not find one such. Hamilton also remarks that Boyer never saw the limb inverted after the fracture. With commendable consistency, Guthrie tried to explain the abnormal position of the limb in such cases as the result of muscular action. Inversion, he was of opinion, would follow on a fracture which was so situated as to leave the small external rotators acting upon the upper fragment, whilst the two smaller gluteal muscles exerted their influence on the shaft of the bone. To this ingenious hypothesis, R. W. Smith rightly took exception, because Guthrie had left out of his calculations the psoas, the iliacus, the pectineus, and the adductors. Dupuytren considered that, if the line of fracture were so placed as to leave the shaft fragment of the neck behind the acetabular piece, there would be inversion of the limb. And, strange to say, the

great practical experience of R. W. Smith led him to hold the exactly opposite opinion. But Smith left the matter with this suggestive remark: "The question is still open to investigation." For my own part, I would submit that these rare cases of inversion are not to be explained by any theory of muscular action. Indeed, Smith appears to me to have exploded that hypothesis by showing that when the deformity has been removed and the limb restored to its natural length by extension, as soon as the extending force ceases to act, though the limb is again shortened, the foot will be found to remain everted. Nor need we attempt to arbitrate between Dupuytren and Smith in their antagonistic theories concerning the relative position of the acetabular and crural fragments as explaining the rare inversion; for there is a much simpler solution of the problem. It is this: If the external violence which broke the neck of the bone did its work when the limb was inverted, inversion may persist. Inspection of Smith's six cases of inversion goes far towards proving the correctness of this theory. Communion or impaction is described as having obtained in five out of the six instances. The egg will not stand upon the table; but rap its end down upon the smooth surface with enough violence to fracture and cause some comminution of the shell, and a condition of stable equilibrium is at once obtained.

But to return to the question of the cause of the eversion of the limb: Diagram C represents an apparatus by means of which I have been

DIAGRAM C.

enabled to test the relative power of the muscles of external and internal rotation of the thigh, and with this result, that the muscles of internal rotation are considerably stronger than their opponents. A is a strong spring balance, which is connected with a flanged foot-plate B. The balance is fixed upon a board twenty inches by fifteen, and the board is secured against the wall and rests upon the floor. For experimentation, the man lies supine, and with his heel upon the floor, the sole of the foot is lodged within the foot-plate. Now, keeping the knee straight, he to his utmost inverts or everts the thigh, as the case may be, and the central rod of the balance is drawn out, the pounds' force being registered upon a dial D by means of an indicator C, which is connected with the rod of the balance by a slender cord of silk. With the board in this position, inversion of the right limb and eversion of the left could be tested; and to try eversion of the right and inversion of the left, the board would have to be turned upside down. I repeat that I find in this way that the muscles of inversion are stronger than those of eversion. The centre of gravity of the lower limb lies far to the outer side of a straight line running from the centre of the hip-joint to the middle of the heel. Moreover, when a man is lying supine upon a firm and flat surface, the weight of the limb is transmitted to that surface by the back of the pelvis, by the calf, and by the heel; the back of the thigh does not rest upon the plane of support, because the femur arches boldly forwards in its course from the hip to the knee-joint. So, in the supine subject, the centre of gravity of the thigh is

elevated, as well as being to the outer side of the theoretical axis of the limb. During sleep, the centre of gravity assumes the lowest possible convenient position by eversion of the limb. Then the front of the capsular ligament becomes tense and sets all muscles at rest. If the thigh be now somewhat flexed, so as to temporarily slacken the ligament, further eversion is permitted; and if in the mortuary the ligament be divided, still further eversion is obtainable. Moreover, if the neck of the femur be divided inside the capsule by means of a chisel, eversion to its full and characteristic extent is insured. For then the weight of the limb can no longer be received from the head of the femur and transmitted by the pelvis. The limb sinks and rolls outwards in search of stable equilibrium. But granting, for the sake of argument, that the eversion of the limb after fracture of the neck of the femur is due to the action of the pyriformis and company, how are we to explain the outward rolling of the limb which is so characteristic a feature of fracture of the shaft of the femur? "Rotation outwards of the lower fragment", says Mr. Bryant, "is found in nearly every case."

In different British and foreign museums, I have examined and taken notes of one hundred and fifty-two specimens of union after fracture of the femur below the lesser trochanter. Some of the bones have been picked up in graveyards, some had been removed from mortuaries. Some of the patients had been treated, I suppose, *secundum artem*, and many, if we may be allowed to judge from results, had not. Of these bones, only fourteen showed inversion of the lower fragment. In some of these cases, the inversion was but slight; and in most of them the malposition, comminution, and much new osseous cement were noticeable. Of the other preparations, about 50 per cent. showed eversion of the lower fragment, whilst 50 per cent. were femora united with neither inversion nor eversion. Those fourteen exceptional specimens were instances, I take it, of the violence which caused the fracture leaving the limb pounded in a state of secure inversion. So the broken ends of the bone had remained crossed or interlocked, or imbedded in the surrounding and retentive tissues. To attempt to account for the eversion of the limb after the neck or shaft of the thigh-bone has been broken, by the hypothesis of muscular contraction, is to wander from substantial reality to shadowy theorising.

And as an ending to this imperfect paper, I will ask this pertinent question: When administering an anæsthetic for the painless dealing with a broken neck of the femur, has ever a surgeon observed the everted limb to take up of itself a position of inversion or even to right itself?

ON EVERSION IN FRACTURE OF THE NECK OF THE FEMUR, ETC.

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Now that this discussion has been reopened, it may be as well to finish it while it is fresh in the memory. With Mr. Edmund Owen, I perfectly agree, that the eversion of the lower limb in sleep, death, paralysis, and fractured femur, is equally due to the unresisted rolling outwards of the limb, owing to the suspension of the ordinary muscular functions. We are strengthened by the testimony of Professor Spence, in the form of an ancient conviction, and by that of Mr. Cooper Forster in his recent conversion. To me, this was once for all fully proved by a friend, when we were resident colleagues in University College Hospital ten years ago. The fact cannot, I think, be disputed, is probably widely known, and should be recollected in differential diagnosis; though, as Mr. Spence truly says, it needs no profound vindication. Eversion is present in most fractures of the pelvis no less than of the femur, including the neck, and is due in all to the natural falling outwards of the uncontrollable limb, provided the fracture of the neck be unimpacted.

But what is the cause of eversion in impacted fracture of the neck of the femur? This is a point of some interest, because inseparable from a complete discussion, though unnoticed by all the gentlemen who have shared in it, including Mr. Davies-Colley; but one which has been clearly expounded by Bigelow.

Impacted fracture of the neck he has clearly shown to be everted owing to impaction of the posterior wall only, with a mere bending of the anterior wall, or at any rate its non-displacement if actually broken; due to the greater strength of the anterior wall, as anyone may see on examining these fractures in dissection, and on preparing sections of the femur according to Bigelow's directions and engravings.

The rare occurrence of inversion in these fractures he equally clearly explains as due to a greater force, sufficient to overcome and impact the anterior wall as well as, and more than, the posterior (The Hip, pp. 118-138).