ON

SUPRA-CONDYLOID AMPUTATION OF
THE THIGH.

BY

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IN all cases in which, from either disease or accident, it is deemed advisable to amputate through the knee, or at some point above but near that joint, two questions of prime importance must always present themselves for consideration to the operating surgeon. The first of these is to determine which operation is attended with least risk to the patient; and the second, which is the best kind of stump for the subsequent adaptation of an artificial limb. As regards the first of these questions, it cannot be denied that, although the introduction into surgical practice of knee amputations is of comparatively recent date, the weight of all generally acknowledged surgical authorities who are or have been engaged in civil practice, and who have had opportunity of practically testing the value of this operation, is in favour of the amputation at the knee-joint. The main objects of this paper are to point out the advantages of amputation at the knee and, finally, to discuss a modification of Gritti's method, which I

have ventured to term the "supra-condyloid amputation of the thigh," and which, although I have only performed it twice on the living subject, seems to me to retain the advantages of the various modes of amputating at the knee, and to get rid of their supposed disadvantages if not entirely, at least to a very great extent.

It is now little more than forty years since amputation at the knee, previously recommended and practised by Petit, Brasdor, and Hoin, was, after a period in which it fell into disuse, revived by the late Professor Velpeau. In his paper, published in 1830, he gives a brief account of nine cases which had been recorded by these surgeons. Of these, one only terminated unsuccessfully. From the results obtained by his predecessors, as well as by himself, Professor Velpeau, in a rather lengthy paper, deals with the various advantages of this procedure, which may be briefly epitomised as follows :

I. That the belief in the risk of exposing large cartilaginous surfaces is proved to be imaginary.

II. That after amputation at the knee the weight of the body can be placed on the face of the stump; whereas in all amputations nearer the trunk the support must be at the tuberosity of the ischium.

III. That after amputation at the knee the hip-joint preserves all its movements, and the patient need not walk as if that joint were anchyloid, as he must do after amputation of the thigh.

IV. That the shock is not great, as the wound is almost entirely confined to the integuments, and no muscles of great bulk are divided.

V. That only one artery of any considerable size requires deligation after this mode of amputation.

Fifteen years subsequently, in 1845, Prof. Syme, notwithstanding the rash and indiscriminate proscription of Velpeau's operations (which were stigmatised in one of the leading surgical journals as "experimental murders"), introduced a modification of Velpeau's circular amputation at the knee, this modification consisting in sawing through the condyles

and taking a long flap from the calf of the leg. The great advantages of this procedure are, that the medullary canal is not opened, that the amputation is further removed from the trunk, and also that there is less risk of the formation of the tubular sequestra, which not unfrequently occur after amputation of the thigh, and which result in Mr. Syme's opinion, from injury to the medullary membrane or division of the nutritious artery or arteries. This operation, which appears to be identical with Hoin's, Mr. Syme subsequently abandoned in favour of Mr. Carden's method.

It is hardly necessary to cite authorities to prove that amputation through or in immediate proximity to the knee-joint, is a less hazardous procedure than amputation of the thigh. The researches of Mr. Pollock, Dr. McCormac, Dr. Brinton, and others, sufficiently attest this fact.

Cruveilhier is of opinion that the non-interference with the medullary canal obviates many of the dangers of amputation, and Malgaigne states that when the surgeon has the choice, the amputation at the knee merits "*toute préférence sur l'amputation de la cuisse dans la continuité.*" Dr. Thomas Markoe, in a classical paper on this subject, published in the 'New York Journal of Medicine' for January, 1856, thus expresses himself:—"The stump left after operation at the knee, if it be a good one, is perfectly capable of sustaining the pressure of the body on a simple cushion. This fact is fully demonstrated by the cases published both here and abroad. To the poor man this single circumstance makes all the difference between his being able to earn his living by active employment and his being laid up for life a hopeless cripple. To the rich man, who is able to secure the aid of an artificial limb, it makes the difference between a point of support at the knee and a point of support at the ischium. In fact, it is practically the difference between amputation below and amputation above the knee."

Lastly, I may mention that Prof. Syme has remarked that he feels assured that amputation at the knee will, when its performance is possible, "supersede amputation of the thigh,

which, notwithstanding all the attempts to improve it, has so long remained an opprobrium of surgery."

Were it necessary I might adduce many more opinions of eminent operating surgeons in favour of the amputation through or close to the knee-joint. But, in truth, after the able paper recently read before this Society by Mr. Pollock, this is hardly required.

It is worth while to consider the principal objection which orthopædic mechanists make to such amputations. I have spoken to several of them, and it is certainly of importance to know that there is a great uniformity of opinion among them, which is that, for the subsequent adaptation of an artificial leg, the stump after amputation at the knee is inconveniently long. Mr. Heather Bigg remarks that although the retention of the patella and consequent ability of the patient to take a firm and efficient bearing on the end of the stump offer many advantages, yet they are neutralised by the circumstance that the presence of so long a stump interferes with the shape and artistic beauty of the prosthetic mechanism, it being absolutely impossible to give a natural representation of the knee-joint when so large a portion of substance remains to be disposed of. "Again," he says, "from the length of the stump requiring a resting surface, that surface would project beyond the other limb, on the knee being fixed, giving the wearer an appearance of possessing one leg longer than the other." He, therefore, is of opinion that for amputation above the knee the junction of the lower and middle third of the thigh should, if possible, be selected for the operation.

It appears, however, to me that this objection is hardly one that should deter the surgeon from performing when, it is possible, the less hazardous operation; for I cannot but think that the difficulty of so arranging the appliance, as that on the limb being flexed the concave resting surface should not project beyond the stump, but follow accurately its convexity, would not be wholly insurmountable, even when the amputation is made through the knee-joint. There would be less difficulty when the amputation through the condyles, "the

trans-condylar amputation" (Lücke), is performed; and still less when the amputation above the condyles is selected, in which procedure the thigh can be diminished in length fully one inch or an inch and a quarter.

The operation to which I wish to draw special attention in this paper is a modification of the procedure known in some of the Continental schools as "Gritti's amputation," which is itself a modification of Mr. Carden's amputation at the knee. One great difference between my operation and those practised on the Continent is that the femoral section is made considerably higher up, being fully half or three quarters of an inch above the antero-superior edge of the condyloid cartilage. Having made sections of a large number of femora in this situation, I can confidently state that the bone may be divided as high as I have mentioned, and in some cases even higher, without opening the medullary canal.

In the great majority of cases the medullary canal terminates at a point three quarters of an inch above the cartilage of incrustation on the outside, and over one inch above on the inside, anteriorly. Posteriorly, one half an inch above the articular cartilage on the inside, and more than three quarters of an inch above it on the outside, as the cartilage of incrustation is higher up in front on the outside and higher up posteriorly on the inside.

In all cases, too, the cartilaginous surface of the patella should be removed, the supposed difficulty of which has been in many persons' opinion a great one, but which, in truth, is quite visionary. The advantages to be derived from dividing the bone so high are, first, that this method of operating ensures that the portion of the flap to which the patella is attached shall constitute the face of the stump, there being no danger when the femoral section is made so high of the patella being drawn up during the process of healing on to the anterior surface of the femur, as there is in the operation through the condyles; secondly, that the divided surface of the femur can be kept perfectly and permanently covered by the patella; and, thirdly, that by making the high section the objection I have already alluded to, of the stump being

inconveniently long for the subsequent adaptation of a mechanical appliance, is obviated to a great extent, if not entirely.

In a paper by Dr. Melchiorj, of Salò, on this modification of Carden's operation, a *precis* of which is given in the 'Biennial Retrospect of the Sydenham Society' for 1867-8, the particulars of three cases in which this operation was performed are described, but in only one of them was the articular surface of the patella removed. It would appear, therefore, that much importance was not attached by Gritti to the removal of this portion of the bone. It seems to me, however, that in order to get osseous ankylosis between the patella and femur, it is necessary to remove the posterior surface of the former, as the chances of union between the two bones taking place would otherwise be extremely limited.

The anterior flap, not rectangular but oval, should reach from a point one inch above either condyle to the other, and should extend downwards to the tubercle of the tibia. A posterior flap, at least one third of the length of the anterior one, should also be formed, as the posterior tissues retract so much more than the anterior ones; and therefore, unless a flap in this situation be made, there is much risk of a gaping wound resulting, which would greatly protract the convalescence of the patient. In making the posterior flap, the convexity at its anterior extremity should be directed backwards, so that in subsequently adapting the flaps the convexity at the extremity of the anterior should accurately fit the concavity at the extremity of the posterior flap.

It will be seen, therefore, that the differences between this procedure and the Italian operation are—

First. That the femoral section is made in all cases at least half an inch above the antero-superior edge of the condyloid cartilage.

Second. That in all cases the cartilaginous surface of the patella is removed.

Third. That the flap is oval, not rectangular.

Fourth. That there is a posterior flap fully one third of the length of the anterior flap.

I may now proceed to give as briefly as possible the particulars of the cases in which I performed this operation, and in one of which the amputation was a primary one.

Michael Crow, æt. 32, by occupation a tailor, was admitted into the Richmond Surgical Hospital on the 7th of last January, suffering from extensive carious disease of the bones of the left leg, ankle-joint, and metatarsus. He stated that, about thirteen years previously, while playing at football, he received a kick on the tibia. The leg, he stated, "got sore" immediately, and the disease spread downwards. For more than ten years the disease was localised to the bones of the leg, being confined, namely, to about their middle thirds. The disease then extended downwards, and about a year after the ankle-joint and metatarsal bones became involved.

On his admission into hospital, the patient had a pale anæmic appearance, and was much debilitated from the long continued and extensive disease. The leg, ankle, and foot were much swollen and œdematous, and numerous sinuses existed leading down to softened diseased bone, through which purulent matter, varying as much in consistence as in quantity, continually oozed. Although there were no sinuses or other evidence of disease in the upper extremity of the tibia, I deemed amputation at the knee preferable to that immediately below the tubercle of the tibia, as from the great length of time the disease had lasted I considered it most probable that the bone in its entire extent was involved, a view which a section of the bone made subsequently verified.

On the 18th January I performed the supra-condyloid amputation in the following manner. I commenced by making an incision with a strong scalpel, beginning one inch above the external condyle, and carried it merely through the integument downwards and forwards to the tubercle of the tibia, and then carried it upwards and backwards to a corresponding point on the inner side of the thigh. The knife was then closely applied to the edge of the somewhat contracted integuments, the deeper structures were separated, and the flap containing the patella rapidly dis-

sected back to a point as high as where the incisions were originally commenced. The posterior flap, at least one third in length of the anterior flap, was then made, the first incision, or that through the skin, being so curved that the convexity should look backwards. The deeper structures were then divided with an ordinary amputation knife, and the rest of the posterior flap completed by this instrument. A transverse section of the femur was then made, commencing half an inch above the commencement of the antero-superior edge of the condyloid articular cartilage. The removal of the articular surface of the patella constituted the last stage of the operation, and was not attended with any difficulty. This section I find is most rapidly accomplished with one of the Langenbeck's fine resection saws, the so-called "Stichsäge." Only one vessel, the popliteal artery, required deligation; all other arteries were secured by torsion.

There was considerable hæmorrhage from the popliteal vein, and some delay was occasioned in arresting it. The freshly cut surfaces of both bones were then accurately adjusted, and the edges of both flaps held together by numerous points of interrupted silver wire suture.

It is unnecessary to give the daily progress of the case. Nothing untoward occurred during the convalescence. A better idea than any verbal description I could give of the result, can be gained by an examination of the photograph of the stump, of which a representation is appended (Pl. III). Before dismissing this case, I may mention that the patient has perfect ease and comfort while resting his entire weight on the face of the stump—a result which is never obtained after any other amputation of the thigh, whether it be done by the circular method, the antero-posterior, lateral, oval, or rectangular flap operations.

Primary supra-condyloid amputation.

Michael Kelly, æt. 23, a cabman by occupation, was admitted into the Richmond Surgical Hospital, on Saturday

night, the 19th of February. About ten minutes previous to his admission, whilst driving very rapidly, he attempted to get off the car, and in so doing, while his foot was on the step of the vehicle, the step broke, and the foot passed back, getting between the spokes of the rapidly revolving wheel. The result of this unfortunate accident was, that he sustained an extensive compound comminuted fracture of both bones of the leg. The fibula was fractured in three places, and the tibia, which was broken at about the junction of the middle and lower thirds, was projecting through the soft parts at the inner side of the leg. There was extensive contusion and laceration of the soft parts, which extended as high on the outside of the leg as the head of the fibula. Looking at the numerous fractures that were present, and the great amount of laceration and exposure of the soft tissues, any attempt at saving the limb was obviously hopeless; and also having regard to the fact that the laceration and contusion of the soft parts extended as high as the head of the fibula, I deemed an amputation of the leg at the "place of election" impracticable. I considered, therefore, that, under these circumstances, the supra-condyloid amputation would be the most suitable, and accordingly performed it precisely in the manner I have described in the preceding case. There was in this case, as there generally has been in the primary amputations I have performed, secondary hæmorrhage. It occurred twice. The first time was about half an hour after the operation, and the second on the third day. The first time I was obliged to undo the sutures, and seek for the bleeding vessels, which, I may mention, had in the first instance been apparently effectually secured by torsion. The second time the application of Signoroni's tourniquet for half an hour on the femoral artery had the effect of successfully arresting the bleeding. After this the case progressed most favorably, and, as in the first case, the result was perfectly good.

I may now indicate what I believe to be the advantages of the supra-condyloid amputation over, first, the amputations through the knee-joint with preservation of the patella, those,

namely, of Velpeau, Lane, Blenkins, and Markoe; secondly, the amputation through the condyles, as practised by Syme, Sir W. Ferguson, and others, operations which are closely analogous to, if not identical with, the original operation of Hoin; thirdly, Mr. Carden's operation, and its modification by Gritti; and lastly, the other amputations of the thigh, in which the medullary canal is necessarily opened.

Many of the advantages of this operation are doubtless common to it, and to the amputations suggested originally by Hoin and Velpeau; for instance, the stumps being more useful for progression in consequence of the possibility of making pressure on its extremity, and the patient not being obliged to walk as if he had ankylosis of the hip-joint, as is always the case when the point of support is at the pelvis instead of at the extremity of the stump. The diminished liability to tubular sequestra is another advantage common to all the amputations at the knee-joint. Again, the operation being further removed from the trunk, makes it less hazardous to the patient. The shock is less than in the amputations higher in the thigh, as the muscles which are divided are few in number, and these are divided, not through their thick fleshy bellies, but at their tendinous extremities. The muscular interspaces, in which suppurative inflammation so often occurs after ordinary amputations, not being opened, the chances of this occurring are at all events diminished—a point which Dr. Markoe strongly dwells on. There is less liability also to suppuration, from the fact that the parts divided in making the anterior flap are only skin and fasciæ. In connection with the diminished liability to suppuration, I would also mention here the fact that the posterior surface of the anterior flap in the supra-condyloid amputation is covered with a natural synovial lining.

In Carden's and all other flap amputations in this situation, the posterior surface of this flap contains the obliquely divided open mouths of innumerable arteries, veins, and lymphatics, and large numbers of which have also fenestrated openings in them as well. This peculiarity of

the supra-condyloid amputation must, I am convinced, largely diminish the chances, not only of subsequent exhaustive suppuration, but also of purulent absorption. There is another feature in this operation which I believe must lessen the probability of the pyæmia. Professor Langenbeck has suggested that in amputations of the thigh the cut surface of the bone should, in order to prevent its divided vessels coming in contact with the suppuration in the wound, be covered by a periosteal curtain which, previous to dividing the bone, should be taken from the anterior surface of the femur, commencing about an inch below the point of section. As regards the value of this suggestion for diminishing the mortality of thigh amputations, having only tried it in a very few cases, I am not yet in a position to either verify or disprove Professor Langenbeck's statement on this point. I have, however, tested this plan as well on the human subject as on the lower animals, and the results of my experiments would tend to show the great liability of the periosteal curtain to slough away, and not become adherent to the cut surface of the bone. In the supra-condyloid amputation, however, we have an osseous curtain covering the cut surface of the femur which never yet has been known to slough away, so that if there be any value in Professor Langenbeck's suggestion the supra-condyloid amputation must have this among its other advantages. The preservation of the portion of the patella, to which the tendon of this powerful extensor of the thigh is attached, has, however, other obvious advantages. These are the increased power of extending the thigh in progression, and rendering the formation of a conical stump impossible. If the section of the patella be not made these advantages do not exist. In the first place because the elevated ridge dividing the posterior surface of the bone into two unequal portions effectually prevents the divided surface of the femur and patella being in perfect contact. Again, unless osseous ankylosis takes place, there can be no standpoint or firm point of fixation for the extensors to work on; and, lastly, there will always be liability to exfoliation or necrosis of the cartilage of the patella.

Lastly, there is an advantage in the supra-condyloid operation which is possessed by the ordinary circular method of amputation, and which, among other reasons, makes so many surgeons, myself among the number, in amputations of the arm and thigh cling to the circular method in preference to the ordinary flap operations, and that advantage is that the vessels are divided at right angles to their continuity, and not obliquely as they are in all flap operations, which must render these vessels more liable to take on inflammatory action from the wounds in them being necessarily so much greater in extent. I think, therefore, I may fairly claim for the operation which has been the subject of this communication, among other advantages that I have already mentioned, those of both the circular and flap amputations and the defects of neither.

DESCRIPTION OF PLATE III.

Michael Crow, æt. 32, tailor. Case of supra-condyloid amputation of the thigh for extensive carious disease of the bones of the left leg, ankle-joint, and metatarsus.