C A S E
OF
PUNCTURED WOUND AND LIGATURE
OF
THE POSTERIOR TIBIAL ARTERY,
IN THE UPPER THIRD OF ITS COURSE.

BY JAMES MONCRIEFF ARNOTT, F.R.S.,
SURGEON TO THE MIDDLESEX HOSPITAL.

Received November 11th—Read December 9th, 1845.

WHEN an arterial trunk or main branch is wounded, the rule of practice is, that the vessel should be tied at the seat of injury ; or, as it may be more truly expressed, when it can, it ought to be tied at the seat of injury, as the most certain means of arresting hæmorrhage ; the qualification being rendered necessary by the fact that it is sometimes impossible, or is deemed inexpedient, to put the principle into practice. The circumstance which chiefly operates in creating an exception to the rule is the situation of the wounded artery ; and it is this, no doubt, which has influenced those who, in punctured or gun-shot wound of the posterior tibial high up, have recommended other means of meeting the difficulties and dangers of the case.

A man was brought into Guy's Hospital, having fallen from a considerable height upon a cart. An iron peg in the cart had passed through the calf between the tibia and fibula, and a profuse hæmorrhage ensued ; but by the application of a tourniquet, this was stopped. In six days the bleeding recurred, when the tourniquet was tightened, and the flow of blood again suppressed ; but in two days, hæmorrhage again took place. Sir Astley Cooper tied the femoral artery at the

usual place, and for a week the man went on well, but then the bleeding was renewed, and Sir A. amputated the limb. On examining this after removal, it was found that the iron peg had passed through the posterior tibial artery, at the origin of the anterior tibial, and had penetrated between the tibia and fibula. Sir Astley adds, that "an immediate amputation would be the best course to pursue."* From information which I have received from one who witnessed this case, I have reason to believe that the patient did not recover.

An officer was wounded in a duel, the ball passing from before backwards, through the upper part of the leg, between the tibia and fibula, which was immediately followed by violent hæmorrhage. By the application of compress and bandage upon both openings, all further external bleeding was prevented until the 13th day, when it burst forth afresh, the leg having, in the mean time, swollen greatly at its upper part, attended with pulsation. The bleeding was renewed several times in a few days, when M. Dupuytren being called in, tied the femoral artery in the middle of the thigh, and the patient recovered.

Encouraged by the success of this case, M. Dupuytren was led to expect that it might be the forerunner of other similar fortunate results, and he recommends when the principal artery of a limb ruptured by a ball is followed by an extravasation of blood, presenting the character of an aneurismal tumour, that the artery should be tied at some distance from the wound, between it and the heart.†

On the other hand, Mr. Guthrie, a high authority in these matters, severely criticises the eminent French surgeon. He relates two cases which came under his own observation, of gun-shot wound of the leg, attended with hæmorrhage, where

* Lectures by Tyrrel, vol. iii. page 199. London, 1827.

† *Mémoire sur les Aneurismes qui compliquent les fractures et les plaies d'armes à feu, et sur leur traitement par la ligature pratiquée suivant la méthode d'Anel.* In the "*Répertoire Général d'Anatomie et de Physiologie*, tome v. 1828."

the femoral artery was tied. In one case the arterial hæmorrhage, which led to the ligature of the femoral, did not take place till a month after the receipt of the wound ; in the other it occurred on the 8th and 9th days. In both, the ligature of the femoral arrested the hæmorrhage, but only for a few days, when it recurred, and led to amputation ; in neither case with a favourable result, both patients having died. In one instance the anterior, in the other the posterior tibial artery had been wounded.

In another case of gun-shot wound of the leg, with hæmorrhage, Mr. Guthrie, fourteen days after the accident, cut boldly through the muscles of the calf, and tied the peroneal artery, which had been wounded, thereby saving the limb. He recommends that a similar proceeding should be adopted when the posterior tibial artery is wounded.*

This difference of opinion on the treatment to be pursued in case of wound of the posterior tibial artery high up, is not the only one in which this vessel is concerned. Another exists as to the mode of reaching the artery in this situation, should it be deemed expedient to tie it on account of aneurism or secondary hæmorrhage lower down. Some surgeons, with Mr. Guthrie, advise that the artery should be got at by cutting directly through the whole thickness of the muscles of the calf. Some, and the majority, recommend that it should be reached by incision made on the inner edge of the tibia, between this and the gastrocnemius muscle, which is to be pulled aside, so that the soleus muscle alone is divided. Others think even this operation beyond the domain of legitimate surgery, and consider both as adapted only for the dissecting room and the dead body, and not for the living.

That ligature of the femoral is an uncertain means for arresting hæmorrhage from the posterior tibial artery, is sufficiently shown by the three cases which have been adverted to.

That to reach the last-mentioned vessel in the calf by incision at the edge of the tibia, is attended with considerable

* On the Diseases and Injuries of Arteries. London, 1830.

difficulty, has been acknowledged by Mr. Harrison,* who witnessed the operation, and by M. Bouchet, of Lyons, who performed it: the latter surgeon was even obliged, in order to accomplish his object, to add a transverse incision of the soleus muscle.

The result of Mr. Guthrie's proposal has not, so far as I am aware, yet been ascertained. That gentleman informs me that, since his return to England, at the termination of the war in 1815, he has had no opportunity of putting his recommendation in practice, and I do not find that it has been tested by others. The difficulties and dangers which attend it upon trial in the living body remain therefore to be shown; and it is upon this account, and under these circumstances, that the case about to be related possesses any claims upon the attention of the Society.

Frederick Canacott, ætat. 18, chairmaker, a robust young man, whilst at work on the 1st January of the present year, was struck from behind by a $\frac{3}{4}$ -inch joiner's chisel, thrown at him in anger by a fellow-workman. The chisel struck the calf of the right leg, penetrated deeply, and stuck there. On being withdrawn, great bleeding ensued, which was stopt by tying first one handkerchief round the leg, and then another, and grasping the parts over them. The occurrence took place in a street adjoining the hospital, where he was immediately brought, and where at the time I happened to be.

On uncovering the parts, a small wound was seen at the junction of the upper with the middle third of the leg, nearly in the middle of the calf, but to the inner side of the mesial line. From this, blood, both red and dark-coloured, flowed freely. The wound would not admit the finger, but a director introduced, passed through the calf in a direction forwards and upwards, to a depth of $2\frac{1}{2}$ or 3 inches. From the situation and course of the wound, and the quantity of scarlet blood flowing from it, there could be little doubt that the posterior tibial artery was wounded, and I determined to cut down upon it at once, for the purpose of securing both ends.

* On the Arteries, 4th edition, page 405.

I was so fortunate as to have the assistance of Mr. De Morgan and Mr. Lonsdale, who were upon the spot. The patient was placed on his face, yet inclining to the right side, so as to allow the right thigh to be drawn up a little on the pelvis, and the right leg, which rested on its fore and outer surface, to be flexed slightly on the thigh. Taking the wound made by the chisel as a centre, an incision six inches and a half in length was made through the integument, and this was carried by a succession of strokes through the muscles of the calf, so as to expose the deep fascia of the leg. In it was felt, rather than seen, an opening, from which blood escaped so copiously as to obscure every thing. This hæmorrhage was chiefly venous, the arterial being checked by a tourniquet placed on the thigh, which was now, however, removed, on the supposition that it might increase the venous hæmorrhage. But this did not seem to have been the case, as the dark-coloured blood flowed as before. Finding by pressure of the lower angle of the wound, that the bleeding was considerably lessened, a compress of lint was introduced here, and retained by my dresser's finger, during the subsequent part of the operation. The ligature of two muscular arterial branches was thus facilitated, but venous blood still welled in such quantity from the opening in the fascia, as to preclude all attempts to discover its source, or that of the arterial coming from the same place. The wound in the fascia was, therefore, enlarged by the probe-pointed bistoury to the extent of two inches, and, ultimately, after a deal of trouble and considerable loss of blood, by making pressure with the ends of the handles of scalpels on the various points whence this issued, it was ascertained that, besides the wound of the posterior tibial artery, the *venæ comites* were both divided, one completely, the other nearly so. From the lower end of the former vein the bleeding proceeded, which was held in check by the dresser's finger. To stop that from the latter, an aneurism-needle was carried under it, and a ligature applied to each end of it; the division of the vein was then completed, in order to facilitate the exposure of the artery.

The upper end of the first-mentioned vein still bled from time to time, when the patient cried or struggled, which he did, from pain and cramp, whenever much, and especially sudden, pressure was made on the divided muscles of the calf. But this did not prevent the posterior tibial artery being now seen, from the side of which scarlet blood occasionally issued in a stream. The aperture in it was small, and could not be readily made out; the vessel was, therefore, detached a little from the neighbouring parts, and two ligatures being carried round it, both were tied, one as high up, the other as low down, as the vessel was separated from its adhesions. The tightening of the first or upper ligature did not arrest the hæmorrhage, which only ceased when the lower was tied.

To allow the sides of the wound to be approximated and dressed, Mr. Barrett's finger was now withdrawn, and the compress of lint removed, but the blood again poured out so copiously, that I at first thought of putting a ligature on the end of the divided vein. But, owing to its deep situation under the fascia, and to its being firmly braced down by numerous small veins entering it laterally, this could not be accomplished without enlarging the opening in the deep fascia and the wound generally downwards. A compress was, therefore, re-introduced, and the house-surgeon directed to maintain pressure thereon for some time. This he did for three-quarters of an hour, when the finger was withdrawn, leaving the lint *in situ*. From the presence of this, no attempt was at first made to unite the wound in the integuments by stitches or strapping. Water-dressing simply was applied. The febrile disturbance which ensued was considerable. On the fourth day, the compress of lint, loosened by suppuration, was removed. On the 8th day the ligature from the lower part of the artery, on the 9th that from the upper, came away. During the night of the 11th the patient, who stated he had been dreaming, was awoken by sharp pain in the leg, and the sensation of something trickling. The house-surgeon being called, found the wound at its lower part filled with coagulum, and blood of a scarlet colour flow-

ing in small quantity by the side of it. Finding that the pressure of a tourniquet on the femoral artery did not arrest this, Mr. Batley turned out the coagula from the wound, and introduced a compress of lint to the bottom of it (at its lower angle), and over this another, in which he made pressure for an hour. The hæmorrhage was hereby stopped, and it did not recur. In three days the plugs of lint were withdrawn, and the case subsequently proceeded uninterruptedly to a favourable termination.

In this instance the incisions for securing the artery were wholly within the limits of the calf. It has been stated that the external measured $6\frac{1}{2}$ inches in length, its lower end terminating $7\frac{1}{2}$ inches above the inner ankle. The width of the wound, for some time after the operation, was very considerable from the bulging of the muscles, and no attempt having been at first made to bring together the edges of divided integument. It was dreaded, that besides being slow of forming, the cicatrix would be very broad, and perhaps attended with some weakness of the limb; but in less than two months the parts had completely healed, with a cicatrix not more than $\frac{1}{2}$ or $\frac{3}{4}$ inch broad. For some time this was tender under exercise, but for several months (and I have seen Canacott this day) the limb has been, and is, as efficient as the other.

I have given the preceding details at length, at the risk of being considered tedious, in order that a just estimate of the difficulties of the operation may be formed. These were dependent on the depth of the wound,—the pain and cramp on pressure of the divided muscles,—and the venous hæmorrhage; all of these contributed to render the operation tedious, the influence of the first-mentioned circumstance, however, being the least, that of the last, the venous hæmorrhage, the greatest. The disadvantage arising from the depth of the wound, a depth increased by the muscles of the calf leaving their beds, and bulging as soon as the superficial fascia is divided, are best met by making the external and muscular incisions free, and by doing that which was done in the pre-

sent case—enlarging without reserve the opening in the deep fascia ; a proceeding which greatly facilitates the discovery of the bleeding vessels.

The pain and spasm occasioned by pressure, especially sudden pressure, of the divided muscles, would, probably, be less felt, if broad retractors were employed to keep the sides of the wound apart, and these gently but steadily applied.

But the most troublesome circumstance of all was the venous hæmorrhage, a source of difficulty and delay which is not even alluded to by those who have described this operation, and yet one which in recent wounds of the posterior tibial artery must almost invariably be present, so close are the veins to the artery.

Hæmorrhage from the *venæ comites* is troublesome in comparison to venous hæmorrhage elsewhere, from a dense resisting fascia being extended tensely over the veins of the leg, which shields them from external pressure, so that bleeding from their divided ends cannot be stopped except by pressure directly applied, i. e. under the fascia, or by ligature.

The difficulty arising from the extravasation and impaction of blood in the cellular tissue, around the artery, and in the limb generally, was not experienced in this case, owing to the operation having been promptly performed. Where time has been lost in trying the effect of pressure on the part, assisted perhaps by that of a tourniquet on the artery higher up, which, however, can only be partial or temporary, accumulation of blood in the cellular tissue around the wounded vessel must ensue, and add greatly to the difficulty of finding it.

Taking all circumstances into consideration, it must be allowed that the operation of cutting down upon the posterior tibial artery when wounded under the calf, and tying it, is an operation severe to the patient, and troublesome to the surgeon, requiring both time and patience on his part. On the other hand, when we consider that the object of this operation is to save limb and life ; that by adopting it we take the most likely method of attaining these objects, by putting in

practice the most certain means of arresting arterial hæmorrhage; that upon the evidence afforded by this case, no danger arises from the mere size of the wound, and no permanent detriment from the extensive division of the muscles,—I think it must be conceded, until experience shows the contrary, that this is the proceeding which ought to be adopted in wounds of this artery high up.

That it is an operation which ought to be done as soon after the receipt of the injury as possible, will appear very evident, but it is not one which should be undertaken inconsiderately. It requires good light, and intelligent assistants. The case which has been described occurred in the day time, and from what was then experienced, I am disposed to think that it would not have been successfully performed by artificial light, or at least with greatly increased difficulty. Four assistants were required; one to compress the femoral artery, one to separate the sides of the wound, one to tie the ligatures and to press on the mouths of the bleeding veins at the bottom of the wound till they were secured, and one for the sponge.

That in this instance secondary hæmorrhage took place, is no valid objection to the operation. This is an accidental circumstance, which will occasionally happen whenever and wherever an artery is tied. This secondary hæmorrhage, it will be recollected, came from the lower end of the vessel. The presence of the compress of lint left in the wound at this part, may have had some connection, as a source of irritation, with the occurrence of the bleeding; but a sudden motion of the limb, during the patient's dream, would account more plausibly for the pain he felt, and the hæmorrhage which followed.

The importance of immediate interference in wounds of the posterior tibial artery under the calf have been already adverted to, and cannot be too strongly impressed upon the practitioner. The consequences of doubt as to the real nature of the inquiry, and the effects of extravasation of blood going on internally, are well shown in the following

case, the particulars of which have been communicated to me by Mr. Lawrence, under whose care the case did not come until several days after the accident.

"A young man, a carpenter, was admitted into St. Bartholomew's Hospital on the 26th September 1826, having wounded his leg with a pointed iron tool. It had entered a little above the middle of the leg, about an inch behind the edge of the tibia, and penetrated to an uncertain depth. Profuse bleeding followed, which had ceased when he reached the hospital. A surgeon who saw him at the moment, said that he had wounded a large artery, and that he would lose his limb or his life. The limb slowly swelled, becoming at the same time excessively tense, hot, and painful. The glands in the groin swelled, and feverish disturbance ensued. He was bled from the arm, and leeches were applied six times.

"October 14th.—The wound was quite healed. In consequence of the great swelling and tension, pain, fever, and want of rest, an incision was made above the wound, where there was a little softness to the feel, to the depth of an inch and a half. Nothing escaped but a few drops of blood—great relief of the tension and pain followed.

"23rd.—Free hæmorrhage. On enlarging the wound, the finger went into a large cavity, of which the termination could not be felt.

"26th.—There have been small bleedings. To-day, free arterial hæmorrhage came on while Mr. Lawrence was at the hospital.

"It was now obvious that an important artery must have been wounded, and it was a question whether to cut down and find the bleeding vessel, or to amputate. The swollen state of the limb, and the reduced condition of the patient, forbade the former. The mere removal to the operating theatre made him so faint, that it was necessary to wait and give wine to restore circulation.

"Amputation was performed, and the patient recovered. A large cavity, extending from the back of the knee down to the heel, and from side to side of the limb, separated the

muscles of the calf from those on the tibia and fibula. It contained a large mass of recent coagulum, and a pint of reddish fluid, being apparently a mixture of blood and matter. This cavity was inflamed, and partly covered by lymph, partly by fibrine. After removing the coagula, a portion remained behind, adhering to the tibia. On pulling this away, it was found firm, and had a cavity in its basis as large as a hazelnut; corresponding to this cavity, there was a wound of the posterior tibial artery and vein, both being cut half across. The wound in the artery was oval, and without any coagulum." *

In conclusion, I venture to add my opinion, that when the posterior tibial artery requires to be tied high up, on account

* With the above case, Mr. Lawrence sent me a short account of another, in which, as he states, "the patient had a narrow escape from loss of his limb, under a mistaken notion of an artery having been wounded." Although not directly bearing upon the present question, its singularity and importance induce me to give it a place here.

Henry Connell, ætat. 45, admitted January 8, 1827. Ten years ago he had a tooth extracted, profuse hæmorrhage followed, and lasted two days and nights. A fortnight before admission he fell over some stumps of trees into a ditch, striking the front of his leg violently against some hard substance. In the evening the leg became hard and painful, and then gradually swelled, with redness and tension. He was bled, purged, and cold lotion applied.

At the time of admission the leg was swelled from the toes to the knee, exceedingly tense, bright red and shining, and acutely painful. Deep-seated fluctuation towards the upper and outer part. Health unaffected. The house-surgeon made an incision, and viij oz. of blood, partly fluid, partly coagulated, flowed out, with great relief.

9th.—Hæmorrhage in the night to a considerable extent, so that it was necessary to apply the tourniquet. Pulse 60, and weak. Amputation was advised by Mr. Lawrence and Mr. Earle, on the supposition of an artery having been wounded. The patient would not consent. Slight bleeding during the evening.

10th.—Tourniquet removed yesterday. Hæmorrhage in the night to some ounces. Mr. Lawrence examined the parts minutely to-day, first enlarging the wound made by the house-surgeon. The blood was found effused externally to the muscles. The opening was extended down to the heel and up to the ham, and two pounds of coagulated blood readily cleared away. No bleeding orifice could be discovered. The edges were slightly

of aneurism lower down, the easiest mode of reaching it will be by cutting directly through the muscles of the calf, instead of by incision at the edge of the tibia.

approximated, and wet cloths applied. About three pounds of arterial blood flowed in the evening from numerous minute arterial orifices.

11th.—Has slept well. More bleeding from orifices, which could not be found.

The loss of blood weakened the patient greatly, but the bleeding did not recur. The surface granulated, and the wound healed.