The treatment of haemorrhage from the posterior-tibial artery in the upper two-thirds of its course / by William Harrison Cripps.

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THE TREATMENT OF HÆMORRHAGE FROM THE POSTERIOR-TIBIAL ARTERY, IN THE UPPER TWO-THIRDS OF ITS COURSE.

BY

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Few injuries test more severely the skill and knowledge of the surgeon than those of the arteries. In a situation full of peril, prompt manipulation is essential; selection must be made between different principles of treatment; prolonged consideration aggravates the risk, and may involve the death or mutilation of the patient.

The difficulty encountered in the treatment of such cases is considerably increased when arterial hæmorrhage occurs at a point where, owing to its situation, the vessel is more rarely wounded. The treatment of hæmorrhage at one of these points—the posterior-tibial artery in its upper portion—has been selected as the subject of this article. So comparatively rare is the occurrence, that few surgeons who find this portion of the artery bleeding will be able to rely for assistance on the results of their own experience. So important are the complications in the treatment introduced by life, that the most assiduous practice of dissection may of itself prove an inefficient guide. Where, too, doubt on the part of the operator may destroy a life or limb, while accurate knowledge and skill might save both, it is apparent that careful endeavours should be made to elucidate the subject. In this paper it is proposed to test the current opinion as to the treatment proper to be pursued by reference to the recorded experience of surgeons. With this object in view, the reported cases which

have been discovered in the English and American, and most of the French works and journals of surgery, have (as in a former article in these reports, on Hæmorrhage from the Femoral) been collected in an appendix.

To conclusions drawn from statistics certain objections are notorious; and it has been argued that those which are drawn from reported surgical cases are especially likely to be erroneous.

> "The evil that men do lives after them;
> The good is oft interred with their bones."

But where, as in surgical cases, the operators are usually their own chroniclers, success is apt to survive in history, failure to pass into oblivion with the bones which it consigns to decay. Such an objection, however, applies with less force to comparisons between various principles of treatment. Whatever principle the statistics may be called upon to support, the proportion of success to failure will be liable to abatement in an equal ratio.

Hæmorrhage from the posterior tibial may occur under two distinct conditions:—

1. Following amputation of the leg.
2. The result of injury in continuity.

Hæmorrhage following amputation is beyond the limits of the present subject. It may be remarked, however, that if the hæmorrhage occurs shortly after the operation, the desirability of opening the flaps may be considered. But from a careful perusal of the reported cases, it does not seem that this operation has been so successful as to be lightly undertaken; in many instances the vessel could not be found; in some, fatal depression followed the opening of so large a wound. On the other hand, some of the most successful cases in the history of ligature of the femoral were those in which it had been tied for hæmorrhage after amputation, while equal success frequently followed the careful application of a bandage to the stump, the femoral artery being at the same time compressed.

There are three causes which may result in hæmorrhage from the posterior-tibial artery in continuity:—

1. Punctured or incised wounds.
2. Rupture of the vessel by blows, or pressure without external lesion.
3. Laceration by fractured bone.

Four methods in which this injury may be treated are possible:—

(*a*) Amputation.

(*b*) Ligature of both ends of the wounded vessel within the original limits, or on enlargement of the wound.

(*c*) Ligature of the femoral artery.

(*d*) Pressure and bandaging.

(*a*) There may be complications in wounds of the posterior tibial which may demand amputation. The limb may be so severely crushed, or so extensively fractured, as to render unwise any attempt to preserve it.

From whatever cause the hæmorrhage occurs, amputation immediately reduces a highly-complicated case, involved in uncertainty and risk, to one in which the chances for or against life admit of accurate calculation. But that the limb should be immediately amputated whenever the hæmorrhage is complicated by fracture, whether simple or compound, and generally when secondary hæmorrhage occurs, appears hardly to be supported by surgical history, although the first is an axiom of Erichsen,* the second of Lawrence.†

Since death follows amputation of the leg in nearly forty per cent. of the cases in which the operation is performed for 'injury,' and since success means permanent mutilation, it seems that this operation should only be adopted as a desperate alternative; and if by a simpler operation in a large proportion of cases both life and limb have been saved, the surgeon should discard amputation, except as a last resource.

(*b*) The second method of treatment. The ligature of both ends of the wounded vessel, either in the original opening, if an incised wound, or within an enlargement of the wound, if it should be necessary, will at once recall the remarks of Guthrie, who, after the manner of enthusiasts, was too much impressed with his so-called golden rule to allow that it could have any exceptions. Of the operation he states, at a time when it does not appear that he had ever tied the posterior tibial during life,‡ 'The edges of the long incision being easily separated, and to such a distance as to admit of the exposure of the great nerve, artery, and veins, in as distinct a manner as any other nerves, arteries, or veins can be exposed in the human body, the tourniquet is now to be unscrewed, and the bleeding, if the wound did not bleed before, leads to the spot where the artery is injured. The knife may be applied perpendicularly to the fascia, and the artery laid bare three or four inches in extent, *by as common a piece of dissection as any ever practised,* and nothing can interrupt the application of the ligature. The nerve and the fascia cease to be surgical bugbears, and the operation is as simple as any in surgery. No surgeon or anatomist will dispute this statement.' Guthrie was enabled, by the many and striking cases which he had collected, to support the

* Erichsen, Surgery, vol. i. p. 302.

† Clinical Lecture, St Bartholomew Hospital, 1853.

‡ Guthrie on Diseases of the Arteries.

arguments which have generally recommended his views. But possibly he was not altogether free from the common faculty of adapting facts to desired conclusions.

Recorded cases seem, however, to show that in this particular class of hæmorrhage, not only is it incorrect to assume that the only treatment consists in securing the vessel within the wound, or in amputation, but that ligature of the femoral, or even pressure and bandaging alone, may produce with a less severe operation more satisfactory results.

The firm and unyielding character of the fascia by which the posterior tibial in its upper two-thirds is bound down, the depth at which the artery lies beneath the gastrocnemius and the soleus, the great power of those muscles, the contact of the artery with the nerve, the close juxtaposition of the venæ comites, would lead any mere anatomist to dispute Guthrie's proposition as to the simplicity of opening the calf to reach the wounded vessel. The surgeon who has performed or witnessed the operation will not be the more inclined to accept the statement.

The impossibility in many cases of discovering with certainty from which artery the bleeding proceeds, and, therefore, the necessary direction of the incision, is in itself a formidable obstacle in undertaking the operation.

If it be determined to proceed in order to reach the posterior tibial, a deep wound is made some seven inches in length, which probably has to be prolonged in the course of the operation. The walls of this wound formed by the muscular masses of the soleus and gastrocnemius convert it into a deep gully, with more or less unyielding sides. Muscles and fascia are blended into one indistinguishable livid mass by extravasated blood, in which all the usual anatomical landmarks are obliterated.

At the bottom of this wound the vessel must be sought. Since surgical landmarks cannot be relied upon, the only sure guide to the wounded vessel is the arterial blood. As the tourniquet is released for this purpose, the bottom of the wound fills with blood, entirely obscuring the vessel. As often as the wound is cleansed by the sponge, it will be refilled by blood. If, eventually, the surgeon secure the vessel, the patient has been subject to a prolonged operation, and to a considerable loss of arterial blood. A wound of great extent has been necessarily exposed during the operation to severe handling. In these circumstances it might be expected that the patient's life is in considerable risk, and that a high rate of mortality would follow the procedure.

Lawrence, when speaking of an incision in the calf to search for a wounded vessel, says, 'Such a course seemed to me altogether objectionable, as imminently dangerous to life.'

Guthrie himself, in describing his well-known case of ligature of the peroneal in a wound, says, 'Having made an incision over seven inches in length, through the gastrocnemius and soleus muscle, I attempted to discover the vessel, but this was more difficult than might be supposed after such an opening had been made. The sloughing matter, mixed with the coagulated blood, readily yielded to the back of the knife, but was not easily dissected out. The spot which the arterial blood came from was distinguished through it, but the artery could not be perceived, the depth of the wound rendering any operation upon it difficult.' He goes on to state 'that, owing to the altered state of the parts, he could not separate the vessel distinctly from the surrounding parts, and was eventually only able to secure the vessel by passing a tenaculum beneath it, and including the tissues thus raised in the ligature.'

It is obvious that no surgeon could have thus treated the posterior tibial, on account of its close connection with its nerve.

This description of what actually took place in the case of the peroneal artery is difficult to reconcile with Guthrie's theory of a similar operation on the posterior tibial.

In another case, where the result of this operation on the posterior tibial was successful (Appendix, Case VI.), Mr Arnott says, in describing his experience of this operation, 'It is not one that should be undertaken inconsiderately; it requires good light and intelligent assistance. The case described occurred in the daytime, and from what was experienced, I am inclined to think that it could not have been successfully performed by artificial light, or, at least, with greatly increased difficulties.'

Dupuytren, in speaking of hæmorrhage from the calf caused by a pistol-ball, thus graphically describes the difficulty:—'Should a ligature be placed on the ends of the divided vessels? But what were those vessels? Was it the anterior or posterior tibial? or the popliteal, or the peroneal? or was it several of them at the same time? How should they be attacked, before or behind, or at both points successively? But to all who know the depth of these vessels, their relations to the bones, nerves, and muscles, this scheme of cutting down upon the vessel appears impracticable. How could we distinguish the vessel from the soft, torn, bruised parts which surround it? or how could a ligature be passed and tied at the bottom of a wound deep between the bones?'

Those who have had the opportunity of observation will recognise that the preceding remarks apply primarily to cases in which the hæmorrhage is the result of a punctured wound, or of injury from a fractured bone; the majority of which cases, except such as demand immediate amputation, require a treatment generally similar. Where the hæmorrhage is caused by an incised wound which

comes under the surgeon's care shortly after infliction, before sloughing or extensive extravasation of blood has taken place, the searching for the vessel would be expected to present less difficulty, and to be attended with less danger to the patient.

Of the ten cases collected in the Appendix in which the result of this operation is recorded, four were successful, six failed. Of the only successful cases, it will be observed that in two (IV., III.) the vessel was tied in a clean-cut, incised wound; in the other two (V., VI.), a punctured wound was opened by incision immediately after the accident. Of the six cases of failure, three resulted in death (I., II., VII.) In two, the vessel could not be found (VIII., XXI.) In the last case (XV.), after two operations on the wound, profuse hæmorrhage again recurred, and the main vessel of the limb was tied.

(*c*) Ligature of the femoral artery. Five instances in which this treatment met with success, three where it resulted in failure, are recorded in the Appendix. Guthrie's strong condemnation of this method (which seems to have the concurrence of most modern surgeons) appears mainly due to its failure in the two cases referred to in the Appendix (XVI., XVII.) But as these arose from gunshot wounds, and were treated in the immediate vicinity of the battlefield, it may be presumed that the circumstances of the operation and the condition of the patient were alike unfavourable.

According to one of the best authors * on modern surgery, a fracture in the upper part of the leg, complicated with an injury to one of the tibials, is a case for immediate amputation, an attempt to find the vessel or tie the femoral being described as equally futile.

The former, the conversion of a simple into a compound fracture of the worst possible description, would usually be thought inadmissible. If left to itself, and the fracture treated irrespectively of the injured vessel, the result to be expected would probably be similar to what occurred in Dr Black's case (XVIII.); the limb gradually becoming more swollen, and as the pressure from the extravasated blood increases, so will the circulation become more and more embarrassed, till bullæ form and gangrene sets in.

Prolonged search has revealed four cases (X., XI., XII., XIV.) only in which the femoral was tied for fracture accompanied by severe arterial hæmorrhage, two in cases of simple, two in cases of compound fracture. In all these cases the patients recovered with useful limbs. It may be that surgeons have not recorded their unsuccessful cases, or it may be that owing to modern doctrine all such limbs are amputated, and no opportunity is given for testing the value of the Hunterian operation. If such surgeons as

* Erichsen, vol. i. p. 302.

Dupuytren and Syme had sufficient faith in the operation to put it in practice, and if in their time the proceeding was successful, its condemnation as futile by modern surgeons seems to require support by very cogent reasons.

Direct pressure in case of fracture is hardly possible, but if the femoral artery cannot be controlled by digital pressure, its ligature seems to promise a fair chance of success. If amputation become eventually necessary, the previous ligature will not materially decrease the chance of recovery.

In the case of secondary hæmorrhage occurring in the practice of Lawrence, that surgeon acknowledged the uselessness of any further attempt to find the vessel in the wound, and considered the only alternative to be amputation, and at once removed the limb.

Dupuytren, on the other hand, in a similar case of secondary hæmorrhage, ligatured the femoral artery with complete succese, remarking at the time that he had saved the patient from the "cruel mutilation" of amputation which his colleagues wished to perform.

Billroth, in his letters from the seat of war, draws a graphic picture of the difficulties, and in some cases the impossibility, of tying a vessel in a granulating wound. He concludes by saying, that in most of such cases, after much loss of blood has been incurred in the attempt, the main artery has after all to be tied. Beck and Stromeyer also congratulate themselves on the successful result of ligature of the main vessel.

Reference might also be made to S. Cooper's case, occurring after the battle of Waterloo; and also to an exceedingly interesting and instructive case published at length in the 'Lancet' of 1849, vol. i. p. 614, by Mr Massey of Nottingham. In both of these cases the femoral was successfully tied, in the one case for hæmorrhage from the popliteal, in the other, from the anterior tibial. These cases have been excluded from the Appendix, as not affecting the posterior tibial.

(*d*) Pressure and bandaging.

The value of this method of treatment for hæmorrhage is in direct proportion to the danger and liability to failure consequent on the inaccessibility of the wounded vessel, or the special conditions under which the operation has to be performed. Such treatment would appear particularly applicable in many cases of wound to the posterior tibial.

It is not pretended that treatment by pressure is possible in every case of a wound of this vessel, nor should it be anticipated that success will invariably follow even in cases favourable for its trial; but, without doubt, in the majority of instances such treatment deserves a fair and thorough trial, and no operative proceeding

should be hastily undertaken until this has been done. Attention is called to Cases XX. and XXI. in the Appendix as especially illustrative of these remarks.

Few proceedings in surgery call forth the ingenuity and patience of the surgeon in a higher degree than the skilful application of pressure, but to lay down any exact rules for its application would be obviously useless. In the history of cases treated by pressure,* it may be remarked, however, one of the chief causes of success appears to be the careful and tight bandaging of the entire limb, and thus diminishing the total quantity of blood circulating through it. Direct pressure over the whole course of the femoral should also be applied. Again, how frequently is a renewed outbreak of hæmorrhage the result of some involuntary movement during sleep or forgetfulness. Certainly much material benefit might be expected to result from the steadying of the limb by a carefully-adjusted splint.

From the foregoing remarks these conclusions seem to follow:—

(1.) Except where rendered impracticable by the character of the injury, pressure and bandaging should be thoroughly tried, until they appear useless, and likely to prejudice the success of any ultimately necessary operation.

(2.) If the abandonment of this method become expedient, either the femoral should be tied, or the wound enlarged for the purpose of securing the bleeding vessel. Between these operations the features of the particular case must determine.

(3.) In all cases of simple, and in some of compound fracture, where the vessel is not readily accessible, ligature of femoral should be tried before resorting to amputation.

(4.) In wounds other than clean-cut incisions, an attempt to tie the vessel at the wounded point involves great difficulty and danger, and the probabilities of success diminish as the interval between the infliction and treatment of the injury increases.

In many of these cases, due consideration being given to the condition of the patient and the circumstances in which the operation has to be performed, ligature of the femoral artery would be less hazardous than any interference with the wound.

* Secondary Hæmorrhage from Femoral, St Bart.'s Hospital Reports, 1874.

APPENDIX.

CASE I.—'*Lancet*,' 1849, vol. i. p. 226.

Deep wound, not more than half an inch wide, posterior tibial wounded. A bandage placed tight round the leg; removed on the eighth day; on removal, free arterial hæmorrhage took place; wound enlarged; both ends of vessel tied. No more hæmorrhage occurred, but the man died eight days later, delirious, with inflammation of the leg.

CASE II.—'*Lancet*,' 1855 (*July 14th*), vol. ii. p. 30.

A drayman admitted into St Bartholomew's, having squeezed his leg between the dray and a post. No pulsation in posterior tibial, limb tense, swollen, and cold. Mr MacWhinnie, after consultation, anticipated that the posterior tibial was wounded. A free incision was made over the vessel from the popliteal space. After some search a small ragged opening was found in the vessel, and the artery was secured by ligature. Man died, delirious, thirty-two hours later.

CASE III.—'*Lancet*,' 1828, vol. i. p. 716.

At the Royal Glasgow Infirmary, Cowen tied the vessel in a wound (boy, aged 12); bleeding recurred, but on removing dressing, ceased. No recurrence; favourable termination.

CASE IV.—'*Lancet*,' 1850.

Dr Broughton tied both ends of posterior tibial in wound, clean cut, five inches long, made by an axe; recovery.

CASE V.—'*Medical Gazette*,' 1846, p. 233.

The patient was thrown from his horse; half an hour later he was found cold and faint, having lost much blood. A little below the junction of the upper and middle third was a wound in the calf one inch in length, from which blood was still issuing. The wound was enlarged both ways, and after removing a good deal of coagulated blood, the posterior-tibial artery was ligatured in the wound. The patient did well, and perfectly recovered.

CASE VI.—'*Medical and Chirurgical Society's Transactions*,' 1845.

A robust young man admitted into Middlesex Hospital with a punctured wound in the middle of the calf. Arterial blood flowed in quantity. Taking the wound as the centre, an incision six and a half inches long was made down to the deep fascia; this was opened after considerable difficulty from the bleeding. It was ascertained that, besides the posterior tibial being wounded, both venæ comites were divided. Two ligatures, one above, one below punctured wound of tibial, applied. On the eleventh day some bleeding took place, but was easily checked by compression. The patient did well, and recovered with a perfectly efficient limb.

Arnott experienced considerable difficulty in this operation.

CASE VII.—*St Bartholomew's Hospital*, 1874.

D. R., when working at the Enfield factory, was struck on the back part of the calf, at the junction of the upper with the middle third, by a small piece of metal, which, flying off with great violence, buried itself in the tissue; smart hæmorrhage immediately ensued, but soon ceased.

On the following day, the limb being somewhat swollen, and slight hæmorrhage having taken place, under chloroform an incision was made with a view of removing the foreign body. On the small piece of iron at the bottom of the wound being moved, a sudden and violent gush of blood took place from the posterior-tibial artery. The femoral being compressed, the wound was enlarged each way, with a view to tying the vessel. This, after considerable difficulty, was eventually secured, but the man died two days later.

CASE VIII.—'*St George's Hospital Report*,' 1820.

Punctured wound on outer margin of tibia. Wound enlarged, but bleeding vessel not found in front, nor did ligature of anterior tibial arrest the bleeding. Ligature placed on termination of popliteal. Gangrene of the foot set in, and the limb was amputated.

Cases in which the Femoral was tied.

CASE IX.—'*Lancet*,' 1849.

Sir A. Cooper tied femoral for wound below the knee. Hæmorrhage returned; limb amputated.

Case X.—'*Monthly Journal of Medical Science*,' 1842, p. 965.

Woman, aged 62. Simple fracture of tibia and fibula; became compound with a good deal of sloughing. On June 1st sudden gush of blood from posterior tibial, ceasing on application of cold and elevation. On the following night suddenly lost 2 lbs. of blood: slight pressure was merely applied. At nine on the following morning blood gushed out as freely as ever—firm pressure over wound arrested it. The femoral was then tied in Scapa's triangle by Syme. Complete recovery.

The three following cases are from the 'Répertoire Général d'Anatomie et de Physiologie':—

Case XI., p. 227.

A woman, aged 62, had the left leg broken about the middle. Dupuytren, on examining the patient on the following day, discovered a pulsating swelling in the calf. This he thought was the result of a wound of the posterior tibial.

He tied the femoral artery in the middle of the thigh. On the sixth day the size of the swelling was diminished to one-third. The patient did well, and at the end of the fourth month was discharged with a useful limb.

Case XII., p. 230.

Jacques Boudet, aged 30, had a comminuted fracture of the leg, caused by being run over by a laden waggon. On being taken to the Hospital St Eloi, the limb was enormously swollen, with distinct pulsation in the calf. Pressure on the femoral stopped the pulsation. The following day M. Delpech tied the femoral. The patient did well, and in less than three months was discharged perfectly cured.

Case XIII., p. 233.

M. de Gombaut was wounded by a pistol-ball passing between the tibia and fibula in the upper part of the leg. Violent bleeding ensued, but was stopped by compression and bandage. The limb became painful and swollen, with a pulsating swelling in the calf.

On the thirteenth day hæmorrhage occurred; this bleeding was renewed several times, greatly weakening the patient. At this time he was first seen by Dupuytren. He says, 'I found the foot and leg violet coloured, cold, numb, and swollen; on the upper part of the leg was a tense swelling, expanding with each action of the heart. On the tumour were two small openings, one near the back of the fibula, the other on the inner edge of the calf.

These were the holes of entrance and exit of the bullet. For a few hours these holes had been closed by clots of blood, which each pulsation threatened to force out. Repeated bleedings had reduced the patient to a state of great weakness. I advised a ligature should be placed on the femoral artery. If the ligature did not turn out as I expected, or should prove insufficient, it would be the first part of an amputation, not more dangerous by being performed at two different intervals. I tied the femoral. Great attention was paid to keeping the limb warm. When the ligature came away, the wound rapidly healed, and in three months M. de Gombaut walked as well as he had done before the accident.'

CASE XIV.

Mr Cæsar Hawkins tied the femoral for repeated hæmorrhage after a compound fracture of the leg. The patient recovered.

CASE XV.—'*Lancet*,' 1835, p. 460.

A boy, aged 15. Deep cut through gastrocnemius and soleus; immediate and profuse hæmorrhage to the extent of three or four pints (May 2d). On being taken to the North London Hospital, two large trunks were tied in the wound. On the 14th sudden hæmorrhage from the posterior tibial to the extent of fourteen ounces. Stopped by pressure of finger in the wound. Severe bleeding on the 25th and 26th, wound lengthened, and posterior tibial tied higher up. On the 27th again profuse bleeding. Patient nearly dying. Popliteal tied. No more hæmorrhage. Complete recovery.

CASES XVI AND XVII.

Two cases reported by Guthrie. Femoral tied. Hæmorrhage recurred. Both these were after a battle.

CASE XVIII.—'*Lancet*,' 1861, vol. ii. p. 227.

Simple fracture in upper third, on June 23d, a rupture of posterior tibial artery. Limb much swollen from knee downwards; toes cold; bullæ had arisen on dorsum of foot and back of leg. Amputation for special reasons not performed till July 2d; limb in a state of gangrene; died about an hour later.

CASE XIX.—'*Medical Times*,' 1853, p. 592.

In a clinical lecture by Lawrence, he mentions a case of punctured wound of the posterior tibial. The bleeding having ceased,

the edges of the trifling wound became adherent; the limb, however, remained painful and greatly swollen. In the third week a puncture was made in the swelling: nothing escaped but a few drops of blood. A week later violent arterial hæmorrhage took place from the puncture. Lawrence immediately amputated.

Cases in which Pressure and Bandaging were relied upon.

Case XX.—'*Lancet*,' 1861, vol. i. p. 609.

Anterior and posterior tibial wounded by cut five inches long. 'On relaxing the tourniquet, and retracting lips of wound, blood jetted up in several directions. It was found impossible to ligature the vessel without enlarging the wound to a considerable extent; even then it was doubtful whether the posterior-tibial artery could be secured.' Limb bandaged from below upwards, tourniquet on femoral. Complete recovery without further hæmorrhage.

Case XXI.—'*American Medical Times*,' 1864, p. 3.

A musket-ball passed through the leg of a soldier on July 2d, entering three inches below the knee. On August 2d a fluctuating swelling was found on inner side of leg. Although a traumatic aneurism was suspected, a counter opening was made, and a large quantity of fœtid pus and blood escaped, but no active arterial bleeding. Two days later a profuse arterial hæmorrhage took place, the patient being almost pulseless before it could be arrested by compression and bandage. The surgeon searched for the wounded posterior tibial, but the parts were so much disorganised that it could not be detected. The patient's condition precluded any further attempt at an operation, and to sustain the man, stimulants by the mouth and rectum had to be freely resorted to for some days. Wound dressed with permanganate of potash. Recovery.