An essay on the methods of suppressing hæmorrhages from divided arteries / By Thomas Kirkland, surgeon.

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AN
ESSAY
ON THE
METHODS OF SUPPRESSING
HÆMORRHAGES
FROM
DIVIDED ARTERIES.

By THOMAS KIRKLAND, Surgeon.

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ADVERTISEMENT.

NOtwithſtanding much has been lately wrote upon this ſubject, yet no one ſeems to have conſidered it thoroughly. The author therefore begs leave to offer the reſult of his enquiries concerning this matter, imagining, if he has gone farther than other writers, that he is doing ſome ſervice to the Art of Surgery, though this Eſſay ſhould (as it probably will) fall ſhort of perfection.

INTRODUCTION.

WHOEVER takes a view of the late well-intended attempts to recommend a leſs painful method of ſuppreſſing the hæmorrhage from divided arteries, than is generally practiſed, will find that theſe writers have omitted to aſcertain by proper experiments the principles on which the ſuppreſſion depends; and upon enquiry the different theories which have been invented by other writers will appear to be greatly deficient, and deſtitute of any fact or experiment ſufficient to evince their truth.

Indeed

Indeed Mr. Gooch * has conſidered this affair nearly in its true light; but as what he ſays is only conjectural, it ſeems not to have gained preference to the other hypotheſes which have been advanced; a very ingenious ſurgeon at this time adopting the opinion of Pouteau †.

In fact, this part of practice has always been defective, by not learning from nature the true intentions to be anſwered. Hence, from not acting upon right principles, remedies have been applied at random; and nature has often effected a cure, in oppoſition to the moſt barbarous and im-

* Caſes, p. 140. London 1758.
† Mr. White on Spunge.

proper

proper applications. The different ſpecifics which have been cried up and in vogue, and the multiplicity of remedies, ſufficiently point out the uncertainty with which this ſubject has been treated; for had the principles on which we were to proceed been aſcertained, the moſt effectual applications would eaſily have been diſcovered, and the reſt diſcarded as uſeleſs. And though ſince the needle and ligature were introduced, we have been more ſteady in our practice, yet I apprehend we have, even in this particular, been not quite free from imperfection.—And were we not ſo unſettled, as to be near giving it up for remedies recommended with only ſuppoſed advantages?

The

The following eſſay is therefore intended to ſupply theſe defects; and I hope, by proper experiments, and giving a new light to ſeveral facts, I have both aſcertained the principles on which a ſuppreſſion of the flux from divided arteries depends, and what method moſt ſafely and effectually, under different circumſtances, anſwers this purpoſe.

AN ESSAY ON THE METHODS OF SUPPRESSING HÆMORRHAGES FROM DIVIDED ARTERIES.

CHAP. I.

Of the natural or ſpontaneous ſuppreſſion of Hæmorrhages from divided arteries.

WHEN agaric of the oak was firſt introduced in England, for ſuppreſſing the hæmorrhage from divided arteries, I made ſeveral experiments to try in what manner it produced its effects; and I was ſoon convinced, that it had no other property than that of ad-

hering cloſe to the mouth of the veſſel: this circumſtance, together with conſidering how often the ſmaller arteries cloſe themſelves by their own natural contraction, and that it was common for very conſiderable arteries to be cloſed in the ſame manner, when the impulſe of the blood was abated by the ſwooning of the patient *, led me to imagine that the ſame thing muſt of courſe happen in the large arteries, provided the paſſage of the blood through them be firſt intercepted for a time, and that the cloſe contraction which was obſerved in thoſe arteries † to which the agaric had been applied, was intirely owing to the courſe of the blood being impeded by blocking up the end of the veſſel.

Every day's experience confirmed me in this opinion; for I found that the flux from very conſiderable arteries was eaſily and effectually ſuppreſſed by only making a perpendicular preſſure a few minutes upon the end of the veſſel.—But, in order to be more

* See Baron Van Swieten's Comm. vol. ii. p. 34. and Phil. Tranſ. N° 449. p. 313.

† Warner's Caſes, p. 136.

certain

certain about this matter, in the latter end of the year 1755 I made the following experiment.

After tying a large horſe down, Mr. Peale of Maidſtone, then with me, took off one of his hind legs about the middle of the thigh: immediately upon the bone being divided, the horſe drew the ſtump towards his body, at which time the tourniquet ſlipt off, and five arteries, the leaſt of them about the ſize of a wheat-ſtraw, ſome near as large as a gooſe-quill, and one much larger, poured out with great vehemence; but an immediate ſtop was put to the flux by a perſon preſſing with both hands upon the wound; and by continuing this preſſure fifteen minutes, the veſſels became ſo firmly cloſed as not to diſcharge the leaſt drop of blood. However I paſſed a needle and thread round one of the largeſt, intending to make an experiment with the ligature.

The pulſation at firſt was very plainly ſeen at their extremities; but after ſome time it became leſs perceptible, and the wound was

covered with tow, which was kept on with very ſlight bandage.

The horſe was kept alive forty-eight hours after the operation; and though he tumbled about and ſtruggled much in attempting to raiſe himſelf up, yet there was not any return of the hæmorrhage, nor did there appear the leaſt pulſation.

After he was killed we diſſected the thigh, and found that the bleeding was not ſuppreſſed by congealed blood, but by all the veſſels being quite cloſe contracted for near an inch or more from their extremity.

After this I made more experiments of the ſame kind upon brutes with the ſame ſucceſs, and always found, upon diſſection, the ends of the veſſels cloſe contracted for a conſiderable way: by removing my fingers from time to time, while I preſſed upon the veſſel, it was eaſy to diſcover this contraction taking place by a gradual decreaſe of the ſtream of blood; but in Auguſt 1757 the following caſe gave a further light to this matter.

Joſ. Ayre of Caudwell, about twenty years of age, in being bled had the misfortune to have the humeral artery opened along with the baſilic vein, and the operator with much difficulty ſuppreſſed the hæmorrhage by bandage: however a tumor with great pulſation ſoon began to ariſe in the part wounded, which in ſix or ſeven weeks increaſed to the ſize of a pullet's egg.

The nature of the tumor was at once evident, and an eſchar on the upper part of it being upon the point of ſeparation, determined me to perform the operation for the aneuriſm.

The impulſe of the blood againſt the ligature at the time of the operation was very great; and as part of the artery (whoſe diameter was conſiderably enlarged) was expoſed, its pulſation was remarkably viſible: but upon removing the dreſſings the third day afterwards, the pulſation could neither be ſeen nor felt nearer to the ligature than an inch and half; whence I was led to conclude, that the artery had collapſed and gradually cloſed itſelf

up

up to the neareſt lateral branches, as the reſiſtance towards the ligature abated from the blood paſſing through thoſe veſſels.—And it appeared to me ſelf-evident that nature always took this ſtep to ſuppreſs the hæmorrhage from divided arteries, when I reflected that the ſame circumſtance conſtantly happens, when the umbilical veſſels are divided at the birth of the fœtus.

However, as I did not look for the lateral branches in the experiments mentioned, I cut off another horſe's tail near his body, and ſuppreſſed the hæmorrhage by preſſing a few minutes with my fingers; and by a careful diſſection the next day after he was killed, I found that the concluſion I had drawn was (in this ſubject at leaſt) perfectly right.

Is it not owing to this cauſe that an hæmorrhage does not follow thoſe mortifications, where the greateſt part of the limb is deſtroyed and ſeparates? For if the great veſſels were cloſed no farther than where the mortification ends, a flux of blood muſt of courſe enſue upon the coming away of the dead

parts. Is not this evinced in a caſe lately publiſhed by Mr. Antrobus *? where, though the mortification ſtopped only two inches above the ancle, yet it is probable that the large arteries cloſed themſelves as far at leaſt as where the femoral artery divides below the knee; becauſe neither pulſation nor hæmorrhage appeared when the leg was taken off.

It will not, I imagine, appear at all ſurpriſing, that the cloſing of the end of the veſſel an inch only, or perhaps leſs, ſhould be ſufficient to reſiſt the force of the circulation, when it is conſidered, that this impulſe againſt the end of the artery immediately becomes leſs, and ſoon intirely ceaſes, from the blood upon meeting with reſiſtance dilating and paſſing through the neareſt lateral branches; as is fully evident from the gradual decreaſe, and at length the total diſappearance, of pulſation.

* Med. Obſerv. & Inq. vol. ii. p. 152.

Nor

Nor is this contraction of the artery and the alteration in the courſe of the blood long in taking place, as appears from the experiments mentioned: and beſides theſe, in many inſtances I have obſerved, that arteries as large as thoſe we commonly meet with in cutting for the ſtone, or in taking off ſchirrous breaſts, &c. will for the moſt part, if they are wholly divided, be effectually cloſed by preſſure in three or four minutes. And if in taking off a leg, we intercept the courſe of the blood longer than is uſually done, moſt of the arteries will often be cloſed, if the patient is in a tolerable good habit, as I have learnt by tying the large veſſels without looſening the tourniquet.

I took off a woman's leg near the middle of her thigh, and tied the large artery without looſening the tourniquet; upon ſetting it at liberty, we obſerved ſome blood draining down the muſcles from one artery only, and though it had contracted itſelf ſo much as ſcarce to admit the paſſage of any blood, yet by the pulſation it appeared to be a very conſiderable

ſiderable veſſel, and on this account the ligature was uſed.

Several more, which did not bleed, were diſcovered by a ſtrong pulſation at their extremities; and therefore, inſtead of immediately dreſſing the patient, we waited ten or fifteen minutes, and gave her wine to raiſe her ſpirits, ſo that we might ſee whether they would bleed or not, and thereby prevent our being alarmed with a freſh hæmorrhage after ſhe was put to bed: but during this time the pulſation gradually diſappeared, and the bleeding was effectually ſtopped.

Indeed, ſince I have attended to this circumſtance I have ſeen it ſo often happen, that I am well convinced in amputations larger veſſels have been truſted with lint and flour than has generally been imagined; and that when a freſh hæmorrhage returns ſome hours after an operation, it is not from ſmall arteries being dilated by an increaſed motion in the blood, as has generally been thought, but to the principal lateral branches which had cloſed themſelves being again forced open.

That the large arteries are alſo cloſed in a very little time, does not only appear from the experiment made upon the horſe's leg, but likewiſe in ſeveral of thoſe caſes where the courſe of the blood was intercepted, either by the application of agaric or other fungous ſubſtances, eſpecially a caſe related by Mr. Warner *, where, " in an hour after the opera-
" tion, the mouths of the veſſels were found
" totally contracted, ſo as to reſiſt the whole
" force of the circulation;" after which they probably, like the umbilical veſſels, ſhrink into a perfect cord, and become impervious.—And does not nature ſeem to point out, that intercepting the paſſage of the blood for a while, is all that is required from art; as ſome animals by inſtinct, in ſeparating their young from the placenta, lacerate the cord with their teeth, whence probably the ragged fibres ſtop up the end of the veſſel by collapſing over each other?

Seeing then that nature ſuppreſſes the hæmorrhage from divided arteries by the natural

* Caſes, p. 147, 148.

con-

contraction of their circular fibres, when the impediment to this contraction is removed, by intercepting the impulſe of the blood, let us fairly enquire what method beſt anſwers this purpoſe, beginning with the ligature, on account of its having been long in general uſe.

CHAP. II.

Of the Ligature.

THE ſucceſs which has hitherto in general attended the ligature, is a full proof of its efficacy; and it is evident nothing can more powerfully intercept the courſe of the blood, provided it can be properly applied: and though it ſeems to have been a general opinion, that the veſſel only unites in that part where the ſtricture is made, and preference has on that account been lately given to other remedies *; yet I imagine, from what has been ſaid, it will readily be conceived that it is alſo in this caſe cloſed by its own natural contraction, and which will be found true, if the end of the artery can be diſcovered.

But this is often difficult, it being at firſt commonly covered with the ſwelled muſcles,

* Philoſ. Tranſ. vol. xlvii. art. 94.

and

and after ſome time ſends out (like all other parts) new fleſh, and cannot be diſtinguiſhed: therefore as a proof, I ſhall obſerve that the artery which was tied in the horſe's leg, was not only cloſed below, but alſo at leaſt half an inch above the ligature; ſo that every advantage poſſible, in regard to ſtopping the blood, is obtained, provided the end of the veſſel does not ſeparate and come away with the ligature; for though no inconvenience will follow, if the ſtricture is made ſome diſtance from the lateral branches; yet, if it happens to be very near, a freſh flux of blood muſt enſue, which is probably one reaſon why there are ſome few inſtances to be met with of the arteries bleeding again ſome time after they have been tied.

But, from attending ſeveral years to this particular, I find that the end of the veſſel does not ſo often come away as is imagined, and that a ſeparation may be generally avoided, as it only happens when the ligature is thin, and very little ſubſtance is compriſed along with the veſſel in the nooſe; whereas when we take in a proper quantity of the circumjacent

jacent parts to defend it, and the ligature is of a proper ſize, upon digeſtion coming on it becomes looſe and ſlips off, leaving the veſſel firmly cloſed and intire.

However, that we may avoid with as much certainty as poſſible the ſeparation of the end of the veſſel, I would adviſe that the ligature ſhould be made of long twelve-penny flax, without either being the leaſt twiſted or waxed further than juſt the end, to make it paſs thro' the eye of the needle; and if it is rubbed over with ſome ſoft digeſtive, it will ſlip eaſily through the fleſh.

This will be found ſufficiently ſtrong for the purpoſe for which it is wanted, without the leaſt danger of its injuring the veſſel; nor need the compreſſure be greater than is juſt neceſſary to intercept the paſſage of the blood, which will ſtill add to the ſecurity in this reſpect, and at the ſame time produce other advantages, as will be obſerved in their proper place.

And

And further, if the ligature can be properly applied, it is equally effectual, whether the artery be only in part or intirely divided; whether it is at liberty to retract itſelf, or adheres to an undivided muſcle or the bone. And if the needle can be paſſed a proper depth into the adjacent parts, no accident can remove it, if they are found, till the ſtate of contraction and inflammation is over; when, in general, all will have been done that is neceſſary, the preſſure of the ſwelled muſcles moſt effectually aſſiſting the cloſing of the veſſels.

Nevertheleſs, along with theſe advantages it muſt be confeſſed, that great pain often accompanies the uſe of the ligature; which, where it cannot be avoided, would make us prefer any other remedy that is equally ſafe and unattended with this inconvenience. But it very fortunately happens, that where the ligature is moſt wanted, it may be applied with very little or no pain, if properly managed; for the large arteries are commonly ſurrounded with a conſiderable quantity of cellular membrane;

brane; and if we only take in with the veſſel this nearly inſenſible ſubſtance, the patient ſeems undiſturbed during the operation *: and upon enquiring of ſeveral at the time of tying the veſſel, whether they felt much pain, I have always been anſwered in the negative; and though the nerve which accompanies the artery is incloſed in the nooſe, it makes no difference in regard to this circumſtance.

Perhaps it may ſeem ſtrange to thoſe who have not conſidered this matter, that great pain ſhould not ariſe upon a nerve, which is an organ of ſenſation, being compreſſed; but there are ſeveral inſtances in the practice of ſurgery, beſides this, which lead us to imagine that the nerves are incapable of being irritated, till they are diveſted of their coverings, unleſs you penetrate through their coats down to the medullary ſubſtance †; conſequently,

* See Monro, Ed. Med. Eſſ. vol. iv. p. 264.

† In performing the operation upon an aneuriſm ſome time ſince, I accidentally had an opportunity of obſerving the difference betwixt pricking and tying a nerve.

In paſſing the needle under the artery it penetrated the nerve, upon which the patient inſtantly cried out of great pain

quently, when they are alſo defended by the artery, fat, and cellular membrane, they will ſtill be leſs liable to be affected.

This may be illuſtrated by reflecting on the ſituation of the nerves in the bones, tendons, membranes, and the like; where they ſeem to be rendered inſenſible and incapable of being irritated by the compactneſs of the parts which inveſt them *, as appears from the

pain all down his arm, which ceaſed when the needle was withdrawn. But though the ſame nerve was afterwards incloſed in the ligature along with the artery, the patient told me he only felt a prickling and numbneſs, which ſoon went off.

* It does not hence follow, that "wounds of the tendons are the moſt eaſily cured of all others only by the help of nature, without any trouble or bad ſymptom," as an author of eminence has aſſerted: and as it will explain part of what is hereafter ſaid about convulſions, we ſhall juſt obſerve, that though the tendons in their natural ſtate are void of ſenſibility, yet, when they become ſwelled and tenſe, more painful and troubleſome ſymptoms generally ariſe in theſe than in other wounds; probably from the particular ſtructure of the part, by which the obſtruction riſes higher and is long in terminating, and the nerves during this ſtate are put more upon the ſtretch than in any other part of the body.

the new fleſh which follows their being wounded, being ſenſible, and again loſing its ſenſibility, as the part acquires its natural texture.

With this we may obſerve that numbneſs, the uſual conſequence of compreſſing a nerve, cannot here give any uneaſineſs, becauſe the parts to which the nerves were diſtributed are removed.

However, when the veſſels are ſo ſituated that muſcular fibres muſt of courſe be incloſed, the ligature will unavoidably be attended with conſiderable pain; owing probably to the nerves being diveſted of their coverings, and their medullary ſubſtance alone expanded over every fibre of a muſcle; not, I imagine, in the form of papillæ, but in the

But this does not hold good when a tendon is much lacerated, or a large wound is made in any other tendinous part; for then they remain inſenſible, and give no other diſturbance than from the length of time they take to ſeparate; very likely from the obſtructed fluids being freely diſcharged, and the nerves being in a ſtate of relaxation.

ſame

ſame manner, though much thinner, as the retina in the bottom of the eye *.

But this pain is only momentary, becauſe whatever is incloſed becomes nearly inſenſible upon the ſtricture being made. If the ligature recommended is uſed, the parts will be

* If I am not much miſtaken, in tracing the nerves through the muſcles I have ſeen them become a perfect mucus in this manner; and whoever will compare, by the help of a proper glaſs, the medullary part of the brain or a nerve cut open, with muſcular fibres, which are not dried by being expoſed to the air, will find that they are covered with a kind of pulp that has exactly the ſame appearance. And does not an obſervation of Haller's (Senſib. & Irritab. p. 59.) ſeem to confirm this opinion; for in attempting to prove that irritability reſides in the glutinous mucus, he ſays, "the moſt irritable parts are "deprived of that quality only by robbing them of this "mucus by drying;" which is eaſily explained, if inſtead of mere gluten, this proves to be the medullary part of the nerve.

Hence too we may eaſily ſee, how every part of the body (except thoſe which are ſecured by a particular ſtructure) is liable to be affected by the point of the fineſt needle. And how pain is carried by conſent of parts all over the body, neither of which can be well accounted for, if the nerves are ſuppoſed to continue diſtinct cords to their extremities.

leſs irritated; and whether the abſolute ſecurity againſt a future hæmorrhage does not fully compenſate for the uneaſineſs the patient feels on this account, may be gathered from what follows.

But it is thought, "that the ligature, by "compreſſing the adjacent nerve, is ſome-"times productive of convulſions." Now as no facts are brought to ſupport this opinion, and as I have never yet ſeen any accident of this kind happen, though I have always, without regarding the nerve, freely uſed the needle and ligature; nor, upon ſtrict enquiry, found one inſtance of its happening amongſt an extenſive chirurgical acquaintance, I am induced to think with Mr. Sharp *, that the doctrine of convulſions being cauſed by the tying of a nerve is merely ſpeculative, and ſeems, though the theory is changed, to have taken its riſe from the arguments brought againſt Parey, when he firſt introduced the practice of tying the arteries, and ſince to have been copied from one to another by ſucceeding writers.

* Crit. Inq. p. 291.

But

But is it not probable that in this inſtance, as well as many others in ſurgery, by quite altering the meaning of the word NERVUS we have made thoſe ſymptoms follow the tying of a nerve, which ſhould have been conſidered only as the conſequence of pricking a tendon? for long after Parey's time NERVUS was uſed to ſignify TENDON, and by "ner- "voſam aliquam partem, vel nervum †," &c. there is great reaſon to think Parey's adverſary meant a tendon or any tendinous part; eſpecially as he ſupports his opinion by ſhewing, that for fear of the accidents deſcribed, Galen durſt not ſtitch tranſverſe wounds till he had firſt diſcovered the *aponeuroſis of the muſcles*.

However, we will conſider this matter in the light it now ſtands; and for this purpoſe we may obſerve, that the ligature ſeems only

† Nam ſi acu nervoſam aliquam partem, vel nervum ipſum pupugerit, dum ita novo & inuſitato modo venam abſurde conatur conſtringere, nova inflammatio neceſſario conſequetur, à quo convulſio, & à convulſione cita mors. See Parey's Surgery, p. 1133.

capable

capable of irritating and of totally obſtructing the nerves.

Now as the nerves upon the muſcular fibres are very eaſily irritated, a theory plauſible enough may be invented to ſhew, that in certain habits convulſions will come on upon their being tied; but then this would moſt probably happen at the very time they were irritated *: ſo far from this, no one that I know of has even pretended to ſay, that he has ſeen any patient fall into convulſions at the time the ſtricture was made. It is true there are inſtances where convulſions have inſtantly been brought on by irritation †; but they ſeem not to have any analogy with the caſe in hand: for the parts were diſeaſed, and in all probability had a more acute feeling than ever happens to the nerves in their natural ſtate, and conſequently different effects would ariſe.—May not the pain in this caſe, as it is ſmart and of ſhort duration only, ſomewhat in the manner of volatiles applied

* See Sharp's Crit. Inq. p. 292.

† See Van Swieten's Comm. vol. ii. p. 47.

to the noſe, rather enliven the ſpirits than bring on convulſions?

On the other hand, if convulſions aroſe in conſequence of the nerve being obſtructed, inſtead of being a ſymptom that but very rarely happens, they would either in a greater or leſs degree appear almoſt every time a large one was tied; for if theſe are, as is generally believed, diſtinct cords from their origin, the obſtruction and its effects would be always nearly the ſame. But ſo far from this, convulſions of any kind are not more frequent where the large nerves are incloſed in the ligature, than in ſlight injuries where it is not uſed.

Lately Le Dran * ſeems to have biaſſed the minds of people † in favour of this doctrine; but unfortunately his practice immediately contradicts his theory: for ſpeaking of thoſe who, in performing the operation for the aneuriſm, incloſe the adjacent fleſh within

* Op. Surgery, p. 428.

† Mr. Warner's Caſes, p. 146.

the ligature, he ſays ‡, " though by this me-
" thod they tie the nerve together with the
" artery, yet it is very ſeldom any ill conſe-
" quences enſue from thence, as the quantity
" of fleſh included by the ligature prevents the
" nerve from being much compreſſed." And does not the ſame reaſoning hold good, as is already ſhewn in amputations, where as great a quantity of the neighbouring parts is commonly incloſed? Beſides, when he tells us, " that tying the nerve along with the veſſel,
" ſometimes brings on convulſions ſome days
" after the ligature is made." He alſo informs us, " that there will not be any danger
" of this happening, if we apply a button of
" *vitriol* when the dreſſings are firſt re-
" moved;" which, he ſays, " gradually forms
" an eſchar that includes the ligature, and
" renders it uſeleſs."

Now in a few days the ligature becomes looſe ſpontaneouſly, and is no longer capable of doing injury. The parts being now inflamed and more ſenſible, *vitriol* will act with

‡ Loc. cit. p. 409.

great

great violence upon the nerves; ſo that if no ill effects aroſe from this complicated treatment, much leſs could they ariſe from the ligature alone.

If the convulſions then were not the conſequence of the dying ſtate of the patient *, is it not probable they were owing to the nerves being irritated, either with acrid matter or ſome other cauſe? for it is well known after the inflammation comes on the nerves become tenſe, and acquire a more acute feeling, and ſometimes, where the fluids are very acrid, in few days are rendered ſo extremely ſenſible, as to bring on convulſions upon the ſlighteſt touch: and this ſeems to hold equally good in regard to the locked jaw, which within theſe few years has been ſaid, "ſometimes "to come on in conſequence of the ſtricture "made upon the arteries and their neigh-"bouring parts by ligatures;" for in all the caſes of this kind which have come to my knowledge, it appears not to have happened till the injured part has been inflamed and painful. In wounds it has often come on,

* Sharp's Crit. Inq. p. 292.

when there has been the greateſt reaſon to believe that the habit was become bad *, and the parts extremely ſenſible from a long continued flux of acrid matter falling upon them. But it ſeems moſt frequently to have occurred in wounds of the joints and other membranes †, where the nerves being put more upon the ſtretch are more liable to produce this terrible ſymptom, which ſeems only to differ from other convulſions in its degree of violence, and affects thoſe, probably, where the whole nervous ſyſtem is in a moſt extreme degree of irritability, as appears by the large and repeated doſes of opium neceſſary to quiet the ſpaſms.

From the whole then of what has been ſaid, there is reaſon to acquit the ligature of

* Dr. Clephane ſays, " In all the caſes of the locked " jaw I ever ſaw, the blood appeared of a looſe texture, " never ſizey." Med. Ob. & Inq. vol. i. p. 59.

† See Hippoc. de Morb. Popular. lib. v. p. 334. ver. 9. and p. 339. ver. 405 and 412. Cornarii Verſione. Parey, lib. xii. p. 464. Baron Van Swieten's Comm. Boerha. vol. iv. p. 182. Ranby on Gun-ſhot Wounds, p. 70 & ſeq. Warner's Caſes, caſe 13. Neal on Agaric, p. 32. Med. Inq. vol. i. caſe 1 and 7. and vol. 2. caſe 24.

being

being productive of thoſe convulſions which ſometimes have happened to attend a wound wherein it has been uſed.

Another kind of ſpaſms, that are partial and attended with pain, are ſaid conſtantly to attend the uſe of the needle and ligature; and it muſt be confeſſed, that while the needle is piercing a muſcle a ſpaſm is often produced: but it may with equal truth be obſerved, that it immediately ceaſes when the parts incloſed are numbed with the ligature. And it ſeems more likely that thoſe ſpaſms, which continue more or leſs for ſome time after the operation, ariſe from the nerves being irritated by the knife, by the air, and by the dreſſings; for whoever attends to this circumſtance will find, that the ſpaſms which follow, for inſtance, an amputation of the leg, immediately ſeize the muſcles upon their being divided before any needle can be uſed. And we know by experience they will continue ſome time after the irritating cauſe is removed, in proportion as the nerves were more or leſs affected *. That a ſimilar effect

* See Whytt on vital and invol. Mot. p. 20 and 242.

will be produced by the other cauſes aſſigned, there is reaſon to conclude from obſerving, that even the muſcles of animals, immediately after death, are thrown into ſpaſms by being expoſed to the cold air; and ſpaſms are alſo often brought on by touching naked wounds with dry lint.

Beſides, ſpaſms follow thoſe amputations juſt in the ſame manner, where the veſſels are not tied *; nor can the abſence of this ſymptom with juſtice be aſcribed to the omiſſion of the ligature in amputations of the breaſts †, becauſe in this caſe the muſcles, which are the ſeat of ſpaſms, are ſeldom touched with the needle; the cellular and adipoſe membrane only being taken in with the veſſel, and which, from their ſmall degree of ſenſibility, give but little uneaſineſs: and out of many inſtances I do not remember any patient attended with *troubleſome* ſpaſms after this operation, though the needle and ligature were always uſed.

* Phil. Tranſ. vol. xlviii. part 2. p. 591.

† Ibid. p. 596.

Another

Another objection to the ligature is, " that " it increaſes the ſymptomatic fever, becauſe " its application gives violent pain:" but though it often gives ſmart pain for an inſtant, it does not follow that it aggravates the ſymptomatic fever, for the pain is only momentary, and whatever is included in the ligature immediately becomes ſo inſenſible, as to give no future diſturbance. It is true, an inflammation will take place above the ſtricture; but as an inflammation of equal degree would probably have occurred, though the ligature was not uſed, very little difference of pain can ariſe from this cauſe, as is evinced by the ſymptoms following an operation being much the ſame, whether we uſe many ligatures or few.

But the ſymptomatic fever ſeems not to ariſe from the pain which accompanies or immediately follows any part of the operation, but to the diſtenſion which is cauſed by the obſtruction and inflammation that comes on ſome time after in conſequence of the diviſion of the parts; for that pain which ariſes from the nerves being irritated and diſordered in the

the operation, preſently goes off, the irritating cauſe being inſtantly removed. And does not the ſymptomatic fever gradually come on, a few hours after the operation, as the parts about the wound begin to ſwell, and again decline as the diſtenſion abates, from the lymphatic veſſels freely tranſmitting their contents?

Beſides, from the account given us of the ſymptomatic fever following an amputation of the leg, where the ligature was omitted, we ſee * it came on about the uſual time, and ſeems to have been nearly the ſame as when it is uſed. And though the ſymptomatic fever has been ſlight in amputations of the breaſts †, where the veſſels were not tied, yet it does not appear to be a proof that it is increaſed by the uſe of the ligature, becauſe in this operation the ſymptomatic fever is for the moſt part, if not always, ſlight; for the fat in the cellular membrane eaſily melts down, and the reticular or membranous part

* Phil. Tranſ. vol. xlviii. part 2. p. 591. or Mr. Warner's Caſes, caſe 29.

† Ibid.

ſends

ſends out new fleſh without giving much diſturbance, and in this caſe theſe, with the ſkin, are the only parts wounded; for even when a ſchirrus adheres, it is ſeparated from the pectoral muſcle without doing much injury, as this operation, I imagine, is never practiſed when the adheſion is otherwiſe than ſlight.

With this we ſhould remember, that the ſymptomatic fever is always ſlight where the ſolids are relaxed and weak, in conſequence of the ſmall degree of force with which the blood is carried againſt the obſtructed veſſels. And is it not therefore more likely owing to this cauſe than to the omiſſion of the ligature, that a ſlight fever only followed in thoſe whoſe legs were amputated by Mr. Warner *, as all theſe patients were much reduced previous to the operation? And is not, in ſuch habits, the ſymptomatic fever conſtantly ſlight, though the ligature is uſed.

It is alſo ſaid that abſceſſes are the conſequence of uſing the ligature, and that it ſome-

* Loc. cit.

times

times remains fixed to the laſt, ſo as to retard the healing of the wound; but theſe inconveniencies only happen when the needle is paſſed very deep, and may therefore be avoided by a contrary practice: nor is paſſing the needle deep at all neceſſary (if the parts are ſound) as a ſmall quantity of fleſh or cellular membrane below the ſtricture will ſufficiently prevent the ligature being puſhed off by the impulſe of the blood. However I would caution againſt extremes; for with paſſing the needle but a very little way the veſſel ſometimes may not be tied, and cauſe unneceſſary trouble; if we therefore paſs the needle only a moderate depth, the ligature will always come away in due time without inconvenience, or at leaſt it may be taken away long before the wound is healed, without any danger of bringing on a freſh hæmorrhage: for as ſoon as digeſtion is complete, and the new fleſh begins to riſe, the ligature makes not any preſſure upon the veſſel; and though new fleſh may have covered the nooſe, yet if we take the advice long ſince given by Monro *,

* Ed. Med. Eſſ. vol. iv. p. 275.

it

it may be removed without any hazard of cutting the artery.

This is the light in which I have been led to conſider the uſe and abuſe of the needle and ligature in tying the blood veſſels, and ſhall now proceed to enquire into the method of ſuppreſſing the hæmorrhage by fungous ſubſtances, which, like the ligature, will appear to have their advantage and inconvenience.

CHAP. III.

Of ſuppreſſing the hæmorrhage by the application of fungous ſubſtances, by coagulated blood, by aſtringents, and by perpendicular preſſure.

THE late ſucceſs which has attended the application of fungous ſubſtances is a full proof that an hæmorrhage from large arteries may often be effectually ſuppreſſed by their uſe; and it at the ſame time points out the truth of the doctrine advanced, and what little aſſiſtance in this caſe is wanting.

But the manner of applying funguſes makes a material difference in regard to ſucceſs; for if they are preſſed cloſe againſt the end of the veſſel, they intercept the paſſage of the blood; and the artery cloſes itſelf up in the manner deſcribed: whereas, when this circumſtance is not obſerved, and they are only laid near to the orifice, in the manner Cheſelden * uſed

* Phil. Tranſ. N° 478. p. 33.

ſpunge,

ſpunge, they ſuppreſs the hæmorrhage by choaking up the mouth of the veſſel with coagulated blood, which hinders its being cloſed; and though it ſtops the bleeding at preſent, yet it may be the ſource of a future hæmorrhage.

This is evident from the experiments made by La Foſs *, where the coagulated blood, which filled the end of the artery, was formed into a cone with its apex towards the heart; conſequently, if the plug happens to extend to the next collateral branch, a freſh flux of blood muſt enſue upon its coming away; for it does not unite with the veſſel, as ſome have imagined.

I know there are inſtances, where an orifice made in an artery has been ſtopped with a clot of ſolid blood, which adhering firmly to the cicatrix of the integuments, produced a conſiderable calloſity, and which ſeems to have given riſe to this opinion. But it muſt be obſerved in theſe caſes, the wound was

* Philoſ. Tranſ. vol. xlix. part. art. 10 & 11.

cured without coming to ſuppuration; whereas when the air has free acceſs, we well know a putrefaction of the coagulated blood, as well as digeſtion, is always the conſequence; and I make no doubt but the ſeparation of coagulated-blood is one cauſe why a freſh bleeding has ſometimes come on after the inflammation was abated, and matter began to be freely diſcharged. In a very late inſtance, where the bleeding from a divided artery had been ſuppreſſed by coagulated blood, I ſaw it renewed again next day by taking this blood away; the artery bleeding in the ſame manner as when it was firſt opened; but upon preſſing it betwixt my fingers it was ſoon effectually cloſed. Hence we may obſerve, that the practice of laying allum, or any thing elſe, at the end of the artery to coagulate the blood, is very improper, as every impediment to the contraction of the veſſel ſhould on the contrary be removed.

This leads me to take notice of Petit's opinion, who imagined that the hæmorrhage from divided arteries was always ſuppreſſed by plugs of blood within the veſſel; becauſe

he

he found in ſome of them, after the death of the patient, coagulated blood, which extended itſelf upwards a conſiderable way.

But notwithſtanding this, it is very probable that the hæmorrhage was ſtopped by the natural contraction of the veſſel; for we find in the two waggoners mentioned by Monſ. Fagot *, where, after death, coagulated blood was found in the ſame manner, " their ex- " tremities were contracted and ſtraitened, as " if they had been tied." And in the many experiments I have made on this occaſion, I never found coagulated blood but once; and then the extremity of the artery was cloſe contracted †.

Pouteau ‡ opened ſeveral arteries, and never found any coagulum; nor is there any

* Philoſ. Tranſ. for 1753; or Mr. Warner's Caſes, p. 136.

† It was in the artery of a large dog which was ſtrangled.—The horſes, &c. were killed by being bled to death in the uſual manner, which ſeems to prove that the coagula are not formed while the blood circulates regularly, but when the animal is near dying, or immediately after death.

‡ Melanges des Chirurg. p. 314.

coagulum

coagulum found in the umbilical veſſels of children after death: from all which may we not conclude, that this circumſtance is merely accidental, and no ſtep taken by nature, who is always uniform, if no impediment is in the way? Indeed, I think with ſome other writers †, that it is of the ſame kind, and produced in the ſame manner as the fibrous blood we often find in the great arteries near the heart: that which I ſaw had exactly the ſame appearance; nor did it ſeem ſufficient to have blocked up the veſſel. What is already ſaid about coagulated blood preventing the contraction of the veſſel, here alſo takes place; and was it extended to the extremity of the artery, putrefaction and its conſequences muſt of courſe enſue, from its being in contact with the air.

It follows then, that whatever fungus is uſed, it ſhould be preſſed cloſe to the end of the veſſel; and that kind which adheres cloſeſt ſhould be choſen. Mr. White ſays ‡ that ſpunge is on this account preferable; and if

† Gouch, Pouteau.

‡ Loc. cit.

his

his directions, in regard to the choice, preparation, and manner of applying it, be obſerved, I believe he ſays true; but even this ſticks the faſteſt when it is leaſt wanted; for though after a while it adheres ſo firm, that it is removed with difficulty, yet, till the parts begin to ſwell and become moiſt, the adheſion is very ſlight.

Bandage therefore muſt be carefully applied to preſerve it in its proper ſituation; and if this circumſtance had been duly attended to, inſtead of relying upon a ſpecific property in agaric, better ſucceſs would probably have attended it when in vogue; for where agaric itſelf proved ineffectual, tight bandage and common dreſſings ſuppreſſed the hæmorrhage. And we might produce innumerable inſtances which prove, that whatever is kept firm upon the end of the veſſel is ſufficient for the purpoſe.—However, if what is ſaid about tying the great arteries be true, moſt ſurgeons, I imagine, will ſtill ſecure them with the ligature; for no ſort of bandage can with ſafety in amputations be ſo applied, but the fungus may ſometimes be diſplaced by ſpaſms, coughing,

ing, vomiting, or the like: and ſhould an hæmorrhage return from theſe veſſels, we know death may enſue from the loſs of no very large quantity of blood. Mr. Sharp's † patient, in whom the veſſels burſt open three hours and half after he had applied agaric, died in about twenty minutes with the loſs of leſs than thirty ounces of blood, including what was loſt in the operation: nor could aſſiſtance be ſpeedy enough to prevent this cataſtrophe, though it was upon the ſpot when the hæmorrhage returned; and how much more likely is this to be the caſe in private practice, eſpecially in the country, where the perſon obliged to be intruſted with our patient is often an intire ſtranger to chirurgical operations?

But ſuppoſe our aſſiſtant ſhould be ſo lucky as to compreſs the tourniquet time enough to ſave the patient's life, yet it is probable a quantity of blood will often be loſt, that may be injurious to him; for though the loſs of ſome blood from this accident may be ſerviceable, when the patient is not much re-

† Phil. Tranſ. vol. xlviii. part 2. art. 78.

duced

duced by the diſeaſe †; on the other hand, the loſs of a few ounces, when he is become weak, will be very improper, and very likely retard the recovery of his health: and we may obſerve, even in ſtrong habits, that the diſcharge of blood ought not to be committed to chance, but intirely directed by the judgment of the ſurgeon. And though it ſhould happen that very little blood is loſt, the patient may not only undergo great pain from the compreſſure, till the ſurgeon can be called, perhaps from a conſiderable diſtance, but the parts may be much injured by the fluids being ſo long in a ſtate of ſtagnation.

But this inconvenience will for the moſt part attend the uſe of this remedy in amputation of the limbs; for all agree that it is neceſſary to keep the limb compreſſed a conſiderable time with the tourniquet, and which will alſo in all probability overbalance the pain cauſed in uſing the needle and ligature. Nor can we help thinking but ſome miſtake hap-

† See Mr. Warner's Caſes, caſe 44.

pened in deſcribing thoſe caſes, where we are told, though the tourniquet was kept compreſſed for half an hour, that the patient was remarkably eaſy during that time. Mr. Sharp's * patient, when he uſed agaric, complained *grievouſly* of pain ariſing from the tourniquet; and my patients tell me, it is the worſt part of the operation: beſides, I have obſerved when a piece of fungus adheres cloſe, it gives very conſiderable pain in being removed; ſo that upon the whole, this method of ſecuring the great veſſels is attended with more pain and leſs ſafety, than the ligature when properly applied.

This reaſoning alſo holds good in regard to the leſſer arteries, when they are ſurrounded with the cellular or adipoſe membrane only; though it cannot be extended to the tying of thoſe which are ſituated amongſt the muſcles, becauſe, as is already obſerved, the ligature is here attended with conſiderable pain; nor is the tourniquet in this caſe wanted; and I make no doubt, but theſe veſſels may in ge-

* Phil. Tranſ. vol. xlviii. part 2. art. 78.

neral be truſted with ſpunge, or any thing elſe that adheres cloſe to their extremities: but the ſpunge ſhould be removed the firſt or ſecond dreſſing, otherwiſe the new fleſh growing into its pores will cauſe an increaſe of pain in the removal.

On the other hand, if the bleeding ſhould happen to return, though on account of the ſize of the veſſels it might not be dangerous, yet even here more blood might be diſcharged than it would be prudent to loſe; a freſh hæmorrhage is always alarming to the patient; and as momentary pain ſeems to be the only inconvenience, perhaps many ſurgeons will think it beſt to leave their patients in perfect ſecurity: and we may juſt obſerve, that in many operations the ligature muſt of courſe be uſed upon all the veſſels, as it will be neceſſary to ſtop the bleeding as we go on.

Nevertheleſs, when the fleſh is become tender, and gives way to the ligature, ſpunge ſeems to be the beſt remedy; for though the large veſſels might be pulled out, and tied in

the manner Dionis * deſcribes, yet, being undefended, the end would commonly ſeparate; and unleſs the ligature was placed near its extremity, ſometimes bring on a freſh hæmorrhage in the manner already obſerved. And this was moſt probably the reaſon why Parey had more certain ſucceſs, when he took in, along with the veſſel, ſome of the adjacent parts, than when he incloſed it alone in the ligature.

Where the veſſels are ſo deeply ſituated as not to be come at with the needle, the ſame kind of application muſt have preference, if it can be laid cloſe to the mouth of the artery; and it ſucceeds better in this caſe, as the ſides of the wound aſſiſt in keeping it in its proper ſituation: but before it is applied, it ſeems neceſſary to examine whether the artery is wholly divided; for without this caution we may ſometimes be diſappointed in our expectation, and aſcribe inſufficiency to

* He deſcribes different methods, but that is here referred to, where the thread is paſſed through the end of the veſſel to prevent its being puſhed off by the impulſe of the blood. See chap. on Amputation.

this

this method, as was done to the agaric †, when the want of ſucceſs was owing to the veſſel being in part divided, whence it was incapable of intercepting the paſſage of the blood. Nor ſhould we forget, that in wounds which admit of cure by an immediate union of their divided parts, fungous ſubſtances are unneceſſary, as the common method of dreſſing effectually ſuppreſſes the bleeding, though it is from conſiderable arteries.

However, if the artery is large, and any difficulty occurs, if the part will admit of the practice of dilating the wound, perhaps it may ſeem more proper by that means to uſe the ligature, eſpecially if it adheres to an undivided muſcle or the bone, and bandage cannot be conveniently applied; and where the principal trunk of a large artery is wounded in a longitudinal direction, Mr. Lambert's ‡ method of ſewing it up ſhould, I think, be tried.

† See Neal on Agaric, p. 35.

‡ Med. Inq. vol. ii. p. 360.

When

When an hæmorrhage ariſes from a thin ſtate of the blood, and the diſcharge is from the whole ſurface of the wound, *puff ball* ſeems preferable to ſpunge, or the like, as the blood would probably eſcape through its pores. In this caſe, with tight bandage it has anſwered my purpoſe, till internal medicines had their proper effect: and if upon trial it ſhould prove ſucceſsful under the like circumſtances, will it not be more proper than *ſtyptics* or *aſtringents*, &c. as theſe harden the fibres, and prevent digeſtion, from which inconvenience this remedy is free? Nor do I apprehend the bandage will be ſo unartfully applied, as to bring on a flux of blood by compreſſing the veins, as I imagine in general this obvious cauſe of an hæmorrhage is well underſtood, being pointed out by ſeveral writers on ſurgery, and clearly demonſtrated by Monro *.

Perhaps ſome will think that ſtyptics and aſtringents will forward the contraction of the veſſels: but we may learn how little they

* Ed. Med. Eſſ. vol. iv. p. 271.

are

are wanted, from the artery in the young fellow's arm, which was evidently relaxed and weak, cloſing itſelf without any aſſiſtance; and I am perſuaded, from ſome experiments I have made, that theſe applications, inſtead of aſſiſting, would, if they were not hindered by mixing with the blood in wounds, rather prevent the collapſing of the veſſel by harding its fibres. And however contrary this doctrine may be to the generally received opinion, experience is certainly in its favour; for though by coagulating the blood, they might ſucceed upon very ſmall arteries, yet, being applied to thoſe which were large, they were always found inſufficient to ſuppreſs the bleeding, unleſs tight bandage was at the ſame time uſed, and to which I think it is clear the ſucceſs was owing: for many of theſe compoſitions, which were thought to be aſtringents, had certainly no other property as blood-ſtaunchers than that of choaking up the mouths of the veſſels *.

* See Parey, p. 328. Hildanus, p. 812. Clow's Surgery, p. 27.

It

It is obvious that the fungus, when uſed, muſt be kept in its proper ſituation by bandage differently applied, acco ding to the part wounded; and in this matter every ſurgeon's own judgment will beſt direct him. However we may juſt obſerve, that in amputations good ſticking plaiſter, as adviſed by Mr. White *, and keeping the hand preſſed harder againſt the part for a few hours, may often be ſufficient; though the machine recommended by Mr. Gooch † will, probably, be more certain; and when this is not at hand, a circular piece of leather may be made to anſwer nearly the ſame purpoſe.

This piece of leather muſt be large enough to cover the end of the ſtump, and near its edge muſt be cut four ſlits in oppoſite directions, that will admit each a fillet.—Suppoſing a leg taken off below the knee, two fillets being paſſed through theſe ſlits croſſways, and under a roller or a piece of cloth that goes round the thigh, above the knee, muſt be

* Eſſay on Spunge.

† Caſes, p. 131 and 141.

brought

brought back again, and tied upon the end of the ſtump, by which means the dreſſings will be fixed, and any degree of preſſure may be made: and this bandage, if it is kept from ſlipping down, by being faſtened with filleting to a roller round the waiſt, ſerves equally well when we amputate above the knee. Nor do I recommend this method without experience; for having amputated a leg, where the blood was extremely poor, and the fleſh very tender, the ligatures were forced off the veſſels a few hours after the operation, by a fit of coughing and vomiting; I immediately applied the bandage above-mentioned, with bolſters of dry lint, which effectually anſwered the purpoſe: for, though the patient vomited and coughed ſeveral times afterwards, the hæmorrhage did not return.

Indeed bandage ſeems hitherto to have proved leſs ſerviceable than it might have been, merely from imagining it would be uſeleſs, unleſs the ſides of the veſſels were brought together in cloſe contact; whereas, had the preſſure been made only upon the end of the veſſel, and juſt ſufficient to reſiſt the im-

pulſe of the blood, it might much oftener have been uſed without inconvenience, and with better ſucceſs, as there is reaſon to think from many inſtances.

We have only further to add on this head, that where the wounded artery cannot be come at, preſſure is ſtill the only remedy; and where things are ſo circumſtanced that we are obliged to choak up the mouths of the veſſels with coagulated blood, it ſeems neceſſary, for reaſons already given, to make a preſſure, if it can be done, againſt the end of the artery, that the contraction beyond the plug may more certainly take place.

CHAP.

CHAP. IV.

Of ſuppreſſing hæmorrhages by cauteries, cauſtics, &c.

BESIDES the methods above-mentioned, Mr. Warner * has ſhewn, that when an artery is opened in the roof of the mouth, the actual cautery is ſometimes neceſſary to ſtop the bleeding: and many years ago, after extirpating a tumor from this part, I was obliged, for the ſame reaſons, to have recourſe to the ſame remedy; but the iron was no hotter than juſt ſufficient to form the neighbouring parts into an eſchar upon the end of the artery; by which means the courſe of the blood was intercepted, and the veſſel left at liberty to cloſe itſelf up; whereas when the cautery is very hot, it not only burns the end of the artery a conſiderable way, but hardening its fibres beyond the eſchar, renders it incapable of collapſing; ſo that it is no wonder an hæmor-

* Caſes, p. 38.

rhage ſhould ſo often enſue upon the ſeparation of the dead parts.

However, the cautery is at all times a cruel application, and ſhould be avoided, if poſſible: nor do I now call to mind any other part where its uſe can be wanted. But if this is cruel, the potential cautery is more ſo, as it ſpreads itſelf further into the neighbouring parts; and yet it is not very uncommon for ſurgeons in performing operations to apply lint ſoaked in ſcalding oil of turpentine, where the artery, though not very large, cannot be readily come at: and this piece of cruelty is ſtill aggravated, when we conſider that a few minutes preſſure would, in all probability, have alone been ſufficient for the purpoſe.

Cauſtics, &c. are, I believe, in general, laid aſide in ſuppreſſing hæmorrhages; and therefore we need only obſerve, that, though they do not, by hardening the ſides of the artery, render it incapable of collapſing above the part deſtroyed, yet, by cauſing its end to ſeparate, their uſe is directly contrary to right practice; and conſequently thoſe adviſe ill,

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who give up every advantage gained by the ligature, in afterwards applying a piece of vitriol.

But all theſe errors in the choice of remedies, or their application, have aroſe from the true principles of ſuppreſſing hæmorrhages not being previouſly inveſtigated; it will therefore give great pleaſure to the author of this little eſſay, if it appears that he has ſet in its proper light this important, though common operation.

THE END.