ACCOUNT
OF
SOME EXPERIMENTS
ON
THE USE OF STYPTICS
IN
HÆMORRHAGE FROM ARTERIES.

BY CÆSAR HAWKINS, ESQ.,
SURGEON TO ST. GEORGE'S HOSPITAL, AND LECTURER ON SURGERY.

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It is probably well known to many members of the Society, that a series of experiments have been made to demonstrate the efficacy of a new styptic, discovered by MM. Talrich and Halmagrand, in controlling hæmorrhage, which, it is asserted, has been invariably successful in Paris, but which has been less uniformly effectual in this country; since, out of five experiments, three of which were made at St. George's Hospital, and two at the London Hospital, three have proved fatal, and in the other two the animals were killed before the time at which secondary hæmorrhage might have taken place had expired.

Most English surgeons, however, are acquainted

with the ingenious experiments published by Dr. Jones, in 1805, which prove how frequently natural means alone will check the hæmorrhage from the largest arteries, and which completely explain the mode by which this is effected. Dr. Jones minutely described the external and internal coagula, which are formed singly or in conjunction, and which are principally employed as a barrier against further hæmorrhage; he shewed also the manner in which *contraction* of the artery sometimes added to the security of the animal, and the circumstances under which *retraction* of the vessel at one time checked the hæmorrhage, and at another time increased it, according to the kind of wound made in the artery. Dr. Jones also explained the manner in which a wounded artery was sometimes obliterated after the operation, while at other times the permeability of the vessel remained, and the wound was completely cicatrized without interfering with the current of the blood.

When I saw all these circumstances described in the Bulletin Générale de Therapeutique Medicale et Chirurgicale, (Oct. 1831,) as if now for the first time discovered, and attributed solely to this new styptic, I could not but suspect some fallacy in the account, and that the styptic acted only a subordinate part in arresting the hæmorrhage, and I wished to show the pupils of St. George's Hospital, who had witnessed the supposed effect of the styptic in some experiments made by MM. Talrich and Halma-

grand, the real principles to which I believed those effects were to be ascribed, especially as many persons, who ought to have known better the principles by which hæmorrhage is controlled, appeared to have been deceived by witnessing these experiments. I did not hesitate therefore, without any previous trial, to make the following experiments in the presence of a considerable number of spectators, including MM. T. and H., in full confidence that *without their styptic* I could, in by far the majority of instances, succeed in controlling hæmorrhage as effectually as if it had been employed. And as the experiments were conducted in a different manner to those of Dr. Jones's, and prove something more than his have done, it may perhaps be interesting to record their result, as a further corroboration of the means by which hæmorrhage is prevented in wounds of arteries.

In most of Dr. Jones's experiments the free passage of the blood from the wounded artery was nearly, or completely, prevented by a continued suture in the skin, so that the blood necessarily forced its way into the cellular texture around, and there became coagulated; a method which he adopted from having found in some earlier experiments, that without this precaution the sudden loss of blood was generally fatal before the necessary clots could be formed. The mode in which, on the other hand, M. Halmagrand conducts his experiments is, to place three small tempons, or compresses of cotton dipped in his "Liquide

Hæmostatique", upon the wound of the artery, and retain them there for ten minutes with the fingers, after which a *single ligature* only through the skin is employed, which does not therefore close the wound, but merely prevents the compresses from being thrown out of the wound by muscular effort; a precaution which he has found necessary during the exertion of the animal to rise, and the omission of which occasioned fatal hæmorrhage in one of his experiments, at which I was present. This method I exactly imitated in the following experiments.

Experiment I.—I exposed the carotid artery of a sheep, and made in it a longitudinal wound about half an inch in length, and placed upon the orifice compresses of tow, of the same size as those which I had seen employed by M. Halmagrand, dipped in a decoction of *Aleppo galls*, (one ounce having been boiled for ten minutes in three-fourths of a pint of water,) and tied a single ligature in the skin before I withdrew my fingers from the wound. The animal was restless during the experiment, in consequence of which, perhaps, a small quantity of blood (about half an ounce) escaped when it rose from the ground, but none was lost subsequently. The compresses were taken away on the second day, and the sheep was killed on the tenth day by another experiment.

The wound in the artery was perfectly closed by lymph, without the formation of any coagulum in the vessel, which consequently remained pervious, the

cicatrix itself being hardly perceptible. Some coagulum had formed externally along the course of the artery, in the same manner as it had taken place in one of the sheep in which M. Halmagrand had made a longitudinal wound and afterwards applied his styptic, killing it however on the fifth day. (See preparation No. 1.)

Experiment II.—The same day M. Halmagrand laid bare the carotid artery of another sheep, so that the external wound might be such as he was accustomed to make. I then divided the artery transversely to exactly half its circumference, (a kind of wound which M. Breschet's experiments have proved to be more likely to bleed fatally than a transverse wound of either one-third or two-thirds of the artery.) The incision, however, had been made too much in front of the artery, so that M. H. had some difficulty in finding it, and the artery lay to the outside of my fingers instead of being directly below them; in consequence of which, before I could make any pressure on the vessel against the vertebræ, the animal had lost a pint and a half of blood and fainted. When it revived, a short time afterwards, the artery again began to bleed freely, so that the syncope had not allowed of coagulation, and the animal would probably have died if nothing further had been done. I then placed on the wound of the artery the usual compresses dipped in *Ruspini's styptic*, and held them for ten minutes, using a single ligature in the skin. No hæmorrhage occurred; the compresses were re-

moved at the same time as in the first sheep, and the animal was killed by another experiment on the eighth day.

There was some extravasation in the course of the vessel; the external wound, which was suppurating, communicated directly with the artery, which was completely blocked up by a firm coagulum, united by lymph to the interior of the vessel for about half an inch above and below the opening, connected on the side next to the heart with a loose coagulum two inches long. (See preparation No. 2.)

Experiment III.—I exposed the carotid artery of a sheep and cut out a circular portion of the vessel, a kind of wound which Dr. Jones had not tried, (probably because it is not one that is likely to occur in practice,) and placed over the opening the usual compresses dipped in *plain water only*. The animal was so restless however that I could not retain my fingers on the artery with sufficient firmness to prevent some escape of blood several times during its struggles, and after some time I removed the compresses, when as large a stream of blood issued as at first. I then placed some fresh compresses, dipped in water, on the opening in the artery, and retained them for ten minutes, though not without more struggling. The vessel still bled as soon as my pressure was relaxed, and consequently the animal was under the same circumstances, and would probably have died in the same way as another sheep in which M. Halma-

grand had made a similar, but somewhat smaller, wound, and had afterwards applied his styptic unsuccessfully. I therefore altered my experiment, and united the skin coarsely by a *continued suture*, so as nearly to confine the blood, in the same manner as Dr. Jones had done in his experiments. The integuments were distended with blood as soon as my fingers were removed, and some escaped also between the stitches, which were loosely fastened. The animal got up, however, in a short time without appearing at all faint, and there was no further hæmorrhage; it was killed on the sixth day, when the wound was open and suppurating freely. The interior of the vessel was completely filled with coagulum to a considerable distance above and below the wound, which was blocked up by a portion of the coagulum projecting into the aperture. (See preparation No. 3.)

Experiment IV.—I exposed the right carotid artery of the sheep, in which the left carotid had been opened in Experiment II., and removed a portion with scissors, and then placed on the wound three compresses of the usual size dipped in *plain water*, and made pressure with the fingers for ten minutes, and then put a single ligature through the skin. The animal lay quiet during the experiment, and not a drop of blood was lost till the next day, when considerable hæmorrhage occurred, and this continued at intervals till the third day when it died from the bleeding.

The wound of the soft parts was so small and di-

rect that no extravasation had taken place into the sheath of the vessel, and no external coagulum had formed, so that the wound of the vessel remained open. Within it a small recent coagulum only had formed, which nearly closed the end of the vessel nearest to the head, but left the lower orifice quite open. (See preparation No. 4.)

Dr. Jones found in his experiments, that a small wound leading directly down to an artery was more dangerous than one in which the soft parts around the vessel were more disturbed, as the formation of an external coagulum is facilitated by this interference with the cellular membrane. The sheep in this experiment was exposed to this source of danger, but it appeared to me, however, to have died not so much from this circumstance, since there was no hæmorrhage for twenty-four hours, as, in all probability, from its having disturbed the compresses in endeavouring to drink out of a high pail, for the water was found to be mixed with a large quantity of blood, while there was comparatively little elsewhere.

Experiment V.—I exposed the left carotid in the sheep which had been the subject of the first experiment, and placed a hook under the vessel, I then sewed up the wound in the skin coarsely by the continued suture, leaving room for the vessel to be drawn to the edge, and removed a portion of the vessel with the scissors to the extent of nearly half its circumference. The hook being withdrawn, so as to

allow the vessel to recede, the ligature was tightened so as nearly to prevent the exit of the blood, which came through the wound copiously for a few seconds, but then ceased. No further hæmorrhage occurred till the *third day*, when some recent blood was seen dropping from the wound ; this continued at intervals till the fourth day, when the animal died.

The wound was much distended with coagulated blood, and suppuration was commencing ; the opening in the artery was undefended by any plug, neither was there any coagulum in the interior of the artery sufficiently large to prevent hæmorrhage from either side. (See preparation No. 5.)

I should observe, that in all probability the last two experiments were performed under unfavourable circumstances, as the opposite carotid arteries had already been operated on, and in Experiment 4. the left carotid having been entirely obstructed by Experiment 2., only the vertebral arteries remained to convey blood to the head, so that probably the impulse through the right carotid became more powerful than it otherwise would have been ; but, on the other hand, this very circumstance, which may have contributed to the unsuccessful result of Experiments 4. and 5., renders the success of Experiments 1. and 2. still more striking.

It appears, then, that in all these varied experiments, the flow of blood was restrained for a time,

the shortest period at which secondary hæmorrhage occurred having been twenty or twenty-four hours, and that in three of them the wound in the vessel was adequately closed to have prevented any further hæmorrhage. It appears, also, that out of *four* experiments performed in the same manner as M. Halmagrand's, but without the use of his styptic, *two*, viz., Experiments 1. and 2., were permanently successful, in one of them the artery being left pervious, in the other, being obliterated by coagulum; that a third, Experiment 3., failed at the time of the operation for want of sufficient coagulum in the vessel, to defend it after the compresses were loosened; and further, that Dr. Jones's method saved this animal after simple pressure had not succeeded; and that one only, viz. Experiment 4, was altogether unsuccessful, the animal having in this case only died of the operation.

The conclusions which I think may be legitimately drawn from these experiments, and from what I have seen of M. Halmagrand's, (and which are strengthened by the failure of the last two, since the reasons why they failed are plain,) are the following :

1st. Experiments 1., 2., and 4., demonstrate that pressure continued for ten minutes upon an injured artery, *in a nearly open wound* of the soft parts, by means of small compresses moistened in various liquids, may check the hæmorrhage from an artery in which a longitudinal or transverse wound has been

made, or from which a portion has been removed. They thus prove an additional point to the facts ascertained by Dr. Jones, whose experiments upon partially divided arteries were made in *wounds closed by a continued suture*.

2ndly. Experiments 3. and 5., shew that when a portion of an artery has been *altogether removed*, the hæmorrhage may be restrained, and the vessel permanently closed, by allowing the blood to coagulate in the soft parts, as in a diffused aneurism; Dr. Jones had previously proved this point with regard to several other kinds of wounds of arteries, but had not attempted this peculiar modification of injuries of vessels.

3rdly. Experiments 1., 2., and 4., prove that the means by which hæmorrhage is controlled, when pressure is made for a short time in an *open wound*, are the same which Dr. Jones's experiments had shewn to be exerted in a *closed wound*; viz., the formation of coagula, either in the lips of the wound of the vessel, or in the cavity of the artery, or in the cellular membrane around it, or in any two of these situations, or in all of them at once; except in some longitudinal wounds, which may occasionally be closed by the deposition of lymph alone, in which case the vessel may still remain pervious.

4thly. It is shewn further, that if coagulation takes place imperfectly, or if the clot is suddenly or violently disturbed, immediate hæmorrhage will occur.

In two of M. Halmagrand's experiments the compresses were probably thrown off thus by the exertions of the sheep, and the coagulum being consequently disturbed, both of them died. In Experiment 3., also, I could not obtain coagulation at all, the animal being so very restless on the table, and probably it would have died, had I not produced coagulation in a different way.

5thly. Experiments 4. and 5., shew that although the hæmorrhage may be controlled for a time, it may subsequently return at various periods from the causes pointed out in the last section as capable of producing immediate hæmorrhage. In Experiment 4. bleeding commenced about twenty or twenty-four hours after the injury, in Experiment 5. on the third day, and in one of M. Halmagrand's experiments at the London Hospital, described in the Medical Gazette, it did not occur till the fifth day after the wound. Dr. Jones's experiments also lead us to the same conclusion with regard to secondary hæmorrhage from wounded arteries.

6thly. It is probable that styptics applied to a bleeding artery can only be beneficial in two ways,—FIRST, by causing contraction of the coats of the bleeding artery. It is proved, however, by these experiments, as well as by Dr. Jones's and M. Halmagrand's, that whatever may be their effect upon *small* arteries, styptics scarcely induce any contraction of the coats of a *large* artery, and often none at all; but, that whatever may be the means employed to control the hæmorrhage, the formation of a clot, and the deposi-

tion of lymph, are almost always necessary. Surgical experience, moreover, teaches us the same lesson with regard to partially divided arteries, although, no doubt, in cases where an artery is wholly divided, contraction is powerfully exerted to prevent loss of blood. Or SECONDLY, styptics may be of service by accelerating or promoting the coagulation of the blood. If, for instance, the decoction of galls, which was employed in the first experiment, be mixed with recent blood, it instantly produces coagulation, and such, I am informed, is also the effect of MM. Talrich and Halmagrand's "Liquide Hæmostatique;" but Ruspini's styptic, which was permanently successful in the second experiment, and which is often employed in practice with marked benefit, produces no coagulation, nor any other sensible effect on recent blood; neither, of course, does plain water, which was temporarily successful in Experiment 4., promote coagulation. If, then, pressure for a few minutes upon a wounded artery can permanently prevent hæmorrhage, when that pressure is made with compresses dipped in various fluids, which neither produce contraction of the artery, nor facilitate coagulation, we are justified in concluding that if styptics *are* employed, the cessation of the hæmorrhage is to be ascribed principally, if not entirely, to the pressure, or at all events in a minor degree only to the action of the styptic.

7thly. These experiments further demonstrate that the effects of pressure with or without the use of styptics are precarious and uncertain, even in brutes, and therefore, *à fortiori*, ought not to be depended on

in cases of wounded arteries in man, to the exclusion of the almost uniform success of the ligature, whenever its employment is practicable. And, in fact, every day's experience teaches us, in the most striking manner, the important lesson, which these and all other experiments on the subject corroborate, that wherever there is an external wound communicating directly with a large artery, although 1st, there may be complete cicatrization of the wound, and consequently no further hæmorrhage; or 2dly, that a circumscribed false aneurism *may* be formed, (this may take place at least in man, though I am not aware that an aneurism has ever been formed in any experiments upon brutes,) which is capable of being cured by the common operation of tying the artery at some future time, at a distance from the wound; yet we cannot feel confident that either of these circumstances will ensue, but, on the contrary, are obliged to entertain constant apprehension lest the barrier afforded by the internal or external coagula should give way, and, in the first place, when the wound in the skin HAS united, a diffused aneurism should be formed requiring a ligature above and below the aperture in the vessel, but accompanied with an extensive suppurating wound, which might have been avoided if the vessel had been tied in the first instance; or in the second place, if the skin HAS NOT united, then we cannot but feel constant anxiety lest our patient be destroyed by a sudden gush of blood, or, as more frequently happens, be worn out by irritation and by loss of blood, from the no less fatal influence of frequently repeated smaller hæmorrhage.

8thly. But lastly, while I deprecate most strongly any reliance on the use of styptics in wounds of *large* arteries, I do not deny that they may sometimes be of service as *auxiliaries* in the case of hæmorrhage from *smaller* vessels; and if further experience shall prove that the "Liquide Hæmostatique" of MM. Talrich and Halmagrand is really superior in this respect to other styptics, I shall have as much pleasure in acknowledging the fact, as I have in ascribing to their distinguished countryman Paré the revival of the still greater security against hæmorrhage afforded by the ligature.

P. S. It may, perhaps, be interesting to those who are not convinced by my experiments of the small share of credit that styptics can claim in controlling hæmorrhage from large arteries, to be acquainted with the following summary of Dr. Jones's experiments, in which *no styptic* was employed; the knowledge of which induced me to perform my own, although of a different kind to his, with perfect confidence in their result; a confidence in his accuracy, and in the powers of nature, which was not deceived. Dr. Jones's experiments were performed upon the carotid, axillary, femoral, and humeral arteries of horses, asses, and dogs, and completely prove that where the integuments *are closed*, by far the majority of wounds of large arteries will be cured by very simple means, my own experiments serving to shew the same result with regard to open wounds.

1. Partial wounds 22; lived 19; died 3.

2. Secondary hæmorrhage occurred in 5; lived 2; died 3.

3. The kinds of wounds were

Longitudinal wounds	2	Lived 2	Died none.
Oblique wounds	3	 2	 1.
Transverse wounds of less than half the circumference. }	... 3	 3	 none.
Half the circumference cut	4	 2	 2.
Considerable (kind not stated)	1	 1	 none.
Punctured wounds	9	 9	 none.
	<u>22</u>	<u>19</u>	<u>3</u>

4. Died of secondary hæmorrhage 3. One lived for eighty hours; one lived six days; one lived for twenty-five days.

5. Dr. Jones also completely *divided* or *tore through* the same sized arteries, in nineteen experiments; tying the integuments in fifteen, and leaving the wound entirely open in the other four. Of these nineteen, six died, or were killed just before they probably would have died, the remaining thirteen all lived.

Of the six that died three were open wounds; in three the skin was closed by suture.

In four of the experiments the end of the artery

nearest to the heart was tied, of which one died, three lived.

In fifteen nothing was done to the artery; of which five died, ten lived.

Half Moon Street, Jan. 23d, 1832.