**A contribution to the surgery of bleeding vessels.**

# A CONTRIBUTION TO THE SURGERY OF BLEEDING VESSELS.

In a former paper (*The Lancet*, April 17th, 1869) I adduced a number of experiments bearing on the subject of the comparative strength of arteries secured by ligature, acupressure, and torsion, from which it appeared that ligature was by far the most secure method, resisting the highest column of mercury (114 inches) brought to bear upon it by the dynamometer, while acupressure and torsion resisted on an average respectively a column of 23·5 and 13 inches. These experiments were criticised at the time by Mr. Lawson Tait, but I still venture to affirm that they give a fair comparison of the value, as far as security goes, of the different methods. Excepting the assumed normal pressure of blood in living vessels, which was, I believe, stated at too high a figure, the only factor omitted by them is that of the elasticity of, and additional security furnished by, the portion of tissue included along with the artery between the pin and wire when acupressure is performed, and which protection accounts for the inner and middle coats of the vessels being, as is alleged, not cut through by this method.

These experiments have not been continued as originally intended. They are sufficient evidence as they stand, and

they gave place to a new line of experimentation undertaken with a view to improve upon, or add to, our present methods of arresting bleeding from cut vessels.

That none of our present modes is entirely satisfactory cannot be denied. Torsion seems, in some hands, to have given marvellously good results; but, having had no opportunity of witnessing it as applied regularly to large vessels, I can only say, under liability to correction by those who have tried and adopted it, that the small amount of internal pressure resisted by it forms a serious, although the only, objection to its use. In Aberdeen, on the contrary, we have abundant opportunity of studying acupressure, and the result of my own observation is to convince me that it cannot retain the place originally claimed for it in operative surgery. The one real advantage that it possesses is that it allows the wound to be freed from foreign bodies one or two days after operation—doubtless a very important matter, but which can be attained without its employment. The asserted frequency of primary union in wounds treated here by it, and the absence of suppuration in such wounds, are to a certain extent correct. In amputations of the mamma it yields first-class results, primary union and absence of pus being generally achieved; but in other amputations suppuration occurs just as usual, the statements to the contrary being due partly to the great enthusiasm of its advocates, and partly to a careful nurse removing, as far as possible, all traces of discharge before the visit of the surgeon.

Acupressure has several disadvantages. The pins frequently prevent complete closure of the wound at the time of the operation, and the edges have to be accurately adjusted at a subsequent period. The removal of the wires requires a

considerable degree of traction, and, in the employment of the ring-loop, is sometimes a matter of difficulty; while, in at least one recent instance, an acupressed vessel in an amputation wound required, owing to secondary hæmorrhage, the subsequent application of the ligature. The estimate of acupressure I have formed is similar to that of many other surgeons who have given it a trial.

Considering, then, the superior strength of ligatured vessels, it would be a step in advance could the ligatures be applied in such a manner as to retain their superior security, and yet so as to allow of their being removed about the second day after operation, before the tendency to suppuration has commenced in the wound, and also so as to avoid snaring off the ends of the arteries and the tissue grasped by the forceps in the usual mode of applying them.

All these advantages are combined in the method I have now to propose—namely, that the bleeding vessels be secured by the knot depicted in Fig. 1, which if it be run close, and

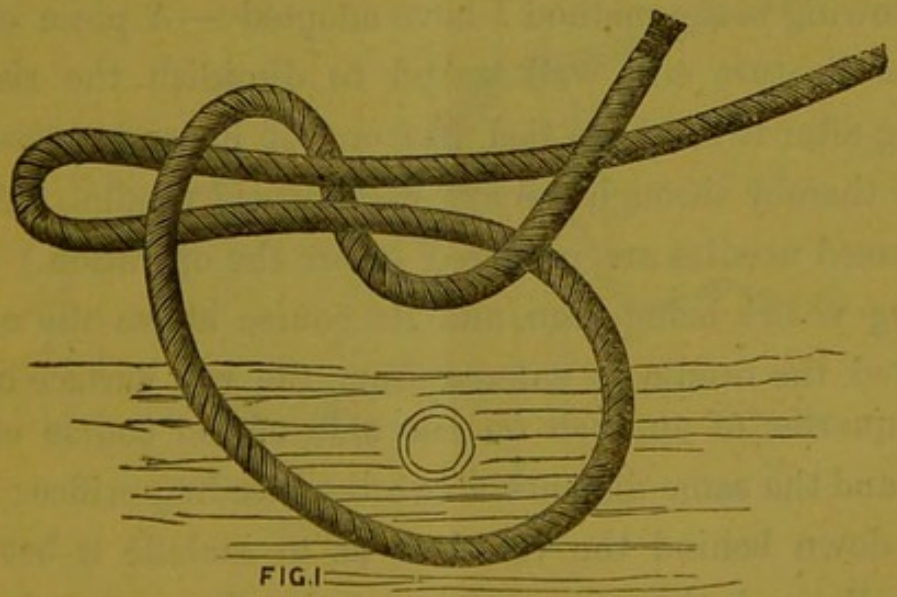

FIG. I

the short end cut off close to the knot, can be removed by very moderate traction on the long end. The knot, it will be

perceived, is merely the "thumb or over-hand knot," similar to the first part of the knot ordinarily applied to arteries, with the single exception of a loop of the long end being employed instead of the undoubled cord. Its hold is perfectly sufficient when tied, but I shall afterwards come to discuss its security.

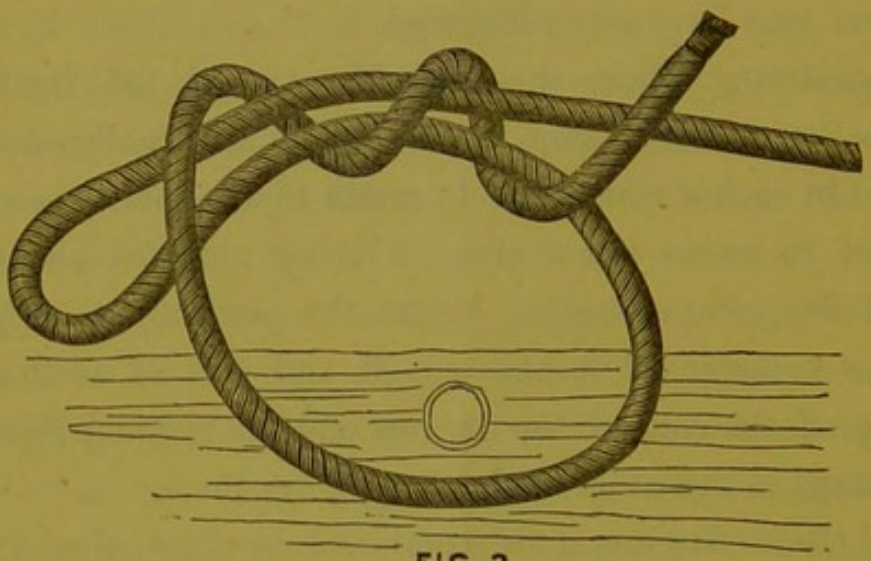

FIG. 2

In applying the knot to the flaps of an amputation wound, the following is the method I have adopted :—A piece of *the strongest* ligature silk, well waxed to diminish the risk of slipping after it has been tied, has one of its ends passed an inch or thereby through the eye of a curved needle. (A few such armed needles are prepared before the operation.) The bleeding vessel being seen, and its course above the orifice estimated, the needle is entered from the raw surface of the flap, a quarter of an inch on one side of the course of the vessel, and the same distance above the bleeding orifice; then passed down behind the vessel so as to include it between the needle and the raw surface of the flap; and, having crossed behind the vessel, is brought out a quarter of an inch on the other side of its track. The needle is next drawn

through, bringing a couple of inches of the thread with it, as in Fig. 3, and it may then be detached from the thread. A

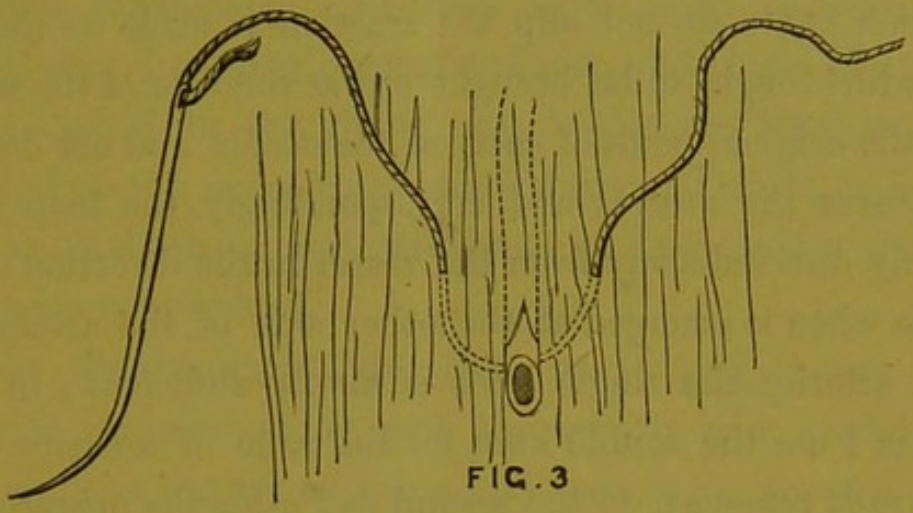

FIG. 3

loop of the long end, an inch or thereby in length, is then used to form, with the single short end, an ordinary "thumb knot," as in Fig. 1, or, if additional security is required, a

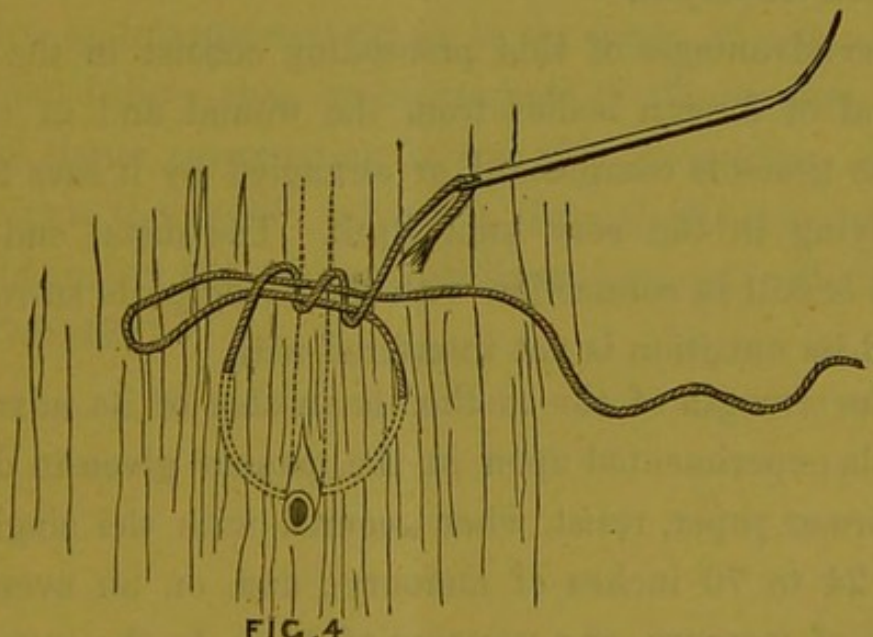

FIG. 4

double knot, as in Figs. 2 and 4. The knot is closed upon the vessel and included tissue by traction on the loop and short end; the strands of the loop are placed close to each

other, so as to lie in contact throughout and offer no obstacle to removal when the long end is pulled; and, finally, the short end is cut off close to the knot.

Such knots do not slip till traction is made on the long end, which ought to be brought out at the side of the wound next the original point of entry of the needle, and not doubled again over the vessel; and, correspondingly, the loop is laid suitably directed away from the vessel in the direction of the needle when it emerged at the other side of the artery. In small arteries the single knot is amply sufficient; in large arteries I use the double knot for the sake of security. The ligature is removed, on the second day after the operation, by gentle traction on the long end; and the amount of force required for its removal, while too great to be readily effected by accident, is, notwithstanding, less, even with the double knot, than that needed to remove the wire where acupressure has been employed.

The advantages of this proceeding consist in the speedy removal of foreign bodies from the wound, and in the fact that no tissue is compressed or strangled by it save the portion lying in the very knot itself. The distal end of the vessel is still in connection with the living parts surrounding it, and its nutrition is not interfered with.

The strength of the method is another of its advantages. Vessels experimented upon in the manner given in detail in my former paper, resist, when secured with the single knot, from 24 to 70 inches of mercury; and, on an average, 39 inches of mercury, or a pressure of 19 lb. to the square inch, as against 23·5 inches of mercury with acupressure, and 13 inches with torsion. The double knot resists the full column admitted of by my dynamometer—viz., 114 inches of mercury,

or 57 lb. to the square inch. I have tested in animals this application of ligature to cut vessels, and to vessels deligated in continuity, before using it in man, and the results were perfectly satisfactory. In man they have hitherto been equally so. I have at present a stump after Pirogoff's amputation treated in the above way, where the ligatures were removed on the second and third days, and which is healing with as small an amount of discharge as I ever saw obtained, even with acupressure.

The disadvantages are, that, as in acupressure, some tissue is included along with the vessel; and where structures such as important veins and nerves run parallel to the artery, damage might be done by their inclusion. Thus it is best suited for amputations; indeed, without further experience of it, I should hesitate to employ it in the deligation of an artery in continuity upon a human subject. I have had no opportunity of testing it in that most difficult of all vessels to secure, an interosseous artery in the angle of a flap amputation, but believe that, by laying hold of the bleeding orifice and the tissue surrounding it, and then proceeding, as in a flap, to pass the needle behind it through the grasped mass, it would answer as well as the ordinary ligature.—*The Lancet, May 27th,* 1871.