Longworth (L. R.)

LIGATURE OF THE EXTERNAL CAROTID ARTERY.

BY

LANDON R. LONGWORTH, M.D.

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Fig. 1.

Fig. 2.

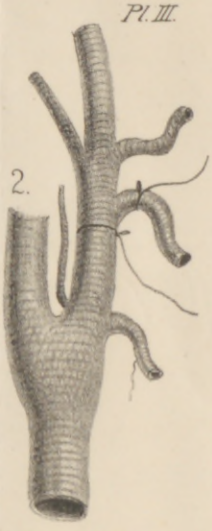


Fig. 3.

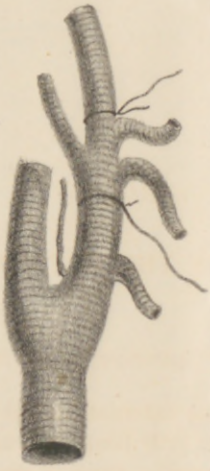
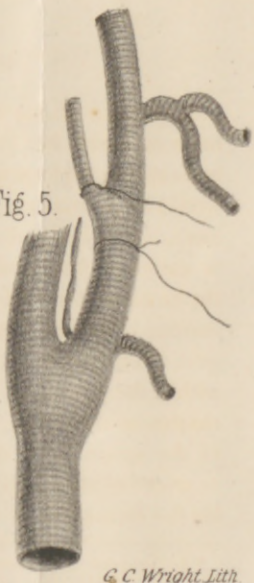


Fig. 4.

Fig. 5.



L.R. Longworth Del.

G. C. Wright Lith.

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I.

LIGATURE OF THE EXTERNAL CAROTID ARTERY.*

BY

LANDON R. LONGWORTH, M.D.

LIGATURE of the external carotid is an operation which seems to have met with but little favor, and has therefore been comparatively but seldom performed. Even in those cases in which this procedure would have attained their purpose equally well, or better, surgeons have, as a rule, preferred to tie the primitive carotid, inasmuch as it is easier to find, and more especially because from the shortness of the trunk of the external carotid, and the proximity of large and numerous collateral branches (the superior thyroid, ascending pharyngeal, lingual, facial, and occipital arteries being given off usually within the first inch above the bifurcation) there would seem to be reason to fear the recurrence of secondary hemorrhage, inasmuch as the space between the point selected for the ligature and the nearest collateral above and below would appear, *à priori*, too short for the formation of a firm and organized coagulum.

* An Inaugural Dissertation for the degree of M.D., to which was awarded the first prize, at the Annual Commencement of the College of Physicians and Surgeons, New York, Feb. 27th, 1873.

It should not be forgotten, however, that this objection can only apply to that part of the artery which lies below the digastric and stylo-hyoid, the portion above these muscles as far as its division into temporal and internal maxillary being a trunk of considerable length, and free from branches of any moment, with the exception of the posterior auricular.

These two objections then—the greater difficulty of securing the artery, and the apprehended danger of secondary hemorrhage—have so far influenced the minds of surgeons, that ligature of the external carotid, compared with that of the primitive vessel, has been a very rare operation, and would, in all probability, have been still rarer, were it not for the fact that the former operation possesses two advantages over the later, viz. : first, that it is more efficient in arresting the circulation in the parts beyond the ligature, unless at the same time with the common carotid the internal carotid be also ligated ; and, secondly, that it is free from certain grave dangers incident to the latter operation consequent upon interference with the cerebral circulation and the nutrition of the brain.

Such, then, seem to be the relative advantages and disadvantages, briefly stated, of the two operations respectively, from an anatomical point of view. From a consideration of these points mainly it is that surgeons are apt, as a rule, in cases which admit of a choice, to tie the common carotid—and internal also, if necessary—rather than to resort to ligature of the external carotid. Indeed, the latter is by many excluded from the catalogue of formal operations, and regarded as applicable only to direct wounds of the vessel itself.

Accordingly, although ligature of the common carotid is a frequent surgical measure (one author alone, Dr. Pilz, having recorded 600 cases) I am able to find the records of no more than 35 cases of the operation under consideration.

As the practical results, however, of this limited number of cases hardly seem to justify the ill favor attaching to the operation, I have thought it worth while to tabulate them, in order to compare the conclusions drawn from direct experiment with those adduced from *à priori* reasoning.

But before proceeding with the enumeration of the recorded cases of this operation, I wish to say a few words in regard to the sources from which I have obtained the majority of them.

In the year 1863 a very lively as well as lengthy controversy took place between the members of the Surgical Society of Paris on the advisability in general of the preliminary ligature before the removal of tumors where much hemorrhage is expected, and more particularly of the preliminary ligature of the common carotid before extirpation

of tumors of the parotid. (*Vide Bulletin de la Soc. de Chir. de Paris*, 2d series, vol. iv.) The fatal results shown to have followed this measure in many cases led to the suggestion on the part of M. Broca of substituting for it the ligature of the external carotid. The subsequent discussion gave occasion for two articles, which were read before the Society, one by M. Le Fort (*Gazette hebd.*, 1868, Nos. 28, 30, 35), on the mortality after ligature of the common carotid; the other, by M. Guyon, on ligature of the external carotid. The general conclusions arrived at by both gentlemen accorded the preference to the external carotid, although no detailed comparison of the two operations was made by either. This opinion was indorsed by the Society, a letter of thanks sent to M. Guyon, and a vote passed authorizing the publication of his article in the bulletins of the Society. (It will be found in the sixth volume of the *Mémoires de la Soc. de Chir. de Paris*, p. 197.) In this excellent work M. Guyon has endeavored to systematize the operation, and has added some valuable contributions to the surgical anatomy of the artery. He passes over the therapeutic application of the operation, and its relation in point of efficacy with that upon the primitive vessel, nor does he consider ligature above the digastric, but mentions his regret, during the revision of his memoir, at this latter omission. He records twenty-four cases, the greater number (fifteen) of which were furnished him personally by the operator, Maisonneuve. M. Guyon believed that all of these were cases of ligature below the digastric, and remarks that no instances of the operation above that muscle had fallen under his notice. I find, however, that two of them (those of George Bush and John Lizars; *vide infra*) are recorded as having been performed above the digastric. Beside this author no one, so far as I am aware, has tabulated any cases of ligature of the external carotid, except Günther (*Lehre v. d. blutigen Operationen am Halse*, ed. 1864, page 94), who has collected ten, five of which are the same as those of M. Guyon. To this number I have been able to add a few more cases from scattered sources.

(1.) The first case of this operation recorded is related by Benjamin Bell in his Principles of Surgery. The artery was wounded during the extirpation of a tumor of the neck, and both ends secured. The patient recovered. As there seems to be some doubt, however, as to whether the artery tied was really the external carotid, I have excluded this from the general summary (*vid. Günther's Lehre von den Operationen am Halse*, ed. 1864, p. 94).

(2.) In the year 1827, George Bushe removed a pulsating tumor from the temporal region of a little girl two years old. Hemorrhage occurred which could not be arrested by the actual cautery or

by pressure on the common carotid. The external carotid was then ligated above the digastric. The hemorrhage ceased, and the child recovered. The ligature separated on the 18th day. M. Guyon erroneously tabulates this case as one of ligature below the digastric (*vide Lancet*, 1827-28, vol. ii., p. 413).

(3.) Mr. Scott, in 1830, in the London Hospital, having to remove the right superior maxillary bone in a man 48 years of age, guarded himself against hemorrhage by placing a ligature about the external carotid as a preliminary step. The patient recovered (*vide London Medical Gazette*, vol. vii., p. 286).

(4.) C. W. Wutzer, in the case of a man 41 years of age, suffering from a tumor of the soft palate, tied the external carotid below the digastric as a preliminary step before extirpation. The artery was surrounded with a double ligature at the site of origin of the superior thyroid, which had an abnormal origin four lines above the bifurcation. The tumor was then removed with only slight venous hemorrhage. The ligature came away on the 22d day. The patient was cured. (*Organ für d. gesammte Heilkunde von Neumann Wutzer und Kilian*, vol. i., p. 429.)

(5.) John Lizars, in the year 1830, tied the external carotid before removal of a tumor of the superior maxilla encroaching on the orbit, cheek and hard palate in a woman 55 years of age. In this case it was the common trunk of the internal maxillary and temporal arteries which was tied, although the artery was approached from below the digastric. M. Guyon records it as a case of ligature below the lingual. (*Lancet*, 1829-30, vol. ii., page 24.)

(6.) Mr. Wallace, of Dublin, in 1833, tied the external carotid in a case of nævus, occurring in a girl 13 years old, on the right cheek, near the corner of the mouth, as large as a hen's egg. The tumor was greatly reduced in size after the operation. (*Lancet*, 1833–34, vol. i., p. 851.)

(7.) Engel, in 1842, tied the external carotid for a wound of that vessel in a suicidal attempt. The wound was crescentic, 5½ inches long from the angle of the jaw downwards towards the larynx. The œsophagus was also divided. The patient, although he had lost a great deal of blood, recovered. (*Schmidt's Jahrbüch.* xl. p. 212.)

(8.) Günther, in the year 1845, tied the external carotid above the digastric for hemorrhage, after extirpation of a parotid. (*Günther's Lehre v. d. Operationen am Halse*, p. 96.)

(9.) Wutzer, in 1847, in the case of a man 38 years of age with a malignant tumor of right side of neck and fauces, tied the external carotid during an attempt to remove the tumor. The mass was dissected from below upwards from the great vessels, and a ligature

placed upon the artery about 4 lines above the bifurcation, close under the origin of the lingual. The tumor was, however, not removed for fear of injuring the vagus nerve. The ligature separated on the 16th day, and the wound soon healed. (*Canstatt. Jahresbericht von* 1847, p. 125.)

(10.) Maisonneuve, in the case of a woman 30 years of age, with an aneurism by anastomosis in the temporal region, tied the external carotid 5 or 6 lines above its origin. The superior thyroid was also ligated. The tumor shrank, and pulsation ceased. The ligature came away on the 16th day. Five days later slight hemorrhage took place from the wound. Compression was used. During the succeeding two days hemorrhage took place twice. The common and internal carotids were now tied. Great difficulty was experienced in the operation. The sympathetic nerve was included in the ligature; the patient became hemiplegic, and died three days later. (*Gaz. des Hôpitaux*, 27th Oct., 1849.)

The following cases of Maisonneuve were obtained personally from the operator by M. Guyon, who has recorded them in the memoir above quoted:

(11.) Maisonneuve, in 1852, in the case of a man 53 years of age, with cancer of right side of tongue, tied the right external carotid, and extirpated the tumor. The patient was discharged from the hospital in the 8th week after the operation.

(12.) (13.) In 1854 the same operator tied both external carotids in a woman 32 years of age, with cancer of the tongue and jaw. Discharged 6 weeks after operation.

(14.) (15.) In the same year the same operator tied both arteries in the case of a man 50 years of age, with cancer of the tongue. Discharged in five weeks.

(16.) (17.) In the same year he also again tied both arteries, in the case of Leon Boucher, aged 34 years. Discharged 5th week.

(18.) In 1855 he tied the right external carotid in the case of a man with cancer of the tongue. The patient died of his disease one month after the operation.

(19.) In the same year he tied the left external carotid in a man 42 years of age, with cancer of left side of tongue and jaw. The patient died of cancer two months afterwards.

(20.) In 1856 he tied the right external carotid in a man 51 years old, with cancer of the tongue, pharynx and jaw. Discharged the 7th week.

(21.) (22.) In the same year he tied both arteries in a man 44 years of age with cancer of the tongue. Died of his disease in three months.

(23.) (24.) In 1854 he ligated both external carotids in the case of

a man 26 years of age, with cancer of tongue. Discharged six weeks after.

(25.) In 1855 M. Ad. Richard tied the external carotid for a traumatic aneurism in the parotid region. (*Gazette des Hôpiteaux*, April 3d, 1855.)

(26.) Bertherand tied the external and common carotid in the case of a girl 4½ months old for an erectile tumor of left side of head. I have excluded this case from the general summary, inasmuch as the common carotid was tied at the same time with the external.

(27.) Prof. Sédillot tied the external carotid for a very extensive vascular tumor of the scalp and face. The superior thyroid was also ligated. (*Traité de Méd. Operatoire, Sédillot*, p. 249.)

(28.) In 1856 Roser tied the external carotid in the case of a woman for hemorrhage proceeding from a varicose aneurism of the vessels of the right ear and of the neighboring parts. Several other arteries were also tied. (*Deutsche Klin.*, 1857, p. 399.)

(29.) Prof. Busch, in the case of a man 34 years of age, with retropharyngeal tumor, tied the external carotid above the digastric prior to extirpation. (*Schmidt's Jahr.*, xcviii., p. 341.)

(30.) Widmer tied both ends of the artery in the wound after having accidentally divided it in the extirpation of a parotid. (*L'Expérience*, vol. ii., p. 336.)

(31.) M. Foucher tied the external carotid for grave hemorrhage after amputation of the tongue by means of the écraseur of Chassaignac. (*M. Guyon, sup. citat.*)

(32.) Larrey reports two cases of wound of the external carotid, in one of which an English surgeon tied both ends of the artery in the wound. (*Clin. chirur.*, vol. ii., p. 129.)

(33.) M. Dolbeau, in 1864, tied the external carotid in the case of a girl 15 years old, in whom ulceration of the lingual artery had taken place in consequence of an abscess of the right submaxillary region. The artery was tied in the midst of inflammation, and the wound was stuffed with charpie. The girl recovered completely in two weeks. (*Bulletin de la Soc. de Chir. de Paris*, 1864, 2d series, vol. v., p. 180.)

(34.) In 1869 Prof. C. Heine had under his care a man 21 years of age, with a very extensive cirsoid aneurism of the vessels of the ear and scalp in the temporal region. The tumor had been increasing in size for a considerable period, and had resisted local measures. Prof. Heine tied the temporal and posterior auricular arteries without result. He determined on extirpation, and as a preliminary step tied the external carotid below the digastric. Pulsation was at once arrested in the tumor. During its removal 19 ligatures were applied.

Some days afterwards hemorrhage took place from the wound in which the external carotid had been tied, which was not amenable to pressure. The common carotid was now ligated. This was followed by some cerebral symptoms, which, however, passed off, and the patient ultimately recovered. (*Schmidt's Jahrbüch.*, 147, pp. 69–71.)

(35.) In the autumn of 1872, Prof. H. B. Sands removed the left half of the inferior maxilla from the person of a gentleman about 50 years of age, for a cancerous tumor, in an operation at which I had the honor to be present. The external carotid, which was involved in the tumor, was divided, and ligated at about half an inch above the bifurcation. The internal carotid was exposed for almost its entire length in the bottom of the wound. On the tenth day sudden hemorrhage took place from the wound, owing to ulceration of the coats of the internal carotid. Dr. Sands now ligated the common and internal carotids, and the patient recovered. I have not included this case in the general summary, on account of these arteries having been tied before the separation of the ligature on the external carotid. (Not yet reported.)

These are all the cases that I have been able to collect of ligature of the external carotid artery. They are thirty-five in number. The majority are formal operations; a few, however, were performed for wound, accidental or otherwise, of the artery. Doubtless the artery has been tied for wound much oftener than would appear from the statistics which I have given, but as these cases are not all of them reported under the head of ligature, it is very difficult, indeed almost impossible, to find them.

Excluding from the total 3 cases, for the reasons given, we have: 31 recoveries to one death, resulting from ligature of the common and internal carotids, which operation was rendered necessary by secondary hemorrhage. (In another case secondary hemorrhage occurred, which required ligature of the common carotid.) In 5 cases the artery was tied on both sides. In 4 cases it was tied above the digastric.

From a consideration of the results of these cases, it is difficult to avoid drawing a more favorable conclusion in regard to the success of this operation than is generally arrived at from a purely theoretical stand-point. As already stated, the apprehension of secondary hemorrhage, which has prejudiced surgeons against it, is based upon the fact, that the space above and below the point available for the ligature, and the numerous and large collateral branches, would appear, *à priori*, too short to admit of the artery being closed by the formation of a firm and organized coagulum. This space is certainly not so great as might be desired.

The point usually selected for the application of the ligature is from four to six lines above the bifurcation, and between the origins of the superior thyroid and lingual arteries. The distance between the origins of these arteries is said to be usually about half an inch. Out of 31 cases in which M. Guyon measured the distance from the bifurcation to the nearest of the upper collaterals (the lingual, occipital and facial), in 26 it exceeded one centimetre, and in 5 it fell below this measurement. He concludes that it may exceptionally exceed two centimetres and even attain to three, but that, in the majority of cases, it oscillates between 12 and 18 millimetres. He leaves out of account the superior thyroid in his measurements, inasmuch as its origin almost always coincides with the bifurcation, and, moreover, because when it has an abnormally high origin it will be seen and tied. Out of 28 cases which I have examined in relation to this point, I have found the distance from the superior thyroid, or from the bifurcation when this artery was given off below from the common carotid, to the next collateral above, to equal or exceed half an inch in 20 cases, and to fall below in 8.* In several of the latter cases this distance could have been much increased by tying off one of the collaterals; and this should be done if during the operation a branch is seen arising close to the site of the ligature, in order to increase the space for clot-formation. In one very abnormal case the collaterals all came off in a bunch very close to the bifurcation.

It is not always the superior thyroid or the lingual which encroaches upon this space. In one case the occipital came off within half an inch of the bifurcation, and in another the ascending pharyngeal came off from a point midway between the bifurcation and the upper collaterals. In 4 cases the trunk attained the length of an inch.† I think that the study of these cases justifies me in hazarding the opinion that the extent of artery free from branches is apt to be greater in long-necked than in short-necked subjects, and in men than in women.

In any event, however, it would seem reasonable to suppose that no great reliance can be placed on the effectual sealing up of the artery in this situation, by an extensive and firm coagulum. Whether any such coagulum did actually form, or whether it materially assisted in the closure of the artery, in the cases where the ligature was applied on the living subject, is difficult to determine, inasmuch as a post-mortem inspection of the condition of the vessel was practicable in one case only, the rest recovering from the operation.

Three patients of Maisonneuve, however, died at short periods after

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* 12.5+millimetres. † 25+millimetres.

the operation for cancer, but no mention of an autopsy is made. It is quite probable that the artery was closed in all these cases by the usual plastic effusion and natural reparative processes between and around its coats, without the intervention of any considerable clot. For the fact must not be lost sight of, that the efficient agent in the closure of an artery under ligature is the plastic material which coheres within the vessel with the lacerated coats, and externally around the artery and along its sheath, penetrating the very substance of the external coat next the ligature, and uniting that coat with itself into one consolidating mass.

It would be foreign to my subject to enter upon a discussion here of the necessity or importance of the coagulum in the closure of an artery under ligature. Suffice it to say that it is not regarded as necessary under all circumstances; for it is a well-known fact, an artery may heal without its agency. Its importance has not been considered so great of late years as it formerly was. Guthrie, in his commentaries, ed. 1855, page 80, remarks: "The idea usually entertained, that a great artery cannot be closed by the ordinary process of nature under a ligature, if a branch be given off near it, is erroneous. I never placed reliance on this opinion unless in the accidental circumstance of the outside of the orifice of the branch being in contact with the ligature, the irritation caused by which outside may not be sufficient to close the orifice within."

This opinion, although perhaps somewhat strongly expressed, would seem, nevertheless, to be in a measure both corroborated by, and at the same time to explain the extraordinary success and immunity from secondary hemorrhage which has hitherto attended the ligature of so short a trunk as that of the external carotid.

Whatever may be the correct view, however, in regard to the advisability in general of tying in the vicinity of large collaterals, the danger in this particular instance, judging from the results of the actual operation, seems to have been greatly overestimated. For, although in these cases it is quite probable that no considerable clot was formed, still the tissues in which the artery was tied, partaking of the great vitality and reparative power of the neighboring parts of the face, consolidating with and around the artery, together with the healing of its coats, were sufficient of themselves to effect the firm closure of the vessel before the separation of the ligature.

Whether this be the true explanation or not, it is certain that the operation has thus far met with most gratifying results; so much so, indeed, that it seems almost superfluous to institute a comparison between these results and those following the ligature of the common carotid. The mortality after the latter operation is somewhat dif-

ferently estimated by different authors. Dr. Pilz, in a very elaborate work, published in *Langenbeck's Archiv* for 1868, vol. ix., in which he has tabulated 600 cases, gives a ratio of 319 recoveries to 259 deaths, 22 being unaccounted for; from the mortality, however, 29 cases should be deducted, in which death was not directly due to the operation. This leaves a death-rate of over 2 to 5. The statistics given by M. Le Fort (*supra citat.*) offer little more encouragement than those of Dr. Pilz. He has collected in all 435 cases. Out of 43 cases in which the artery was tied for hemorrhage from wounds, in 11 the hæmorrhage returned, 25 were cured, and 14 died; in the remainder the result was not recorded. In 7 cases where the ligature was practised after operations, 4 recovered and 3 died. In 38 cases of vascular tumor, the operation effected a cure in 6 cases only, in one of which latter Bertherand tied at the same time the external carotid. Out of 14 cases in which it was performed for bleeding from tumors, 11 died, 1 of "thundering" hemorrhage, 1 of repeated hemorrhages, 1 of exhaustion on the second day, and 8 (!) of brain-accidents. (I do not quote the cases in which the artery was tied for aneurism.) If we add to this that disorganizing inflammation of an eye, loss of memory or of intellectual power, or hemiplegia more or less permanent, are not unheard-of in some of those reported cured, it may well be doubted whether we are justified in exposing a patient to the fearful risks attending interference with the cerebral circulation, when the safer operation of ligature of the external carotid will serve our purpose. The fact that this latter is rather more difficult and unfamiliar than the operation on the primitive vessel, and the apprehension of secondary hemorrhage, which experience has not sustained, should have comparatively little weight in influencing the choice.

But this is not the only reason for giving the preference to the external carotid. It is not merely upon the basis of relative hazard that the choice should rest; the relative efficiency of the two operations in commanding the circulation beyond the ligature should also be taken into account.

Before passing, however, to a consideration of the therapeutic value of these respective operations in cases that admit of a choice, I wish to allude to a point which, although I have not found it insisted upon in any work on operative surgery, seems to me to be not unworthy of attention.

I think that, whatever importance may be attached to the supposed danger of secondary hemorrhage under ligature of the external carotid among large collateral branches at the usual seat of ligature, it is no more than just to acknowledge that this theoretical objection can

hardly apply when the artery is tied above the digastric and stylo-hyoid muscles; for the vessel has here a course of about two inches free from branches of any considerable size. The few small unnamed twigs given off to the parotid gland and other tissues in contact with the vessel, together with the posterior auricular, are scarcely ever of sufficient calibre to cause much anxiety on the part of the surgeon. I have seen one case, however, in which the occipital artery being very small, and losing itself in the sterno-mastoid muscle, the posterior auricular was of large size, and gaining the groove behind the mastoid process, replaced the occipital in its distribution to the scalp. But this anomaly is, I believe, infrequent. Under ordinary circumstances, then, the objection which has caused the operation below the digastric to be regarded with disfavor can hardly have the same weight when applied to the operation above that muscle. Moreover, it should not be forgotten that the artery in the latter situation is also of much reduced calibre, being nothing more than the common trunk of the temporal and internal maxillary, and is at the same time embedded in tissues possessed of a very high degree of vitality, whose early and perfect healing and consolidation may, in most cases, be confidently expected. Although the artery lies at a considerable depth from the surface, it is probable that little difficulty will be found in securing it, for the ramus of the lower jaw and the posterior belly of the digastric form good and fixed guides to it. M. Guyon, who, however, acknowledges that he has not studied ligature in this situation, hints that the depth of the vessel might offer some embarrassment to the operation, but George Bushe (*Lancet*, 1827–28, vol. ii., p. 413) and Prof. Busch, of Bonn, who have both performed it, agree in pronouncing it easy. Certainly nothing is easier on the cadaver. The artery is separated from the vital parts in relation with it by parotid tissue and the stylo-glossus and stylo-pharyngeus muscles, so that little fear may be entertained of wounding the plexus venosus of the parotid externally, or the eighth pair of nerves, the sympathetic, the internal jugular vein, or the internal carotid artery beneath.

Of course the application of this operation is more limited than that upon the artery below the digastric, or upon the primitive carotid; but in those cases in which it is applicable, it would appear on anatomical grounds more efficient than either of these in arresting the circulation in the part affected, as will be noticed further on. It will be noticed that all of the cases of this operation in the table were attended with entire success, although in one of them the previous compression of the common carotid had failed to control the bleeding. It would seem, then, on every score preferable to ligature of that artery. The external carotid may be tied: (1) for direct wound of the

vessel itself; (2) for wounds of any of its branches, where the divided ends are not accessible to the ligature in the wound; (3) for hemorrhage from tumors; (4) as a preliminary step in the extirpation of tumors of the parotid, of the antrum, of the soft palate and fauces, of the pharynx, etc.; (5) for hemorrhage, not otherwise to be controlled after operations involving any of its branches; and finally, (6) for vascular tumors, when other means have failed, in any part of its distribution. As regards direct wound of the vessel itself, I think there can be little doubt that the proper proceeding is to tie the divided ends of the artery in the wound. But in regard to wounds of its branches, where this principle of ligating the divided ends cannot be put in practice in consequence of their inaccessibility, the rule is not so well established. The choice lies between ligature of the external carotid, and the simultaneous ligature of the common and internal carotids, ligature of the common carotid alone being so inefficient in checking such hemorrhage on account of the rich anastomoses with the arteries of the opposite side, the inferior thyroid with the superior, the princeps cervicis with the profunda cervicis, and the two vertebrals in the cranial cavity with the internal carotid and its branches, that this operation is rarely resorted to at the present day by good surgeons. Of course the additional ligature of the internal carotid augments the dangers somewhat, but setting aside the question of the relative hazard of these operations, which has already been discussed, there does not seem to be much contrast in regard to their relative efficiency in arresting the circulation in the wounded vessel; the only difference in the anastomotic circulation after the two operations being that, whereas, when the external carotid is tied, the recurrent circulation between the inferior and the superior thyroid arteries is prevented; when the common and internal carotids are tied this channel is left open, and instead of it the recurrent circulation through the branches of the ophthalmic with the facial and temporal is somewhat checked, although, perhaps, not to any very great extent, on account of the free anastomosis between the arteries at the base of the brain. Of course, after both operations, the recurrent circulation between the lingual, facial, occipital and temporal of the opposite side is permitted, as is also that between the profunda cervicis and the muscular twigs of the vertebral with the princeps cervicis. If there is any difference, then, ligature of the external carotid is to be regarded as the rather more effectual measure, inasmuch as it prevents the recurrent flow through the superior thyroid artery, the anastomoses between which and the inferior thyroid of the same, and the superior thyroid and inferior thyroid of the opposite side, are very rich, and might in some cases tend seriously to augment the danger of recurrent hemorrhage.

If it should be considered necessary, in order to stop the flow of blood, to cut off the circulation from both sides of the head, a juncture which will probably but very seldom present itself, the external carotids must be chosen, for it is more than probable that the simultaneous ligature of both common carotids will always prove promptly fatal. This has been demonstrated, I believe, but twice by actual operation; few surgeons will be found, however, willing to repeat the experiment.

When a considerable space of time has intervened between the application of the ligatures it is a well-known fact that many of the patients (about three-fourths) have recovered; but as the operation was resorted to in several instances for the cure of epilepsy, in which disease ligature of the common carotid has met with an extraordinary and widely disproportionate success, these statistics can hardly be considered as furnishing the ratio of mortality which will be likely to follow the operation when resorted to for the control of hemorrhage.

The opportunity for applying the ligature on both external carotids will more often present itself in cases of extensive cirsoid aneurism which has resisted other treatment. This procedure has been strongly recommended by Prof. Bruns, in his *Handbuch der pract. Chirur.*, ed. 1854, vol. i., p. 161. He at the same time deprecates ligature of the primitive carotid in these cases, on account of its inefficiency, not a few of the patients having died of hemorrhage from the weakened and dilated vessels while the ligature was still upon the artery. Prof. Bruns shows, in the event of both external carotids being ligated, that the only channel capable of supplying the recurrent flow in front would be the supra-orbital and frontal branches of the ophthalmic; and unless the disease were seated in the forehead, their influence need hardly be feared. Posteriorly the blood would reach the scalp only through the anastomoses of the princeps cervicis with the profunda cervicis and the muscular twigs of the vertebral.

He adds that further assistance would be given from below by the connection of the inferior with the superior thyroid. This latter, however, is probably an oversight, inasmuch as the superior thyroid is given off on the cardiac side of the ligature. This channel would remain pervious in case both common carotids should be tied. It will be seen, then, that the ligature of both external carotids is the most effectual operation which can be devised for cutting off the blood-supply to the scalp and face. No cases of the performance of this operation had come under the notice of Prof. Bruns at the time when he wrote; since then, however, Maisonneuve tied the artery on both sides in five cases of cancer of the tongue without a single bad symptom referable to the operation. Not only in cirsoid aneu-

rism then, but also in cancer of the tongue or of severe hemorrhage from wound or ulceration of that organ, this procedure may be had recourse to ; the ligature of one or both lingual arteries may, however, perhaps be preferable in these latter cases.

In cases of hemorrhage from wounds in the course of the internal maxillary artery, or from tumors of the parotid, of the antrum, or of the soft palate, fauces, or pharynx ; after extirpation of such tumors ; or after operations on these parts, the ligature of the external carotid above the digastric would appear best calculated to cut off the circulation in the part affected. The channels, through which the recurrent circulation would in such a case establish itself, are the anastomoses of the internal maxillary with its fellow of the opposite side, and particularly with the facial, and the anastomoses of the temporal with its fellow and with the occipital and ophthalmic, and this recurrent flow might be further almost entirely cut off, should it become necessary, by pressure on the facial and temporal arteries. In the other conditions enumerated, which may call for ligature of the external carotid, the same considerations will influence the choice of operations as in the case of hemorrhage, the problem being in each condition essentially analogous. Aneurisms in the course of the branches of the artery are usually traumatic and superficial, and can be treated locally with success.

Summing up what has been said regarding the therapeutic value of the several operations under consideration, I think I may hazard the following general conclusions :—

1. That ligature of the common carotid is the widest in its application, but most dangerous and least efficient.

2. That ligature of the external carotid below the digastric and stylo-hyoid muscles is more limited in its application, but less dangerous and more efficient.

3. That ligature of the external carotid above the digastric and stylo-hyoid muscles is the most restricted in application, but also safest and most effectual.

4. That ligature of the external carotid on both sides has hitherto been uniformly successful and is the most efficient measure at our command for arresting the distal circulation.

In regard to the method of operating, M. Guyon, to whose memoir allusion has already been made, directs that an incision should be made from a little external to the angle of the jaw downwards to within a short distance of the anterior border of the sterno-mastoid muscle from one third to one half an inch below the upper border of the thyroid cartilage. Some cervical glands and venous branches chiefly connected with the facial and lingual veins which overlie the artery should be dissected away. The glands should not

be torn away or lifted, for fear of lacerating the veins to which they are intimately adherent, but freely incised and the veins tied and divided if necessary.

The hypo-glossal nerve is then to be sought for crossing the artery at right angles, and serving as a guide to the artery lying immediately beneath. The identity of the vessel may be determined by its relation to the nerve, and the presence of a collateral, when it happens to come into view, and by the fact that pressure on the exposed vessel commands the pulse in the temporal. M. Guyon lays great stress on the importance of the hypo-glossal nerve as a guide to the artery and to the point at which the ligature should be applied. He states as the result of his investigations that this nerve crosses in nearly all cases at the origin of the bunch of collaterals and more particularly at the origin of the lingual. From a knowledge of this fact we may infer the length of vessel free from branches by merely exposing the nerve. Maisonneuve and others, however, seek the artery from the bifurcation upwards, and by many the nerve was neither seen nor looked for.

The operation is thus described as performed by Mr. Wallace (see *Schmid's Jahrbüch.*, v., page 55). An incision two inches long was made along the anterior border of the sterno-mastoid, having the greater cornu of the hyoid bone in its middle. During the division of the platysma two veins were cut and tied. Near the end of the os hyoides was felt the pulse of the deep-lying artery, and two rather large lymphatic glands connected closely with it, between which latter a vein of the size of a crowquill crossed the artery in immediate proximity. These parts were drawn aside, the artery laid bare for the space of one line, and the ligature passed around it. The wound was brought together with two sutures and adhesive plaster.

C. W. Wutzer made an incision two inches long, beginning one inch above the angle of the jaw. The external jugular vein, which lay in the line of incision, was drawn back. The facial vein now appeared in the lower angle of the wound and the posterior belly of the digastric muscle in the upper. A gland as large as a hazel-nut covered both carotids anteriorly.

The wound was enlarged downwards half an inch, by means of which were uncovered the external carotid, and further outwards and backwards the larger internal carotid half covered by the internal jugular vein. The external carotid gave off the superior thyroid four lines above the bifurcation. At this point the sheath of the carotid was opened, and the artery surrounded by a double ligature. The hypo-glossal and vagus were neither of them seen.

It will be noticed that the incision was made in this case somewhat too high up, it being unnecessary to begin so high as an inch above the angle of the jaw, and that the operator was obliged to enlarge it downwards subsequently. It is convenient to remember that the great cornu of the hyoid bone is placed about opposite the usual point for application of the ligature, and as it can be readily appreciated by the finger through the skin, the operator will avoid the annoyance of being forced to stop to prolong his incision if he makes it in such a manner that its middle shall be on a level with this landmark —as was done in Mr. Wallace's case.

The veins and lymphatics do not seem to have offered any serious obstacle to the dissection ; they can, no doubt, as a rule, be drawn aside without the use of injurious violence.

The lingual vein is of small size, and usually crosses the external carotid at a short distance above the bifurcation, in a nearly horizontal direction.

The facial vein, however, is much larger ; it occasionally receives as tributaries the superior thyroid vein, together with some superficial veins arising along the median line of the neck below the chin, and a branch of communication with the veins in the parotid, and passes obliquely downwards across the carotids either at, or a little below, or a little above, the bifurcation, on its way to join the internal jugular vein. The plexus thus formed by this vein, and the tributaries named, generally lie to the inner side, and sometimes partly over the artery, but are not very constant either in situation or arrangement. I have seen two cases in which the facial vein accompanying its artery under the angle of the jaw, passed across the external and internal carotids and joined the internal jugular under cover of the digastric.

Unfortunately this anomaly is, I believe, rare ; in the majority of cases the vein will be so situated as to be encountered in the operation. Usually it can be drawn most easily to the inner side. There is no reason that the pneumogastric nerve should either come into view, or be injured during the operation, as it lies well to the outer side, and behind the internal carotid and the internal jugular vein.

The hypo-glossal may or may not be seen winding around the occipital artery and crossing the external carotid a little below the digastric muscle, and at a moderate distance above the point available for the ligature. With a little care it need not be wounded.

The superior laryngeal nerve, however, crossing obliquely behind the artery from above downwards, and from without inwards, might be injured, if the tissues beneath the vessel should be included with it in the ligature. The point at which the ligature should be applied,

and the extent of artery free from collateral branches, have already been alluded to. The occasional necessity of a secondary ligature remains to be considered. Velpeau hints that "it might be important to place the ligature above and below the whole group of arteries (tout le bouquet artériel) which the external carotid gives off near its origin" (*vide Motf's Velpeau*, p. 233). In order to accomplish this it would be requisite to draw the digastric muscle upwards, care being taken to avoid the hypo-glossal nerve, so as to apply the upper ligature above the facial artery. This method was not adopted in any of the recorded cases; and as Velpeau himself cites no instances of ligature of the external carotid, it may be doubted whether this procedure is called for in the majority of cases. When, however, the lingual, facial, and occipital arteries come off very near together, and at an unusually short distance from the superior thyroid, this suggestion may be a very valuable one (see Plate III., fig. 3). But as it would in ordinary cases scarcely be advisable to make during the operation a sufficiently extensive dissection of the artery to ascertain these points with precision, the rule, which will probably in general be followed as most practical, will be, to tie any collateral that may chance to come into view at or near the point chosen for ligature of the main trunk, or to place a double ligature upon the parent vessel at the site of origin of such collateral. The circulation in the superior thyroid has been arrested by both these methods by Maisonneuve and Wutzer, etc. (see cases Nos. 4 and 10). In Wutzer's case the artery is said to have been given off four lines above the bifurcation. This is unusual. In the 28 cases above mentioned it came off, with one exception, at, below, or within one line above the bifurcation, so that in the greater number of cases no great advantage will be gained by ligating it. Prof. Sedillot, of Strassburg, considers it, however, as very advantageous (see his *Traité de médecine opératoire*, p. 249). The collateral which will perhaps most frequently be found to encroach upon the site of the ligature is the lingual, and by tying this artery, in the average cases, the greatest amount of space will be gained. No rule can, however, be laid down beforehand for any particular case, but that procedure should be adopted which seems best to meet the requirements of the case (see Plate III.).

In the after-treatment of the wound everything should be done which will promote primary union; for, as already suggested, much of the success of the operation may depend upon the speedy healing and consolidation of the tissues about the ligature.

I do not find in the records of the cases any detailed account of the method of tying the external carotid above the digastric, and

must therefore content myself with a description of the operation based upon dissections on the cadaver. The jaw should be closed, and the head gently extended and rotated to the opposite side, in order to render the parts moderately tense ; an incision should be made through the integuments and platysma myoides, beginning just below the lobe of the ear and from five to six lines behind the ramus of the inferior maxilla, passing near the angle of that bone, in a direction downwards and forwards for the distance of about two inches.

If the cut is not commenced further upwards or inwards than the point indicated, little apprehension may be entertained of dividing Steno's duct or the principal branches of the facial nerve, as they are emerging from the parotid gland upon the face.

The infra-maxillary branch, however, running close to the angle of the jaw, and nearly parallel with the incision, on its way to supply the platysma, might not escape uninjured. The superficial layer of the deep fascia, which in this situation passes across from the anterior surface of the sterno-mastoid on to the masseter muscle, may now be divided. This will expose the dense and thickened deep layer of the deep fascia as it passes from behind the sterno-mastoid to be firmly attached to the angle of the inferior maxilla. It should not be separated from its connection with the bone, for fear of turning aside the artery with the parotid still covered by the firm prolongation running inward to the styloid process forming a capsule for the gland. In order to avoid this it should be opened at a short distance from its attachment to the angle of the jaw. This being done the posterior belly of the digastric muscle will be seen toward the outer border and lower angle of the wound, and the ramus of the inferior maxilla toward the inner border ; the space between will be observed to be occupied by parotid tissue.

Beneath this tissue lies the artery at a depth of from 8 to 10 lines from the ramus of the jaw, and very nearly on a plane with its posterior border. The parotid gland should now be loosened from its attachments and drawn in a direction upwards and outwards, when the vessel will come into view, emerging from beneath the upper border of the digastric and stylo-hyoid muscles.

The temporo-maxillary vein, with its radicles and the communicating branch between it and the internal jugular, will be drawn aside with the parotid, in which gland they are embedded. The branch of communication of this venous plexus with the facial vein may appear in the outer border or lower angle of the wound ; it will not usually require division.

In those rare cases in which the parotid and sub-maxillary glands are continuous, it may be necessary to divide gland tissue, as perhaps

also in case the parotid surround the artery lower down than usual. Behind, the vessel is separated from the internal carotid, the internal jugular vein, the sympathetic, and the eighth pair of nerves, by the stylo-glossus and stylo-pharyngeus muscles, as well as by a portion of parotid tissue.

The sheath of the artery should be opened at a point about half an inch above the digastric and stylo-hyoid, this being about midway between the origin of the facial just below the lower border of these muscles and the division of the artery into temporal and internal maxillary opposite the neck of the jaw-bone. Should the posterior auricular be seen to be of large size, and arising near this point, it might also be surrounded. The aneurism needle should be passed from without inwards, to avoid the plexus venosus.

Explanation of Plate 3.

Fig. 1.—The external carotid artery tied at the seat of election, below the digastric muscle.

Fig. 2.—The same as Fig. 1, with simultaneous deligation of the lingual artery, which arises immediately above the seat of election.

Fig. 3.—The same as Fig. 1, with simultaneous deligation of the external carotid artery above the origins of the lingual, facial, and occipital arteries, which arise close to one another, and to the seat of election.

Fig. 4.—The same as Fig. 1, with simultaneous deligation of the superior thyroid artery, which arises immediately below the seat of election.

Fig. 5.—The same as Fig. 1, with simultaneous deligation of the occipital artery.

The lingual and facial arteries arise by a common trunk far above the seat of election.

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