EXPERIMENTAL RESEARCHES ON CICATRIZATION IN BLOODVESSELS AFTER LIGATURE

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ON

CICATRIZATION IN BLOODVESSELS

AFTER LIGATURE.

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EXPERIMENTAL RESEARCHES ON CICATRIZATION IN BLOODVESSELS AFTER LIGATURE.

Skilful treatment of hemorrhage is an infallible criterion of good surgery. Dieffenbach has well said, "From the behavior of a surgeon in cases of severe hemorrhage are we able to judge of what metal he is made." The mechanical measures employed in the management of hemorrhage have at all times constituted subjects of special interest to surgeons. Presence of mind, a steady hand, prompt action, an accurate anatomical knowledge, familiarity with the various hæmostatic agents, and clear ideas on the process of cicatrization in vessels, are prerequisite conditions of success in the treatment of the most frequent, and, at the same time, the most alarming emergency which presents itself to the surgeon—hemorrhage.

Ignorance, hesitation, and timidity, in the event of sudden, unexpected, and alarming hemorrhage, only too often mean death, while, on the other hand, the exercise of skill founded on knowledge is often the means of saving human life under the most desperate circumstances. For the benefit of suffering humanity fear of hemorrhage has deterred pretenders from performing bloody operations, which has left the cultivation of the field of operative surgery to men of skill and science.

Perhaps no branch of surgery has reached a higher degree of perfection than the treatment of injuries and diseases of the bloodvessels. The bold operations which have characterized the present era of surgery owe their inception and their legitimacy to the aseptic ligature. The aseptic ligature and the antiseptic treatment of wounds have rendered secondary hemorrhage an

exceedingly rare accident after operations. Every surgeon of the late war of the rebellion is painfully aware of the frequency with which secondary hemorrhage occurred after gunshot injuries or any of the capital operations. Billroth reported 23 cases of ligation of large arteries after gunshot wounds, and of this number in seven, or 30.4 per cent., secondary hemorrhage took place. Porta collected 600 cases of ligation of large arteries, including the aorta, innominata, carotid, subclavian, axillary, common iliac, external iliac, and femoral; of this number 75, or 12.5 per cent., were followed by secondary hemorrhage. Pilz has published a table of ligation of the common carotid artery where the operation was done 158 times for hemorrhage; of these cases 35, or 33.5 per cent., suffered from secondary hemorrhage, which proved fatal in 16, or 15 per cent. How different the results of to-day! An artery is ligated, the ligature is cut short, the wound heals by primary union, and permanent obliteration of the vessel is the rule. The aseptic ligature, wherever and whenever it can be applied, has almost entirely displaced all other hæmostatic agents, and is now universally acknowledged as the safest and most reliable measure in securing provisional and definitive closure of vessels. Like all material improvements, it has met with opposition, but a more extended trial has silenced criticism. Every surgeon should be in possession of clear and definite ideas of the processes which nature employs in effecting cicatrization in bloodvessels after ligature, so as to qualify him to select and apply the various hæmostatic agents intelligently, and to measure their effect by well-defined anatomico-pathological principles.

This subject has for a long time furnished a fertile field for theoretical speculations, pathological investigations, and experimental research.

For more than forty years the doctrine has been prevalent that definitive closure of a vessel after ligature is invariably due to the formation and organization of a thrombus. The doctrine is still taught by many of our teachers and recent text-books on surgery. The object of this paper is to disprove this assertion, and to establish the fact that the production of the intravascular

cicatrix is always the result of proliferation of the stable connective-tissue cells and endothelia of the walls of the vessel independently of the formation of a thrombus. The various theories which have been advanced to explain the process of obliteration in vessels will be briefly mentioned in their proper order, and the results of different methods of experimentation will be described, and, finally, the results of my own experimental work will be noticed, thus bringing the whole subject of cicatrization in bloodvessels after ligature before the Fellows of the Association for further consideration and discussion.

1. *History of the Ligature.*[1]

For a better elucidation of our subject it is necessary to briefly pass in review the history of the ligature, as it will reflect in a true light the pathological ideas entertained by surgeons at different times regarding its immediate and remote effects in arresting the circulation in a vessel after ligation.

The history of the ligature has been variable and eventful, and has always been intimately connected with the history of surgery, ever constituting a reliable barometer indicating the status, the rise and fall, in the art and science of surgery. Its use as a hæmostatic agent was not the result of reasoning or logical deduction, but was prompted by instinct. It was used and described long before the circulation of the blood was discovered. The discovery of the circulation, anatomico-pathological investigations, experimental researches, and clinical observations, have all been contributing in rescuing this invaluable agent from the dark domain of empiricism, and have secured for it a position as a remedial agent second to none in points of importance, reliability, and frequency of use.

The first account of the application of a ligature for the pur-

[1] In the preparation of this part of the paper I am greatly indebted to the following articles: W. Greifenberger, Historisch-kritische Darstellung der Lehre von den Unterbindung der Blutgefässe. Deutsche Zeitsch. f. Chir., vol. xvi. A. Adamkiewiez, Die mechanischen Blutstillungsmittel bei verletzen Arterien, von Paré bis auf die reneste Zeit. Archiv für Klin. Chir., vol. xiv.

pose of preventing hemorrhage is given by Sus'rutas, a disciple of the divine Dhavantari in his Ayur Vedas (1500 B. C.), who tied the umbilical cord in newly-born infants, with a string, eight inches from the navel previous to cutting it. A number of writers, among them Platner, Holtze, Langenbeck, and Fischer, allude to Hippocrates (460–377 B. C.) as the discoverer of the ligature. They base their opinion on the following passage from his works, translated into Latin by Fassius:[1] "Sanguinem e renis profluentem sistunt animi deliquium, figura aliorsum tendens, venæ interceptio, linamentum contortum, appositio, deligatio."

Archigenes (100 B. C.) made free use of the ligature after amputations. Celsus (30–25 B. C., 45–50 A. D.), in his works, refers to the ligature as a well-known remedy, and credits an obscure physician of the Alexandrian school with its discovery. Celsus used the ordinary linen thread, and gave particular indications for its use and manner of application. In speaking of the operation for hydrocele, he says:[2] "Nervus, ex quo testiculus dependet, præcidendus; post id venæ et arteriæ ad inguen *lino deligandæ* et infra vinculum abscindendæ sunt."

Galen (131–211 A. D.), although no practical surgeon himself, yet familiar with the literature of that day, frequently mentions the ligature, and gives particular directions to apply it to the proximal end of the bleeding vessel. For ligature material he advises silk and fine catgut. The definite closure of the vessel he attributed to the action of the tissues surrounding it, as is evident from the following quotation:[3] "Quæ namque caso in abscisis vasorum partibus coalescit, ea pro opercula est ac osculum eorum claudit." The name of Antyllus (350 A. D.) occupies such a prominent position in vessel surgery, and his method of procedure in cases of aneurism is so familiar to every student in surgery, that more than a simple allusion to his name would appear superfluous.

[1] Hippocratis medicorum omnium facile principis opera omnia quæ exstant. Frankf. ii. p. 1194.

[2] Aul. Corn. Celsi de medicina libri octo, quos ad Leon. Targæ recens, de J. H. Waldeck, Münster, 1827, p. 150.

[3] Claudii Galeni opera omnia. C. G. Kühn, Lipsiæ, 1827, T. x. L. iii. cap. xxii. p. 941.

Paulus Ægineta (625–690, A. D.) treats extensively of the ligature, quoting freely from the writings of Celsus and Galen. In practising ligation of vessels as a therapeutical measure in diverse affections he passed two ligatures beneath the vessel with the aid of a needle, cut the vessel between them, and, after permitting the requisite amount of blood to escape, closed each end of the vessel separately. Rhazes (850–922, A. D.) mentions, as a last resort to arrest hemorrhage from large vessels, the ligature which he made of strong linen thread.

The prolific writer, Avicenna (980–1037, A. D.), disposes of the subject of ligation of vessels briefly thus:[1] "Quod si (sc. vena) fuerit pulsatilis, tum melius est ut veles eam cum filio lini, et similiter si fuerit ron pulsatilis, verum tamen multoties elevatur sanguis ejus." Aneurisms he treated in accordance with the teachings of Antyllus. He limits ligation to arteries, believing that bleeding from veins is arrested spontaneously or yields to the use of the customary styptics.

Avenzoar (1113–1162 or 1196, A. D.) and Averroes (1198) were familiar with the ligature. The latter, in his commentaries on the writings of Avicenna, directs that in performing arteriotomy the vessel should be surrounded by two ligatures before it is divided.

Roland (1252), a pupil of Roger, of Parma (1214), again mentions the use of the needle in applying the ligature, a practice followed by most of the prominent Italian surgeons at that time.

Bruno, of Castel Longobrugo (1252), pointed out the difference between arterial and venous hemorrhage, and gave the advice, in case the bleeding could not be arrested by any other means, to seize the artery or vein with a small hook and carry a thread with a needle around the vessel and tie it firmly.

Guy de Chauliac (1300–1363, A. D.) prefers the ligature when the artery is deeply seated, in which case it is well brought into view, and that end is firmly tied which is placed towards the heart or liver.

[1] Avicennæ Arabum medicorum principis Canon medicinæ, ex Gerardi Cremonensis versione per Fabium Paulinum Utinensem. Venetiis apud Juntas. 1595, Lib. iv. Tract. II. cap. 17.