Remarks

OS

THE TREATMENT OF GANGRENE.*

BY

W. SAMPSON HANDLEY, M.S., F.R.C.S.,
Surgeon to the Middlesex Hospital.

FROM the fact that Professor Leriche was originally asked to open this discussion, and that, failing him, I have been asked to do so, I gather that the interest of the occasion is expected to centre on the more recent methods of vasomotor surgery in relation to gangrene. I may be absolved, therefore, in opening the discussion, from attempting a general survey of the whole subject, and my remarks must not be taken as limiting the scope of the subsequent discussion.

A word of gratitude to the physicians is appropriate, and especially to Dr. Banting, for the gift of insulin, which has entirely changed the outlook in cases of amputation for diabetic gangrene and in other operations upon diabetics. In such cases the co-operation of a physician is now essential, and when the urine has been rendered sugar-free by insulin the surgeon can intervene almost as confidently as in the non-diabetic; such at any rate is my experience.

Vasomotor Surgery of Gangrene.

The surgery of the sympathetic owes its modern developments to the observation of Claude Bernard that section of the cervical sympathetic causes dilatation of the vessels of the head and dilatation of the pupil on the side of the operation. Waller showed that stimulation of the peripheral or upper end caused constriction of the vessels and contraction of the pupil. Thus the motor action of the sympathetic upon unstriated muscle was clearly demonstrated, and the surgeon was presented with the key of the arterial sluices, and given the power of flooding areas of low nutrition with reviving blood.

At first the attack was made chiefly on the main sympathetic chain, or upon the nerves passing to this chain from the special nerves—a dangerous, difficult, and uncertain field of surgical work.

Jaboulay and Leriche transferred their attention to the peripheral parts of the sympathetic nerves which, as Jaboulay knew in 1896, run along the main arteries of the limbs on their way to the arterioles.

Though the modern surgery of the sympathetic is mainly a French structure, there are embedded in its foundations some forgotten stones of British origin. I find that John Hunter did an experimental decortication of a dog's artery to find whether defect or injury of the external coat will produce an aneurysm. Hunter says:

"I dissected the carotid artery of a dog, taking off carefully the external coat until I could almost see the blood through the internal one; I then left the dog and his artery to themselves, at the end of three weeks killed the dog, when I found the surrounding parts had consolidated themselves to the artery, rendering it stronger in this part than it was before."

Lord Lister showed in 1858 that the destruction of the posterior half of the spinal cord in the frog produced permanent paralysis of the arteries of the hind limb. Preservation of any segment, however small, of the posterior half of the cord allowed the arteries to recover their tone. He also showed that even after division of all the soft parts of the hind limb except the main artery and vein, the arteries of the distal portion, after initial paralysis, soon recovered their contractile power. The

nerve filaments concerned must, as Lister pointed out, run along the main artery or vein, or, less probably, through the bone.

I wrote to the late Professor Bayliss and drew his attention to Lister's crucial experiment showing that the vasomotor nerve supply ran along the main blood vessels. He replied saying that the recovery of tone in Lister's experiment, where, as you remember, all the soft parts were divided except the main artery and vein, might be ascribed to a natural tendency on the part of unstriated muscle removed from nervous control to go into spasm. This interpretation is negatived; it seems to me, by Lister's other experiment showing *permanent* loss of vascular control in the hind limb after destruction of the posterior half of the spinal cord. In my opinion Lister's experiments demonstrate that nerve fibres running along the main vessels are an essential factor in the vasomotor control of the arterioles of the limbs, and vasomotor surgery has thus an experimental basis.

Jaboulay, about 1906, endeavoured to produce vasodilatation of the foot in perforating ulcer by denuding the femoral artery and tearing away the small nerve twigs which, in the region operated upon, were found passing to the artery from adjacent nerves. Leriche, in order to interrupt more completely the sympathetic filaments, removed the outer coat of the artery for a considerable length—a true decortication of the artery, such as Hunter had experimentally practised—and he called this operation sympathectomy. To avoid confusion it is best to describe Leriche's operation as arterial sympathectomy.

Leriche thus describes his operation:

"The technique is to isolate the artery on [? for] 8 to 10 cm., to fix the vascular sheath after dividing, to hold one part with a forceps and dissect off the cellular tissue either with knife or cannula round until there has been effected complete denudation of the vessel, which becomes greatly reduced in size. This brings no injury to the arterial wall. I verified this fact twice at four and eight months' interval."

Leriche has had successes from sympathectomy in the following conditions: (1) causalgia after war wounds; (2) certain painful crises preceding gangrene caused by obliterative endarteritis; (3) "painful acroparaesthetic syndromes consecutive to bruise of finger, to wounds of hand, palm, or foot-sole"; (4) in Raynaud's disease; (5) sometimes in cases of painful stump; (6) in muscular spasm secondary to war wounds; (7) in trophoedema; (8) in trophic ulcers, but here the result may be temporary.

Effects of Leriche's Operation.

Leriche finds that as soon as the adventitia is pinched a contraction of the vessel occurs, its pulsation stops, and its size diminishes. If the cellular layer (presumably the tunica adventitia) is actually excised, the artery shrinks still more, to one-third or one-fourth only of its normal size. The contraction affects only that portion of the artery which is injured by the operation. It usually causes the pulse to disappear, but does not altogether interrupt the circulation. For some hours pulsation is imperceptible or feeble and the limb is colder than its fellow by 3 or 4 degrees Centigrade—a very serious consideration in cases of actual or threatened gangrene. After three to fifteen hours entirely different symptoms supervene—namely, (1) an elevation of local temperature, amounting to 2 or 3 degrees in the affected limb, accompanied by a subjective sensation of heat; (2) an elevation of arterial pressure up to 4 mg. in the affected limb as compared with the opposite limb; (3) an increased amplitude of the pulse, as shown by sphygmographic tracings.

It is important to notice that after periarterial sympathectomy this vaso-dilator reaction is transitory. It diminishes about the fifth or sixth day and disappears in three to four weeks.

* Made in opening a discussion in the Section of Surgery at the Annual Meeting of the British Medical Association, Cardiff, 1928.

It will be noted that Leriche does not recommend his operation for actual senile gangrene, and Matthey-Cornat gives as definite contraindications for sympathectomy (a) the circulatory insufficiencies of generalized senile arteriosclerosis, with or without gangrene; (b) arterial thrombosis and obliterations. He points out the danger, in gangrenous or pre-gangrenous conditions, of the ischaemic period of lowered circulation which follows Leriche's operation and the risk of attempting decortication on an atheromatous artery. Matthey-Cornat devotes special chapters to the dangers and accidents of sympathectomy, with 6 deaths and 40 accidents in 500 cases. Among the accidents are rupture of venous plexuses, tearing off branches of the artery, wounds or lateral perforation of the artery, sometimes necessitating ligation of the vessel, total rupture of the artery, secondary haemorrhage, thrombosis of the artery, and replacement of dry gangrene by rapidly spreading moist gangrene.

Leriche, on the other hand, holds that sympathectomy may render durable service in senile arteritis if used with discretion. He thinks it indicated in the severe premonitory pains of gangrene except when there are attacks of "paradoxical" vaso-dilatation with heat of the foot. The operative outlook is, however, poorer in presence of habitual cyanosis, diffuse oedema, or neuritic pains than when the attacks are of vaso-constrictor type. Tissue infections contraindicate the operation. For incipient gangrene it is indicated if examination shows that the arteries are still dilatable. If they appear obliterated the operation is only justifiable to prepare the way for a low amputation close to the gangrenous area. Sympathectomy, he thinks, is useless for intermittent claudication upon present evidence. If, upon exposure, the artery is found friable and "malacique" he recommends my method of alcohol injection. If it is transformed into a hard impermeable cord the artery should be resected to interrupt the sympathetic fibres. For the gangrene of young subjects he places more hope for the future in internal secretion therapeutics than in surgical measures, which can only have a temporary effect.

Leriche suggests that in order to minimize the risk of gangrene in cases where the main artery of a limb has to be ligatured, as for aneurysm, the artery instead of being simply tied should be divided between two ligatures. He states that whereas simple ligation is followed by dangerous vaso-constriction lasting some hours, resection of the artery produces immediate and lasting vaso-dilatation. No doubt the same effect could be obtained by a combination of alcohol injection with simple ligation.

I must now call your attention to the method of alcohol injection, which I believe to be a definite advance upon Leriche's operation. I claim for it that it is able in certain cases to avert threatened gangrene or to arrest the spread of senile gangrene already present and to avert the necessity of amputation. In other cases it permits a low amputation to be used instead of a high one.

The technique of periarterial injection is not difficult, though it requires care and delicacy. The femoral artery in Hunter's canal is exposed as for ligation for a length of one or two inches. With the finest obtainable hypodermic needle 2 to 3 minims of alcohol are injected at four points spaced out round the calibre of the artery. The needle is introduced obliquely and nearly parallel with the length of the artery. The artery may be partially rotated to make the posterior injections. On one occasion I punctured the artery and injected alcohol into its lumen. This was shown by bleeding on withdrawal of the needle. The puncture sealed under sponge pressure and no ill effect followed. When the injection is complete a whitish band, perhaps half an inch wide, should be seen round the artery, but no constriction takes place. The wound is closed.

Effects of Alcohol Injection.

In successful cases the vaso-dilatation produced by alcohol injection is immediate. There is no initial period of vaso-constriction with slackness or absence of the distal pulse lasting for some hours, such as follows sympathectomy. The cold foot may become obviously warmer than the

sound one even before the patient is out of the operating theatre. This fact alone, especially in cases of threatened gangrene, gives the method a decisive advantage over sympathectomy. But this is not the only advantage. Whereas the effect of sympathectomy, according to Leriche, passes off within about five weeks the vaso-dilatation following alcohol injection may last for a year or more. These clinical differences may be connected with the absence in alcohol injection of the local contraction of the artery seen in sympathectomy.

Criticisms.

The method of alcohol injection is open to many criticisms. It is admittedly uncertain in its results. Sometimes no alteration in the circulation or surface temperature of the limb can be detected. It appears probable, that there are anatomical differences in the distribution of the vasomotor nerves, and that while they sometimes join the artery high up so that they are amenable to alcohol injection of the femoral, in other cases they join it below the level of the injection. In senile cases organic changes of the artery may have made such progress that the muscular mechanism of the vessels may be entirely functionless or the main arteries may be thrombosed. It is to be specially noted, however, that some cases with advanced organic changes in the vessels, and no pulse to be felt in the limb, may nevertheless be strikingly benefited. Moreover, in thrombosis of the main artery the operation may assist in opening up the collateral circulation. But it must be admitted that it is at present impossible to make a proper selection of cases.

What are the indications for alcohol injection? They are not yet defined, and a process which appears to be so safe lends itself to the method of trial. My experience would lead me to recommend it strongly in cases of threatened or incipient senile gangrene of a lower limb. It should, if possible, be applied in the prodromal stage, where severe pain and pallor and coldness of the foot are the principal symptoms, and before actual gangrene has occurred. Extensive gangrene reaching to the leg is a contraindication unless alcohol injection is followed by an immediate low amputation, since, as I have shown, the increased blood supply may lead to fatal toxic absorption. If the foot above the dead area is congested, and warmer than the sound foot, the operation is contraindicated. In such cases there is probably a septic infection of the tissues, associated with already existing vaso-dilatation.

Alcohol injection appears to be useless in Buerger's disease, and of doubtful value in Raynaud's disease. I have not yet tried it for chronic or perforating ulcer of the foot or for painful or ulcerated stumps.

In conclusion I would say that the surgery of the sympathetic is yet in its infancy, and that it requires for its development a further study of the sympathetic system by anatomists and physiologists and of arterial disease by the pathologists. Many obscurities still remain. Leriche's operation has been justified by a number of brilliant successes in other conditions. Leriche himself does not recommend it for incipient or actual gangrene. Though some surgeons continue to use it for actual or threatened gangrene, I believe that it will be replaced by the method of alcohol injection, which secures the same result in a simpler and safer way without risk to the integrity of the artery, without initial vaso-constriction, and with more permanent vaso-dilatation. For these reasons I think alcohol injection is not a mere technical variation of Leriche's method, but a distinct advance upon it, and that, particularly in senile gangrene, it is the vasomotor operation of choice.

While vasomotor methods can be applied successfully in the early stage of gangrene to limit its spread and to restore the vitality of dying tissue, they find their main field of application in an earlier stage before gangrene has actually begun. A serious additional responsibility is thus placed upon the medical man to whom complaint is first made of symptoms of arterial dystrophy likely to end in gangrene. Upon him it devolves to allow vasomotor surgery a fair field for its attempts to avert the loss of a limb.