ARterial Dercortication

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In 1918, Professor Halsted interested me in what was then the comparatively recent work on perivascular surgery, reported by René Leriche, of Lyons, France. An interesting observation on surface temperature, which bore definite relationship with certain features of interest in Leriche's work, was made at that time in the Surgical Clinic of the Johns Hopkins University.

The following are extracts from Doctor Halsted’s reported case, in which he ligated the left subclavian and carotid arteries near their origin from the aorta, for the cure of a huge, left subclavian aneurism. Two years after this proximal ligation, the aneurism developed a pulsation and grew larger, at which time the patient reentered the hospital and had it excised. The point of interest to this discussion is the fact that several hours after the excision of the aneurism it was noted that the left hand and forearm, which for the preceding two years had been strikingly cold, had now become abnormally warm, appreciably warmer than the corresponding limb on the sound side; and it was further noticed that the hand remained warm for several weeks after the operation. This rise in surface temperature over that portion of a limb distal to the complete removal of a segment of artery is one of the interesting phenomena which Leriche reports as following his operation of arterial decortication. This hyperthermia he attributes to the vasodilation which, he says, accompanies removal of the sympathetic nerve plexuses about an artery. Any excision of an aneurism would necessitate, of course, the complete removal of these fibres, if such be present.

In a long series of papers, Leriche has called attention to sympathetic nerve plexuses which are said to lie in the intimate sheath of the large arteries and in the adventitia of these vessels, and he specifies that certain definite results follow the excision of these structures in the treatment of different syndromes. The surgical removal of these structures, an operation called by him "Sympathectomy," was conceived, proposed and accomplished in 1889 by his teacher, Jaboulay, who performed it with curative results on the femoral artery in certain perforating ulcers of the foot, and to a less successful degree, on the celiac trunks in certain visceral disturbances, the nature of which has not been ascertained. Before considering the rôle which the sympathetic fibres are said to play in these clinical pictures, we will enumerate the steps in the operative procedure.

Technic of the Operation

Leriche has designated his operation as an "Arterial Sympathectomy," according to the arterial level at which it is performed, axillary, brachial, iliac, or femoral. The main arterial trunk is exposed by the classic route of
access a considerable distance proximal to the part affected. Thus the brachial artery is the operative site of election for disturbances in the fore-arm and hand, and the common or superficial femoral arteries for lesions in the foot or leg.

The external fibrous sheath covering the artery is incised for a distance of eight to ten centimetres, and the artery, with its inner, more intimate sheath and its adventitia, is now exposed. This inner sheath, which is fused with the adventitia of the artery, is grasped with tissue forceps and is incised directly on the vessel wall. Traction is maintained on one of the lips of the sheath of filmy tissue thus isolated, and this structure is completely freed from the artery over the length of the incision with a knife or fine scissors. The artery is in this manner stripped of its external coat, together with the fibrous tissue which is adherent to it.

Occasionally, one is able to remove only small cellular fragments of this external layer, but at other times definite laminae may be dissected away. Leriche lays much stress on the complete removal of the thin meshes of loose tissue which adhere to the body of the artery, and the thoroughness of the removal of these strands is seen when the artery is gently swabbed with a moist gauze. With the artery thus moistened, it assumes a whitish, felt-like appearance, and the more or less detached débris, which clings to it, is easily seen. This arterial decortication is continued until the main body of the artery appears as a smooth homogeneous surface.

In the course of the operation, one is required to expose any collateral branches present in order to guard against their injury. Should these require ligation, we have found it prudent to ligate them at some little distance from the parent trunk in order that the decortication be completed without stripping these ligatures. In several of the cases here reported, the exposure of the operative field and the ease and safety of manipulation have been facilitated by grossly freeing the chosen segment of artery from the neighboring structures over the requisite distance, cutting the collaterals where necessary, and leaving the artery and its intimate sheath for the time being intact. A sheet of rubber tissue may then be drawn under the artery from side to side and clamped to the four corners of the wound, after which the more minute dissection of the artery is completed. Certain objective reactions in the hands of Leriche and his compatriots have been found to follow and be consequent upon this procedure.

POST-OPERATIVE OBJECTIVE REACTIONS

1. Reaction of Visible Arterial Contraction 37.—As an immediate consequence of the denudation of the artery, a diminution in its calibre takes place until it has progressively reduced in size during the operation to that of a small, whitish cord, reminding one of a nerve trunk. In our series of ten decortications, five on the femoral and five on the brachial arteries, we were able to verify this and Leriche's further observation that the arteries of larger calibre were much slower in their contraction than the smaller. We
found indeed that the femoral artery was rarely much reduced in calibre. In two of these femoral cases no contraction whatever in the artery took place.

In the decortication of the brachial arteries only did we notice that pulsation could be neither seen nor felt as the operation progressed, a fact due to the local constriction of the vessels in the operative field. In two instances, the pulsations disappeared over the distal portion of the artery, while it could still be made out in the proximal area. Toward the end of three of the operations on the brachial artery, pulsation was seen to reappear.

2. Reaction of Vasodilation with Hyperthermia. — Whereas Leriche constantly found a post-operative increase in surface temperature over those parts distal to the decortication, we were able to ascertain this in but one patient. He stated that this increase in temperature was at times noted on the evening of the operation, more often on the following morning, but usually occurred thirty-six hours after the operation, and marked the onset of the reaction of vasodilation.

In most of the instances recorded by Leriche, the local hyperthermia disappeared about the fifteenth day after the operation, a fact which illustrates the transitory character of the reaction. In connection with this previously mentioned case of Professor Halsted may be mentioned a patient in whom a quadruple ligation and excision of the sac was performed for the cure of an arteriovenous aneurism of the axillary artery. The forearm and hand of this patient were much warmer four months after the operation than those on the sound side.

Lesions, other than those mentioned, may result in an elevation of surface temperature. This may occur in the upper extremity following injury to the median and ulnar nerves, and it is probable that such lesions injure the sympathetic fibres which course in the nerves and which are destined for the skin capillaries. Vincent has observed hyperthermia in the arm of a soldier, who was injured in the axilla and who presented signs of lesion of the median and ulnar nerves, and in whom, at operation, was discovered injury to the brachial plexus. Gorodiche reports a patient with hyperthermia of the forearm and hand, who was wounded in the inner aspect of the upper arm ten weeks before, and who showed symptoms of injury to the median nerve. This hyperthermia definitely exceeded the boundary of the sensory field of this nerve.

3. Reaction of Increased Peripheral Blood-pressure. — Leriche reports a constant post-operative rise in the systolic pressure distal to the point of operation, but we have been unable in any of our cases to verify this observation. He has found an increase of as much as 40 mm. of mercury, and states that the maximum elevation of pressure is reached on the second or third day. This local hypertension becomes attenuated in the days that follow, until it is completely dissipated about the same time as in the excess surface temperature. His estimation of diastolic pressure showed no pronounced variation. His observations were made with a Pachon oscillometer.
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and his readings were taken at the malleoli and at the wrists, where the dressings interposed no variation.

Claude Bernard 7 suspected that the greater accumulation of blood in a part would lead to hyperthermia resulting in an increase in blood-pressure. In order to study the action of the sympathetic fibres going to the head, he conceived a method of differential mercury manometry, and was able to indicate by a simple difference in mercury level all modifications of pressure in two symmetrical arteries of the face. He made his experiment upon a horse, and his manometer consisted essentially of a U-tube with branches partially filled with mercury. One end of this instrument was joined by a tube to the right labial artery and the other to the left. Under normal conditions the manometer was at rest and the mercury remained at the same level in both limbs. When, however, the cervical sympathetic chain on one side was cut, the pressure in the manometer on that side rose, and the difference in pressure between the two sides in five experiments measured respectively, 40, 60, 60, 31 and 25 mm. of mercury. It may be worthy of note to here mention the fact that upon galvanization of the distal cut end of the cervical sympathetic, the distal, as well as the proximal portion of the cut artery, contracted. This is definite proof that the vasoconstrictor fibres of the sympathetic system in the head do not travel along the artery, but reach it at different levels.

This local hypertension is based by Leriche on the theory that the vasodilation, which accompanies the decortication, permits a greater quantity of blood to be propagated to the periphery, and this increased flow results in an increased head of pressure.

THEORY OF MODES OF INJURY TO THE SYMPATHETIC FIBRES

Trauma of some sort to the sympathetic fibres is claimed to be the causative factor in the clinical condition which Leriche relieved by this operation. According to him, the fundamental trouble is a disturbance in the vasomotor innervation, with a resulting vasoconstriction forming the basis for the syndromes. His basic assumption is that sympathetic vasomotor fibres course along and ramify in the periarterial nerve plexuses of the extremities. He designates three possible varieties of trauma which result in the disturbance of the vasomotor balance of the extremities, and are the cause of certain definite clinical pictures.

The mechanism of the first mode of injury assumes trauma to the afferent spinal nerve fibres in the tissue of the extremities not necessarily in the immediate vicinity of the vessels or nerves. Traumatic excitation of these sensory fibres conveys impulses which travel to the ganglionic and medullary centres, which cause a reflex vasoconstriction of perhaps the whole extremity. On the basis of this traumatic reflex vasoconstriction, he explains a case in whom there was a definite pre-operative hypothermia proximal to the level of the area traumatized. This patient was injured in the lower third of the superficial femoral artery, but the lowering of the surface temperature was noted as high as the gluteal region.

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In the second variety of trauma, he states that vasoconstriction in a distal part may arise, not by reflex action, but by direct injury to the efferent sympathetic fibres, which are said to lace the arteries with a periarterial network. When these are traumatically irritated but not destroyed, they overact and convey stronger impulses to the periphery than normal, a phenomenon which results in increasing the vascular tone to the point of vasoconstriction, resulting in hypothermia.

He theorizes still further on another variety of injury to the efferent sympathetic fibres in these arterial plexuses, which is destructive in its nature. This destruction of the vasoconstrictive element, which he thinks preponderates, results in a paralytic vasodilation and hyperthermia. It is by this third mode of injury that Leriche would explain the hyperthermia that followed the excision of the subclavian aneurism in Doctor Halsted’s patient, since the efferent fibres accompanying the artery were of necessity sacrificed when that portion of the artery containing the aneurism was resected. The vasoconstrictor element is the more prominent in the first two types of lesion, resulting in hypothermia, and the vasodilator element preponderates in the third variety, with a consequent increase in surface temperature. This complex vasomotor situation, however, may be further complicated by the reduced quantity of blood going to the extremity as the result of partial or complete obliteration of the artery, as well as by the consequences of immobilization of any muscles which may be paralyzed. Thus it may readily be seen from the imagined variety of lesions and the amount of possible injury to the artery and nerve, that there may result all gradations from hypothermia to hyperthermia. In cases of decreased, as well as those of increased surface temperature, however, it is noted that there has been a tendency for the normal thermal equilibrium to become established, and Leriche thinks that this restoration of vasomotor balance is brought about by a reestablishment of the sympathetic nerve continuity by means of the plexuses on the collateral arteries.

In all of the patients for whom he claims relief, he has noted, before the operation, a hypothermia of the affected extremity, which he explains on the basis of a traumatic vasoconstriction. The fundamental point in his therapy is the restoration of vasomotor balance in the part. This restoration he claims to accomplish by excising normal sympathetic fibres from the parent artery of the affected extremity at a point proximal to the lesion.

CLINICAL PICTURES OF THE DISORDERS CURED BY LERICHE

We cannot compare our results with those of Leriche, since none of our cases correspond to those in whom he obtained such spectacular cures. In his hands the operation was successful in a number of unassociated clinical pictures of a rather vague description, but which he considers have in common a disturbed vasomotor balance.

1. Traumatic Disorders of Babinski-Froment Type—The clinical picture described by these men develops after minor injury to the limbs
involving only the soft parts, and the severity of the lesion is not at all proportional to the intensity of the symptoms. Clinically, the disease is described as presenting a definite syndrome which includes contractures and pareses, which develop almost immediately after traumatism.

The motor changes are accompanied by none of the objective signs characteristic of typical organic affections, such as follow lesions of the central nervous system or large vessels. They resemble in many features manifestations of hysteria and one who has not seen but has merely studied reports of this condition, is forced to note this similarity. Unlike hysterical phenomena, however, these patients resist counter-suggestion.

In addition to contractures and pareses, the complete picture may present muscular atrophy, exaggeration of the knee-jerks, and changes in the cutaneous reflexes, together with disturbances in objective and subjective sensibility. Vasomotor, secretory and trophic disturbances are noted in the bones, skin, hair and nails. French neurologists admit that its pathogenesis is still unsettled, but claim that these disorders, whatever names they may receive, constitute a special group, half-way, as it were, between organic affections on the one hand, and hysterical phenomena on the other.

Leriche considers that these symptoms arise from injury in the depths of the tissue, to the sensory and motor terminals as well as the sympathetic fibres, and that from such injury there may result an infinity of small nerve lesions which reflexly result in the vasoconstriction responsible for the condition.

2. Causalgia of Weir Mitchell. Another rare but well-recognized clinical picture, which has yielded to arterial decortication in Leriche's hands, is the causalgia of Weir Mitchell. This syndrome in essence is a painful form of neuritis of the median nerve and described by him during the Civil War and called "Causalgia," from the Greek, meaning "I burn." Its causative factor is trauma and the predominant symptom is pain. In this clinical picture the elbow is flexed, the wrist slightly radially curved, and the hand raised with the fingers extended, with occasional hyperextension of the terminal phalanges. The hand is emaciated and atrophied, making the fingers thin and tapering. Motor disturbances are usually slight and total paralyses are consequently few, although slight weakness in movement is sometimes made out.

The subjective sensory disturbances are the most distressing symptoms, and paroxysms of pain usually occur a few days after the wound is inflicted. This pain is moderate in intensity in the early stages of the disease, but progressively increases. The patient refers it to a semicircle extending from the root of the thumb to the root of the index or middle finger, and it reaches its height four or five months after injury, when it very slowly diminishes in severity.

In considering the mechanism of causalgia, it is probable that we are dealing with trauma to the fibres of the sympathetic system which accompany the median nerve, and which supply the glands, capillaries, and nerve endings
of the different layers of the skin. It has been suggested also, that the symptoms may be the result of injury to the nutrient artery of the median nerve, together with lesion of the sensory fibres in this trunk. Complete cures of this condition have followed decortication of the brachial artery.

3. Results of Excision of Obliterated Arterial Segments.—In limbs affected by arterial obliteration due to trauma, a variety of vasomotor, motor and sensory disturbances ensued. At operation is found an impermeable fibrous cord, or the remains of scar tissue, in which the artery cannot be recognized. With the removal of this obliterated segment, however, Leriche has noted marked improvement in these cases, and he concludes from this fact that the fibrous cord of an artery is not an indifferent structure, but is a real nerve, whose functions, due to injury to the perivascular nerves, have become perverted.

4. Spontaneous Ulcers in Amputation Stumps.—Certain ulcers which occur in amputation stumps over areas where there is no pressure, and which are definitely not caused by infection, are very refractory in their treatment. In this condition the affected stump is cold and edematous, and any granulations present are very friable. The lesion begins as a vesicle, which later bursts and becomes an ulcer. It shows no tendency to heal but continues unimproved over months and renders the use of apparatus impossible. According to Leriche, after decortication of the femoral artery, several of these ulcers have closed promptly, and their scars have remained resistant enough to bear the use of apparatus.

**FUNDAMENTAL DETAILS OF THE AUTONOMIC NERVOUS SYSTEM**

Since Leriche states that both the mechanism of production of these lesions and that of their cure rest upon the involvement of the sympathetic fibres, it is fitting that we review the fundamental physiologic and anatomic bases governing these fibres before we go further.

As there has been much loose teaching and writing concerning the autonomic nervous system, of which the sympathetic division is but a part, and as there is some controversy about the paths along which the fibres of this division run, a portion of this paper will be devoted to considering our present knowledge on that subject. No apology need be made for summarizing Langley's admirable survey of the subject, since the facts which have accumulated are so numerous that it is imperative to try to coordinate them, and since results published on trivial evidence and faulty premise serve but to obscure the issue when no general scheme is borne in mind.

The autonomic nervous system includes the motor nerves which control the activity of the unstriated and cardiac muscle tissue and all glandular structure, and its several divisions take their origin from separated portions of the central nervous system. All of these efferent autonomic fibres leave the spinal cord in four regions, each of which is separated from the other by areas in the brain and cord, from which no autonomic fibres pass. Since the mid-brain, bulbar, and sacral autonomic divisions have no connection with
the sympathetic autonomic fibres which supply the extremities, we will confine our attention to the sympathetic section of this great system. The cord cells of the sympathetic autonomic division lie in that portion of the spinal cord from the first thoracic to the second or third lumbar segments, inclusive; and it is with the fibres of this division that we are especially concerned in this paper.

To properly appreciate the peripheral course of the sympathetic fibres, we must be familiar with the nerve unit of the sympathetic division. In common with the other divisions of the autonomic system, this unit consists of a central and a peripheral neuron. The central of these neurons for any given segment has its nerve cell in that segment of the cord, and this cell sends out its axon from the cord by way of the anterior root of the corresponding spinal nerve. This axon is a medullated nerve fibre and outside of the cord it emerges from the anterior root to end in one of the ganglia of the sympathetic system, and is therefore called the pre-ganglionic fibre of that particular unit. This axon leaves the anterior root in company with other similar axons from similar cells in the same spinal segment, and they leave the anterior root in a trunk which is called the "white communicating ramus." This ramus is white because this group of pre-ganglionic fibres are medullated.

The sympathetic ganglia, about which these pre-ganglionic fibres form connections, are essentially groups of nerve cells of the peripheral neurons, whose function it is to give off non-medullated axons, known as the post-ganglionic fibres. These fibres are grouped into trunks of fibres, each of which courses back to the root of the corresponding spinal nerve, and this trunk is known as the "gray communicating ramus," from the fact that the post-ganglionic fibres which are contained in it are non-medullated.

The sympathetic ganglia of the sympathetic division are divided into two groups, the paravertebral, or lateral sympathetic chain of ganglia, and the prevertebral, or the co-lateral system of ganglia. Since we are engaged in the study of those fibres which run to the extremities only, we are not concerned with the prevertebral ganglia, from which emanate fibres which run to the viscera. The common characteristic, then, of all of the lateral ganglia is that each of the nerve cells there contained sends its post-ganglionic fibre back to the cerebral spinal nerves to be therein distributed to the body wall and the extremities.

Course of the Sympathetic Fibres to the Skin of the Extremities.—From what has just been said, we know that the fibres which run to the skin of the extremities leave the lateral sympathetic chain by way of the gray, non-medullated, post-ganglionic fibres, and course to their destination via the spinal nerves. Thus these fibres are contained in the cutaneous branches of these nerves, and run with them to the skin, a fact of dominant interest in this discussion. It has been generally believed that some sympathetic fibres make their way to the periphery along the sheaths of the arteries, but definite proof that they follow the arteries has not been adduced.

Indeed, it is the opinion of physiologists that the course in the cutaneous
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nerves is the correct one. There is this point, however, to be borne in mind, that the sympathetic system does send fibres direct to the aorta, and that these appear to spread some distance down along the larger arteries. It is not unlikely that these nerve fibres cause some contraction in these vessels, and that in this way a modification of the blood supply to the skin and to the muscles may take place without any direct action on the peripheral vessels.

Course of the Sympathetic Fibres to the Skeletal Muscles.—Since we have seen that the gray rami, which run to the spinal nerves, contain sympathetic fibres which are destined for the innervation of the skin, we may expect that also in these gray rami go the fibres which supply the muscle, and that these muscular nerves send vasomotor fibres to the arteries in the muscle.

HISTORIES OF CASES OPERATED IN THIS SERIES

CASE I (Group I).—E. H., male, age thirty-eight years. Complaint: Pains in the left hand and right foot.

Present Illness and Local Condition.—The patient has suffered since boyhood from chilblains and numbness of the feet in winter. Six years ago the small toe of the right foot became gangrenous to the middle phalanx and the toe was amputated. Gangrene next affected the third toe on the right foot, and amputation followed. Later the leg was amputated at the ankle. Two years later all toes of the left foot became gangrenous and the foot was amputated at the tarso-metatarsal joint. After one year, the index finger of the left hand became gangrenous and was amputated. One year previous to admission in October, 1921, the stump of the left leg began to slough and the leg was amputated below the knee. Upon entering the hospital this stump was again affected and was amputated at the upper third of the thigh. The arteries in all extremities showed normal pulsation.

Operation.—Decortications of the right femoral and the left brachial arteries were performed in the effort to stop the ascending gangrene. Result: The gangrene in both operated extremities gradually progressed until his death one year later. No improvement.

CASE II (Group I).—P. O., male, age forty years. Complaint: Pain in both lower extremities, for the most part confined to the large toes; ulcerations on the mesial surface of both large toes and violent color changes in the foot.

Present Illness and Local Condition.—Four years ago the patient first noticed numbness and pain in both feet while on the march. A short time later two deep ulcerations occurred, one on the mesial surface of each great toe, and all attempts to heal these ulcers by hydrotherapeutic and orthopaedic measures were without avail. Peripheral arterial pulsation normal.

Operation.—Bilateral femoral decortication and left brachial decortication. Result: Marked improvement immediately followed the operation in the lower extremities, as evidenced by the disappearance of the disturbed color changes and the healing of the ulcers into scars. But these scars later broke down and the ulcerations reappeared. For some time an improvement was noted in the left hand and arm, but the pain soon reappeared and the condition is now as before the operation. No improvement.

CASE III (Group I).—E. D., female, age sixty-three. Complaint: Paroxysmal pain in fingers of left hand, radiating up left arm.

Present Illness and Local Condition.—Twenty years ago both hands were numb, blue and white at intervals, especially on cold mornings. The condition has gradually become worse in the last ten years, until a year before her admission to the hospital in August, 1921, the finger tips on the right hand, and a little later
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on the left, grew painful and tender, and small suppurating areas appeared beneath the nails of all fingers. The local points of suppuration of the middle fingers of both hands were followed by gangrene, resulting in self-amputation of the terminal phalanges of these fingers. Pulsation was normal in all extremities. About the stump of the left middle finger was a puffy, edematous area, with a ring of very pale skin adjacent to a distal gangrenous slough. The entire left hand was much more tender than the right.

Operation.—Typical decortication of the left brachial artery. Result: For some days after the operation the pain was diminished and the color changes in the skin were less marked. The pain, however, later became more severe and it was evident that the gangrene was spreading. For this reason the last three fingers of the left hand were amputated at the metacarpal-phalangeal joints, together with the terminal phalanx of the index finger. No improvement.

Case I (Group 2).—C. E., male, age sixty-three. Complaint: Pain and ulceration over the dorsal surface of the middle toe, left foot.

Present Illness and Local Condition.—The patient entered the hospital in May, 1921, suffering from cramp-like pains in the left calf muscles, followed by pains in the toes of the left foot. The onset occurred five months previously, when a small spot of ulceration was noted on the dorsal surface of the small toe of the left foot. This ulceration developed into a deep slough, from which a purulent discharge was noted. Arterial pulsation was not present at either ankle or foot.

Operation.—Decortication of the left superficial femoral artery was performed a month after admission. Result: Several weeks after the operation the gangrenous ulcerated area healed into a very hard, resistant scar, and this area has remained healthy for over a year. Marked improvement.

Case II (Group 2).—N. F., male, age sixty-seven. Complaint: Severe pain in the left leg.

Present Illness and Local Condition.—Two years ago patient noticed weakness in both legs, followed by intermittent, cramp-like pains on exercise, the pains extending from the foot into the thigh. In the last four months the pain was so severe as to render walking impossible. The left leg became violently hyperæmic, swollen and painful, especially in the dependent position. No arterial pulsations could be made out in either leg or below the bifurcation of the aorta. There was marked tenderness about the left knee, foot and ankle.

Operation.—Decortication of the left superficial femoral artery. Result: No improvement followed the operation and death occurred from ascending gangrene of the operated extremity. No improvement.

Case III (Group 2).—A. C., male, age thirty-six. Complaint: Gangrene of the left index finger.

Present Illness and Local Condition.—From 1917 to 1921, the patient suffered with lupus erythematosus of the face, and during the period from 1919 to 1921, he had several attacks of circumscribed œdema in various portions of the body, affecting nose, eyelids, cheeks and legs. The legs were very oedematous at the time of admission into the hospital in March, 1922. Several months ago circulatory disturbances were noted in the fingers of the left hand, terminating in gangrene of the index finger with beginning trophic changes in the middle finger. The whole hand, and particularly the areas about the affected portions, was very tender, and pulsation in the left wrist could be made out with difficulty.

Operation and Result.—Decortication of the left brachial artery was followed by no change in the condition. No improvement.

Case I (Group 3).—C. C. K., male, age thirty-five. Complaint: Excruciating pain over the palmar surface of the right thumb and base of the index finger.

Present Illness and Local Condition.—Patient suffered a slight bayonet wound in the elbow in 1918. Six months prior to admission to the hospital, in October,
1921, while working at the mechanic's trade, he gouged out a small segment of tissue from the radial aspect of the terminal phalax of the right thumb, in which injury the knife cut to the bone. Although the wound healed four weeks later, there followed a constant burning pain in the area above mentioned, which was accentuated when the arm was in the dependent position. Two weeks later the scar tissue was removed, but there was no improvement in the pain. Examination showed an indented area on the thumb where the scar was removed, with this area and base of the index finger exquisitely tender to the slightest pressure. Arterial pulsation was normal. No definite diagnosis could be made other than a pain causalgic in character.

Operation.—Decortication of the right brachial artery was performed. Result: The pain in the finger was almost entirely relieved on the day following operation and disappeared entirely two weeks later. At this time, however, he developed pain and tenderness over the bodies of the flexor muscles of the right forearm, which pain disappeared after a period of several months. Marked improvement.

DISCUSSION OF THE RESULTS

In this series ten arterial decortications were performed on six patients, on one of whom three arteries were decorticated for disease of three extremities, while on another the operation was performed on two arteries for trouble in two extremities. We have made no clean-cut diagnoses in these patients, but have chosen to place them into three groups. In group I, we have described those patients in whom the arterial changes at the time of operation were thought to be spasmodic in nature rather than obliteratorive, as evidenced by the presence of palpable, peripheral, arterial pulsation. In group 2 are mentioned those cases in whom an obliteratorive arteritis had seemed to play the predominant rôle, and where no arterial pulsation in the affected extremities was elicited. Group 3 is that of unaccounted-for pain, in which we have but one case.

In the first, or spastic group, Case I (E. H.) was operated upon with no beneficial result. In Case II (P. O.), no improvement can be recorded, since the violent skin discoloration and the sensation of cold in the diseased extremities have reappeared, and the ulcerations have returned. No improvement followed the operation in Case III (E. D.), in whom an amputation of several fingers had later to be resorted to.

In considering the second group of cases, in whose affected extremities no arterial pulsation could be elicited, one definite cure is reported, Case I (C. E.). Whereas for months this patient had an ulcerative gangrene of the dorsal surface of the middle toe of the left foot, several weeks following the operation the gangrene disappeared and the sloughing healed into a resistant scar, which has remained healthy over several months. In Case II (N. F.), no improvement followed the operation, and the patient later died from an ascending gangrene of the operated extremity. In Case III, no improvement followed the operation, and the gangrene remained as before intervention.

Case I, of group 3, was operated upon for an unaccounted-for pain in the thumb. Following the operation the pain disappeared, but for it was substituted another pain in the flexor group of muscles. This pain later likewise disappeared, and there has been no recurrence of the symptoms.
We wish to state here that we have operated upon no patients who exactly correspond in their diagnoses, or clinical pictures, to those treated so successfully by Doctor Leriche, and it would then appear illogical to pass hasty judgment on this operation from the results of the treatment of our series of cases.

There are, however, certain fundamental principles wherein we differ with Leriche. The conception of primary importance is the knowledge of the path of the vasomotor fibres to the extremities. One gains the conclusion, from careful study of his work, that he considers the majority, if not all, of the vasomotor fibres to the extremities follow the sheaths of, and lie in, the adventitia of the larger arteries. From what has been said concerning the path of these fibres, we see that anatomists and physiologists concur in the belief that they accompany and are embodied in the spinal nerves which run to these parts. If such be the case, the vasomotor sympathetic fibres must leave these spinal nerves at different levels in their course, and supply innervation to the arteries from point to point as this innervation is required. Hence, it is a gratuitous assumption, from the point of view of proven work, that these fibres run a course along the arteries, and that their continuity may be severed, irritated, or otherwise interfered with by a removal of a thin sheet of tissue about the sheath or adventitia. So far as physiologists can prove, the only sympathetic fibres which accompany the large arteries to their termination are those which run from the prevertebral ganglia to the thoracic and abdominal viscera. There now arises the natural question as to the proof that these sympathetic fibres are removed at the time of operation. Points of difficulty in the staining technic for the demonstration of these nerve fibres in the tissue thus removed from an artery, require that further work be done upon this subject. It is rather striking, also, that in our cases, save in one instance, we were unable to demonstrate any post-operative rise in blood-pressure, or increase in surface temperature.

We are, at this writing, forced to the conclusion that an insufficient number of observations of this operation has as yet been made. It is only by careful physiologic estimation of capillary,\(^1\) surface temperature\(^2\) and blood-pressure changes, that a correct conclusion is to be reached. In this discussion, however, we would not overlook the fact that great improvement in otherwise hopeless conditions, has resulted from this procedure, even though the mechanism of the production of the diseases and that of their cure is as yet unknown.

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