

## Original Communications.

### THE PHYSIOLOGY, PATHOLOGY, AND THERAPEUTICS OF THE MOTOR FUNCTIONS OF THE UTERUS.

By H. HANNOTTE VERNON, M.D., Physician to the Blenheim Dispensary; formerly Resident-Accoucheur to St. Mary's Hospital.

#### PART I.—PHYSIOLOGY.

A MORE perfect control over the motor functions of the uterus has appeared to me for some time past to be one of the leading necessities of obstetric medicine. This fact is undeniable; viz., that, in ninety-nine cases out of a hundred, the first and last clinical resource of the accoucheur is ergot of rye. And yet, as a matter of theoretical discourse, the great majority of those well versed in the practice of obstetrics, will refer now to one variety of inertia of the uterus, and now to another; and will, at the same time, admit the utility of various agents over and above the everlasting ergot. The true explanation of this curious anomaly has its origin possibly in the following circumstances:

1. In the want of a complete physiological analysis of labour.
2. In the want of any scientific analysis at all of the complicated pathological conditions which are grouped together under the idea of *inertia uteri*.
3. In the defect of an application of such physiological analysis as exists to the limited pathological teaching on this head; and the want of harmony between these two and a code of therapeutics; and
4. In a deficiency of research of late years in the direction of oxytocics.

Without pretending to do more than advance a very short way towards a more advantageous position for the practitioner of obstetrics, I would submit that the following remarks contain something additional to our present stock of ideas in three several directions; viz.

First. In a more complete analysis of the motor actions of the uterus than exists in any text-book extant.

Secondly. In an attempt to reduce the multitudinous varieties of *inertia uteri* into something like scientific order; and in an endeavour to expound the pathological states which underlie them.

Thirdly. In the addition to our obstetric armamentarium of at least two valuable oxytocics, and in an attempt to draw the connection which really exists between physiology, pathology, and therapeutics, somewhat closer as regards an important branch of the medical art.

A dry and laborious physiological inquiry into the nature of the motor endowments of the uterus is so uninviting, except as a key to aberrant forms of uterine action and their appropriate remedies, that I will endeavour to compress this portion of the subject into as small a space as possible. It is, however, absolutely necessary to follow the physiological analysis closely, because it will be made use of in the sequel. And, as general incitement to such a disquisition, it may be observed that it will be hardly possible to retain a firm grasp of so complex a subject without reducing our ideas to the categorical form given by a scientific arrangement.

The elements of uterine nervi-motor action are

- I. An arrangement of nervous fibres whose peripheral extremities are endowed with sensibility or irritability.
- II. An arrangement of nervous fibres capable of conveying, to certain nervous centres, the excitor stimuli applied to their extremities.
- III. Various nervous centres; either endowed with a power of *originating motor impulses*, or of *reflecting* impressions conveyed to them *in the form of motor impulses*.
- IV. An arrangement of nervous fibres, capable of transmitting the motor impulses, generated in the nervous centres, to an organ endowed with power of motion.
- V. A muscular apparatus, responding to various impulses, either generated in or reflected from various nervous centres; itself possessed, like all other muscular tissues, of an *irritability* of its own, and of a given *tonicity* and *cohesion*.

I. In speaking of an arrangement of nervous fibres, whose peripheral extremities are endowed with sensibility or irritability, as one of the elements of uterine nervi-motor action, and as an element distinct from the conducting apparatus,

although these peripheral parts are only the extremities of the fibres which constitute the conducting apparatus, some explanation is necessary. The reason why what at first sight may appear a trivial distinction is made, is this: that there are morbid states, either of the tissues in which the terminations of the incident fibres lie, or even of the terminations of the fibres themselves, which are quite separate and distinct from any morbid condition of the nerve fibres themselves. Thus, there may be an inflammatory condition of some portions of the uterine tissue, or of the membranes lining the uterus, or of the placenta; and then there is excessive irritability of the extremities of the incident nerve fibres, either of some of them or of all. In cases where the uterus is affected with a low grade of inflammation, whether circumscribed or not, irregular, painful, spasmodic, and almost incessant contraction of the uterus frequently occurs. Women who become pregnant while labouring under imperfectly resolved inflammations of the cervix uteri, whether attended by abrasion or ulceration or not, are generally the subjects of acute suffering during parturition. Such suffering depends upon excentric hyperæsthesia, and is quite distinct from exalted sensibility produced by irritations applied to the trunks of nerves, and still more widely different from that centric hyperæsthesia which depends upon morbid or too mobile conditions of the cerebro-spinal axis, or ganglionic centres. Again; it sometimes happens that the irritability of the peripheral terminations of the incident nerve fibres is *diminished*; and this is most conspicuous in cases where a dead fetus is retained in utero, up to or even beyond the natural term of gestation.\*

II. In like manner the second element of uterine nervi-motor action is a certain arrangement of conductors, or incident nerve fibres pertaining also to two different systems—the cerebro-spinal and the sympathetic. If exception is made of the mechanical influence of tumours, there appear to be very few causes which can interfere with the due performance of the functions of the excitor or incident nerves. At any rate, if any such causes exist they would seem to consist of molecular conditions, beyond our present means of investigation. Or it may be assumed, without any great violence being done to reason, that the nerves themselves, both excitor and motor, may partake of the general hyperæsthesia which affects certain subjects; or they may have a special exalted irritability of their own, by virtue of which impressions made upon or produced at their terminations and origins are multiplied or exalted. But for all practical purposes it may be pretty safely assumed, in the vast majority of cases, that the functions of the excitor and motor nerves, as mere conductors of impressions and impulses, are entire.

III. The third element of uterine nervi-motor action is a certain arrangement of nervous centres endowed with the property of *originating* motor impulses, or with a power of *reflecting* impressions *in the form of motor impulses* also. These nervous centres may be arranged under six heads.

1. The minute ganglia described by Dr. Robert Lee as spread with their branches like a web over the surface of the uterus. Whether such ganglia have any real existence, has, until lately, been matter of dispute; but all physiologists of repute are now agreed as to the correctness of Dr. Lee's observations. These ganglia belong to the sympathetic system, and are the analogues of the ganglia described by Remak as existing on the surface of the heart in connection with branches of the cardiac plexus of nerves.

2. The ganglia of the hypogastric plexus; and, by communication, the whole sympathetic system.

3. The spinal cord.

4. The great ganglia of the brain proper.

5. The hemispheres of the brain.

6. The cerebellum.

It will be endeavoured to indicate how each of these centres act in originating, conducting, or reflecting motor impulses, presently. In the mean time it must be premised that, in order to have a normal action of the uterus, these different nervous centres must have a certain degree of polarity or excitability. If their polarity is defective, there will be irregular contraction of the uterus, or *inertia uteri*; if it is excessive, there will be either irregular, or clonic, or excessive contraction of the uterus.

IV. The fourth element of uterine nervi-motor action is an arrangement of motor fibres, or conductors of motor impulses, issuing from nervous centres of two kinds; viz., either sym-

\* The peripheral arrangements of nerve pertain to either the cerebro-spinal or sympathetic systems.

pathetic or cerebro-spinal. The observations made as to the general integrity of the functions of the impression conducting nerves, apply also to those which conduct motor impulses.

V. The fifth element is a muscular organ containing the body to be expelled, acting "sponte sua," or consensually, or in a reflex manner; and various other muscles acting either in a reflex manner or consensually, or by direct volition. And the containing organ or uterus must be of a given quality as regards its muscular structure; that is to say, it must be of a certain tonic and firmness, and capable of responding to the stimuli conveyed to it by the nerves. Thus particular forms of debility (anæmia, albuminuria) are attended by feeble action of the uterus; in consequence of deterioration of its muscular structure; and women who have borne many children, especially if breeding be prolonged beyond the usual period of life, have generally flabby uteri.

Having analysed the parturient apparatus, and resolved it into its elementary parts, it will be desirable now to show in what manner these different elements act, either separately or in combination. It has been thought sufficient hitherto to reduce the nervous phenomena under two categories: 1st. Centric, or direct, action; and, 2ndly, Eccentric, or reflex, action. But this method of dealing with the subject, although perfectly correct, is hardly analytical enough. It makes each category contain such a multiplicity of different actions, that the mind does not readily appreciate nor easily recollect them. It is preferable rather to take each nervous centre by itself, and to inquire into its mode of action in originating motor impulses, and in conducting them; and into the way in which it reflects, transfers, or diffuses impressions conducted to it by the excitator nerves. I spoke of six different nervous centres or systems of centres concerned in the act of parturition; and I shall now refer to them more in detail, but still as briefly as possible.

1. The ganglia which are described by Dr. Lee as covering the uterus immediately underneath its peritoneal investment, seem to me to be worthy of separate consideration from the ganglia of the hypogastric plexus, and the sympathetic system of nerves generally. In the first place, they are transitory structures developed at a particular period, and for a special purpose, and destined to disappear when that period has passed away, and that purpose has been fulfilled.\* It is almost unnecessary to adduce *à priori* arguments to fortify Dr. Robert Lee's dissections; but if it were so, it might be asked why should the nervous elements of the uterine tissue be the only ones not undergoing evolution during pregnancy. From nuclei and spindle-shaped nucleated cells the muscular structure of the uterus is evolved; within the few short months which suffice for this enormous histological change, small twigs of artery are metamorphosed into trunks of considerable calibre, inconspicuous veins become huge reservoirs of blood, and the mucous membrane is converted into an organ of no small complexity. The second reason why I wish to fix attention more particularly on those sympathetic ganglia which lie in and upon the textures of the uterus, is the parallelism which obtains between them and the ganglia in and upon the heart, and the parallelism which obtains between some of the nervi-motor functions of the heart and uterus.

The experiments of Dr. Lee, Remak, Volkmann, and others, seem to have pretty clearly established that the ganglia contained in the substance of the heart are the nervous centres which originate and co-ordinate the motor impulses exciting it to contraction. It is unnecessary to go into the details of these experiments, further than to assist in showing that there are grounds for assigning to the uterine ganglia an analogous relation to the motor actions of the uterus. Thus—

a. The anatomical arrangement of the cardiac and uterine ganglia is very similar.

b. The heart and the uterus both act rhythmically, though in different degrees.

c. The contractions of the uterus, like those of the heart, travel over the organ in a definite manner, that part ceasing to contract first which first contracted.

d. The contractions of the uterus, like those of the heart, follow the application of a stimulus (applied directly to the organ) less rapidly than in the case of muscles supplied with nerves from the cerebro-spinal axis.

e. The heart and the uterus are not under the direct influence

\* It is, of course, not meant that these ganglia are evolved *de novo* during pregnancy; but that from dormant and extremely minute elements they rise into structures of first-rate importance in the uterine economy. In like manner it is not meant that they absolutely disappear after delivery, but that they undergo the same process of involution which the other tissues of the uterus affect.

of the will; but they act consensually with other muscles which are under the control of the will: and this is true of all muscles supplied by the sympathetic.

f. The contractions of the heart and uterus are not necessarily suspended by the destruction of that portion of the cerebro-spinal axis from which they derive cerebro-spinal nerve-fibres; and

g. The same is true if the nervous communication is cut off, the centre being left intact.

h. Neither is abortion a necessary consequence of destruction of that portion of the spinal column which is in direct relation to the uterus.

i. Parturition can be excited in cases of paraplegia.

j. The uterus, in pregnant animals, will contract rhythmically hours after death.

k. The development of the rhythmical action of the uterus is coterminous with the development of the ganglia spoken of. Although the uterus is capable of a certain amount of contraction in the non-pregnant state, such contraction is not rhythmical in its character, and, so far as is known, travels over the organ in no definite manner.

These arguments are not arranged in a very logical manner, but they will suffice to give a strong probability to the position claimed for the ganglia of the uterus. Hitherto the importance of these nervous centres (which might be called the brain of the uterus, in the same way as the solar plexus has been aptly called the brain of the stomach) has been very much overlooked. That prominence has not been given to those ganglia which are actually situated in and upon the textures of the uterus, and which are the product of the genetic evolution, which I think they possess. The irritability of muscular fibre in the human subject, apart from nervous connexions, is very small. It is true that portions of muscular fibre, separated from nerve and carefully cleaned, will contract upon the application of cold; but this contractility is an endowment common to other tissues, such as the yellow elastic, etc.; and hardly deserves to be called irritability. Again, the well known experiment of Valentin (who stimulated a muscle to contract by galvanic shocks conveyed through its nerves until it ceased to respond to the stimulus, and then produced fresh contractions by applying the stimulus directly to the muscle) is not worth very much; it only proves that, on the direct application of a powerful stimulus, a muscle will contract. It does not show that muscular fibre in the living subject habitually contracts, upon the application of a stimulus, by virtue of its own irritability. Physiological stimuli of sufficient intensity to provoke such action do not, in fact, exist; and, indeed, we have little or no knowledge of muscular action in the human subject, apart from nervous action also.

The following modes of action of the uterine ganglia are submitted:—

a. They act directly or centrally, originating a large share of the motor impulses which incite the uterus to contract; and more especially they preside over and determine the rhythmical nature of such contractions.

b. They reflect impressions conveyed to them, in the form of motor impulses.

c. They conduct impressions conveyed to them to the sympathetic ganglia generally; and

d. Such impressions are also conducted as far as the spinal cord, whence they are reflected, in the form of motor impulses, through the afferent spinal nerves; and the more intense the impression is, the greater will be the range of ganglionic centres to which it is conducted, and the more extensive will be the tract of spinal cord excited.

e. Or impulses originating in the encephalon, emotional, not connected with the will, are conducted through the spinal cord, and reach these ganglia; or such impulses may travel, as it were, by another route, viz., through the sympathetic, beginning in the cervical region, or through the splanchnic nerves.

f. Or centric action of the spinal cord may possibly evolve motor impulses, which are conducted to the uterine ganglia.

2. The ganglia of the hypogastric plexus, and the sympathetic generally, do not appear to bear such an important relation to the process of labour as the ganglia of the uterus proper. The communication is not very abundant, and the hypogastric plexus itself is not very large; and, moreover, it is only its inferior portion which is in direct communication with the uterus. But the functions performed are exactly similar in kind, only differing in degree.

a. They originate or act centrally.

b. They conduct to other centres.

c. They conduct from other centres.

d. They reflect impressions in the form of motor impulses.

3. The exact share which the spinal cord takes in the nervi-motor functions of the uterus, it is not possible, nor indeed necessary, to determine. Whether it or the ganglia proper of the uterus exercise the preponderating influence, *i. e.*, originate or reflect the greater share of motor impulses conveyed to the uterus, does not concern us very much. What we are interested in knowing is the manner of action of the centres in question.

The following modes of action of the spinal column are submitted.

a. It acts centrally, originating motor impulses which are conveyed to the uterus either by its own afferent nerves, or through the ganglia of the sympathetic.

b. It reflects impressions made upon the excitor nerves, in the form of motor impulses; and this, whether the impressions are made upon the excitor nerves of the uterus itself, or of some other organ or part of the body. The sudden application of heat or cold to the general surface of the body is productive of reflex contraction of the uterus; but such reflex actions are more easily set up by irritating the mammary nerves, or the nerves of organs lying in the vicinity of the uterus.

c. The spinal cord conducts motor impulses generated in the great ganglia of the brain, themselves the product of emotion, to the uterus; or conveys to the uterus, from the same sources, influences which suspend its contraction.

d. The spinal column conducts to the voluntary muscles those motor impulses which are the product of the will, and which we believe to be generated in the cerebral hemispheres (speaking in a strictly physiological sense); or possibly it transforms the cerebral act into motor impulses. And the uterus acts consensually with the voluntary muscles so set in action, in the same way as the heart acts consensually with voluntary muscles, or the iris with some of the muscles of the orbit, or the bladder with the diaphragm and abdominal muscles, or the muscles of the intestine with the same muscles, or indeed with the voluntary system of muscles generally.

e. The spinal column receives those influences of co-ordination of voluntary movements which we believe to be generated in the cerebellum.

4. The great ganglia at the base of the brain were spoken of as the fourth system of nervous centres concerned in the parturient act. They must be considered as generating motor impulses, subsequently to the act of *perception* performed by the hemispheres of the brain; or the act of perception by the hemispheres (I speak in a strictly physiological sense again) is followed by the issuing of influences from the great ganglia which exalt, depress, or suspend the contractions of the uterus.

5. The cerebral hemispheres would appear to be the percipients of impressions which are transformed into motor impulses in the great ganglia, and conducted from thence through the crura cerebri and the spinal column to the uterus; or by another route, *viz.*, through the par vagum and the sympathetic. And, again, it would appear that the cerebral hemispheres are the instruments of the will, and, by the intervention of the spinal cord, set in motion those muscles with which the uterus acts consensually. It will be seen that the brain acts entirely in a centric manner. I have not referred to the medulla oblongata, nor to the sensory cerebral nerves, because the latter really belong to the medulla; and the medulla itself acts in a manner no way different from the spinal column as regards the act of labour.

6. The cerebellum acts only as a co-ordinator of those voluntary muscles with which the uterus acts consensually. As far as is known, its action is purely centric.

In some particulars, the account just given of the nervi-motor actions of the uterus is different from any other with which I am acquainted. In most obstetric systems of the present day, there is a casual reference to the reflex nature of uterine contraction, as well as to the influence of the emotions on the uterus during labour. In Dr. Tyler Smith's recent course of lectures, the subject is more fully investigated than in any prior writings; but, admirable as his account is, an undue share of importance is (I would submit, with the greatest deference to such an authority) accorded to the spinal column, which is, in my opinion, only an accessory to the act of labour, though chief accessory.

Intimately connected with the foregoing physiological particulars are some points in the pathology of uterine nervi-motor action.

14, Harewood Square.

## SUCCESSFUL SYSTEM OF DRAINAGE AT WORTHING.

By HENRY COLLET, M.D.

[*Abridgement of a paper read before the South Eastern Branch, June 24th, 1857.*]

As a branch of hygienic or preventive medicine, the subject of this paper cannot fail to interest general practitioners. The narrative may also prove an encouragement to other towns similarly situated to follow an example effecting so much good in the prevention of disease, in the increase in value of life and property, in domestic happiness, especially among the poorer classes, and, it may be hoped, an improvement in the moral and religious tone of society.

There are some now living in Worthing who remember it a small fishing village. It became a popular place of resort, and consequently increasing and prosperous, from the advantages of its position on the coast, its wide spread sands, and the varied beauty of the surrounding neighbourhood. As the population increased, however, the drainage, which was from the beginning without arrangement, and based upon the old polluting system of cesspools, proved defective. These poured their fluid contents by several trunks on the shore, a short distance from the beautiful esplanade, which at times, therefrom, especially during the ebb of the tide, could no longer be resorted to.

Who, then, can be surprised that the town became injured in reputation as a watering place? But this was not all. The wells in many places became contaminated by soakage from the cesspools with which they were in close proximity, so that the water became thereby unfit for use. The requirements to remove these evils were a new system of drainage carried from the shore, and a general and sufficient supply of pure water. How it has been supplied, the following description of the works will show.

*Drainage.* The cesspools in the town (and there was one to almost every house) have been filled up, and water-closets have been substituted. The pernicious system of discharging the sewerage into the sea, in front of the town, has been abandoned. The drainage has been wholly remodelled; a main brick sewer or culvert, of an egg shape, measuring 3 feet 2 inches by 2 feet 3 inches, has been carried through the principal streets, at a depth, in some parts, of 23 feet; and is connected with the other streets, and with every house by branch drains of stone ware, varying in diameter from 15 inches to 6 inches. The main sewer terminates in a sumpt 6 feet 2 inches by 2 feet 10 inches; and a sewerage-well 30 feet deep and 10 feet in diameter at the top, reduced to 6 feet at the bottom. This well is situated considerably to the north-east of the town, and an artificial fall is obtained into it from every direction. In it is placed a sewerage-pump, consisting of three fifteen-inch barrels, worked by steam power, and connected with the engine in the water tower (shortly to be mentioned) by an iron shafting and driving gear, by which it is pumped through an outfall sewer emptying itself into the sea, at a place two miles eastward of the town, called Sea-Mills Bridge. There the sewerage mixes with a stream of pure water from the hills, and with the general drainage of the district. It is worthy of remark, that the abundant supply of pure water, mixed as it now is with the sewerage, so completely, by its antiseptic properties, counteracts the putrefactive fermentation, that neither at the works, nor in the immediate neighbourhood of the outfall, is there any disagreeable smell. Thus the beach and sands are wholly freed from the sewerage which formerly damaged both them and the esplanade; the sands are rapidly improving, and will, it is expected, before long, recover their former firm and dry condition.

*Water Supply.* The water tower at the north-east of the town, with the engine-house and chimney shaft adjoining, have been erected under the direction of W. Rawlinson, C.E. It has a total elevation of about 110 feet, and measures 40 feet square on the plan. There is a central pier of brick, and a spiral staircase of cast iron. The foundation is of concrete. Within the adjoining engine-house, a well has been sunk in the chalk, to a depth of 70 feet, which is lined with iron cylinders, to exclude the surface water. Below this depth, a bore has been driven into the chalk 295 feet further, making a total depth of 365 feet; from it gushes an abundant supply of the purest water, 15 degrees of hardness, which is lifted by the engine into a water-tank at the top of the Tower, and thence distributed into all the houses in the town. The tank is of cast iron, 40 feet square, and 13 feet deep, and will contain 110,000 gallons. Its bottom is 70