

AN EXPERIMENTAL INQUIRY
 INTO THE
 EFFECT UPON THE MOTHER OF POISONING
 THE FŒTUS.

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THE structure of the placenta and the character of its circulation—the close and intimate relation which exists there between the foetal and maternal blood—is naturally appealed to in explanation of the well-known effects produced in the child by various morbid and other peculiar conditions of the maternal system occurring during pregnancy. This intimate relation between the two circulations at the placenta is looked to for an explanation, not only of the transmission of obvious and fully developed disease from the mother to the foetus, as variola and syphilis, but also of those more subtle and obscure changes which are likewise understood to be capable of affecting the child.

Although the influence thus exercised by the mother upon the foetus has been known to everyone for ages past, and is continually illustrated by striking examples, it is only comparatively recently that the converse relation—the influence of the foetus upon the mother—has received any attention.

The subject has been most ably brought before the profession by Dr. Alexander Harvey, in a very interesting series of philosophical papers "On the Foetus in Utero, as inoculating the Maternal with the Peculiarities of the Paternal Organism."* In these well-known essays, he advances some excellent observations, and cites many cases to show "that an explanation offered by Mr. M'Gillivray, of Huntly, is the true one—viz., that while, as all allow, a portion of the mother's blood is continually passing by absorption (and assimilation) into the body of the foetus, in order to its nutrition and development, a portion of the blood of the foetus is as constantly passing, in like manner, into the body of the mother; that as this commingles there with the general mass of the mother's own blood, it inoculates her system with the constitutional qualities of the foetus; and that, as these qualities are in part derived to the foetus from its male progenitor, the peculiarities of the latter are thereby so engrafted on the system of the female as to be communicable by her to any offspring she may subsequently have by other males."

Now, although we are in possession of absolute facts, which furnish clear and convincing evidence of the direct transmission of what may be termed accidental matter from the mother to

* Monthly Journal of Medical Science, for Oct., 1849, and Sept., 1850.

the fœtus, not only of certain diseases, but also of foreign substances—as camphor and oil in the experiments of Magendie and D. Williams—yet we have no such conclusive facts in support of the converse proposition. However strong the argument from analogy may be, supported as it is by the record of cases of extreme interest, yet demonstrative evidence is wanting of the direct absorption of foreign matter from the fœtus by the mother. Indeed, the only experiments in reference to this point with which I am acquainted were attended by a negative result.

In his "Compendium of Physiology," Magendie briefly says, "I have often injected very active poisons into the vessels of the cord, directing them towards the placenta; but I have never seen the mother suffer from the effects of them."

And this negative result may be supposed to depend upon the fact that after all the communication between the maternal and foetal blood is only an indirect one, and is therefore limited. It may reasonably be believed to be one office of the cells which intervene between the foetal and maternal vessels to regulate or control such transmission, to exercise a selecting influence on the materials absorbed, as some other cells in all probability do. It is commonly supposed that the office of these cells is solely connected with the transmission of materials from the mother to the fœtus, one set selecting and separating, and the other elaborating and absorbing them.* Therefore, even if an interchange to a certain extent be admitted, there is still no proof that poisons or other morbid materials, whether arising from within or from without, must necessarily pass from the fœtus to the mother.

But in whatever way the argument may be supported, it is certain that two very opposite opinions are expressed by physiologists on the subject. Dr. Harvey, after quoting this sentence from Mr. M'Gillivray, "I am quite aware that many physiologists maintain that, in the highest species of animals, the blood cannot be returned by the fœtus to the mother during utero-gestation," endorses it with the following statement:—"That this opinion is very generally held by physiologists in this country is quite certain. Dr. Alison, for instance, after observing (on the authority of Magendie and of Dr. David Williams, of Liverpool) that camphor and oil injected into the blood of pregnant animals are soon detected in the blood of the fœtus; but that poison injected into the umbilical arteries, although mixing with the blood on its way from the fœtus to the placenta, does not affect the mother; and that fatal hæmorrhage in the mother does not apparently diminish the fulness of the vessels of the fœtus—adds 'so that it would seem that the transmission of fluids is almost entirely from the mother to the fœtus.' Again, Dr. Kirkes, referring to Professor Goodsir's observations as to the intervention of two distinct layers of cells between the foetal and the maternal portions of the placenta, speaks of the one being 'probably designed to separate from the blood of the parent the materials destined for the blood of the fœtus,' while the other 'probably serves for the absorption of the material secreted by the other set of cells, and for its conveyance into the bloodvessels of the fœtus'—no idea, seemingly, being entertained of a converse process.† Moreover, the view taken by most physiologists of the destination of that portion of the foetal blood which is transmitted to the placenta appears to be exclusively that of *renovation* or *oeration*, by coming into relation with the oxygenated blood of the mother, nothing being said as to *re-absorption* into the maternal system." In a note he adds, "In his 'History of Medicine,' Dr. Alison expresses himself even more strongly on the subject: 'The experiments of Magendie and others have proved that any substance which may be circulating in the blood of the mother finds ready access to that of the fœtus, but that there is little or no transference of fluids in the opposite direction.' Those authors who express a contrary opinion, cannot refer to any facts in support of it.

As the question at present stands, then, the only demonstrative evidence is that yielded by the experiments of Magendie, and these gave a negative answer. All the rest of the evidence

which has been adduced on either side is devoid of proof, is indirect and inconclusive.

This subject was brought before the notice of the Hunterian Society by Mr. Jonathan Hutchinson, in a paper on the "Communication of Syphilis from the Fœtus to the Mother," read there in the latter part of 1856.* It was followed by a very interesting discussion, and it then occurred to me that it should be brought to the test of experiment. I could find no such evidence on record, excepting the experiments of Magendie already referred to, and these had yielded a negative result. But the nature of these experiments appeared to me objectionable; for it seems almost impossible to open the vessels of the cord and inject directly into them, with interfering to a fatal extent with the foetal circulation.

This was the general plan of my experiments:—

By opening the abdomen and uterus to expose and isolate a living fœtus. Then to inject into it, with the least possible amount of violence, some substance capable of ready absorption, and the operation of which is marked by obvious and unmistakable effects. To be sure that no trace of the substance came into direct contact with the maternal tissues. To place the fœtus thus injected in a condition most favourable for the continuance of the circulation, and then to watch for symptoms of the operation of the poison upon the mother.

The poison I selected from some others was strychnia, for these reasons:—

It is extremely active in very minute doses.

It is easily dissolved, and therefore readily absorbed.

Its absorption is rapidly followed by its operation on the system.

The symptoms of its operation are striking and characteristic.

Its effects are not materially counteracted, nor its symptoms masked, by the influence of chloroform.

After some experiments with strychnia dissolved in various menstrua, as alcohol, benzole, &c., I preferred as the most eligible a solution of strychnia in diluted acetic acid. In this way I obtained a very convenient solution of the acetate of strychnia, of sufficient strength.

Twenty-four grains of strychnia were dissolved in seven drachms of distilled water by the addition of one drachm of acetic acid. Twenty minims of this solution, therefore, contained one grain of strychnia.

A certain quantity of this solution was introduced, usually, into the abdominal cavity, through the parietes, by means of an Anel's syringe. This little instrument is very convenient for the purpose. The abdominal wall can be easily pierced with its fine point without any violence. The quantity of fluid injected can be accurately calculated, and when withdrawn, the minute puncture is so closed by the natural elasticity of the tissues, when the fœtus is far advanced in development, as to prevent the escape of any portion of the solution.

The subjects of my experiments were dogs, cats, and rabbits. Dogs, from their size, are the most convenient, and furnish the most satisfactory results.

From a considerable number of experiments, I select the following ones as fair examples:—

Experiment 1.—A pregnant bitch, a common smooth-haired terrier, weighing about twelve pounds, was rendered insensible by chloroform. The abdomen was opened in the median line, and the uterus was partially drawn out. It was carefully divided over a fœtus. The amnion was punctured, and the fœtus, lively and vigorous, was allowed to escape. It was received upon a napkin, and remained connected with the mother only by the cord. The fœtus was carefully supported, so as to avoid stretching the cord. The abdominal wall was cautiously punctured with the point of the syringe, and ten minims of the solution (half a grain of strychnia) were injected into the cavity. When the syringe was withdrawn, no fluid escaped. The puncture was so minute that nothing exuded even upon pressure. The fœtus, which struggled slightly after the operation, and then became tetanic, was suffered to remain where it lay, not in contact with the mother.

An incision was then made in another part of the uterus over a second fœtus, which was only partially exposed, and not drawn out. The side of the chest was wiped dry, the point of the syringe was inserted between the lower ribs, and about the same quantity of the solution was injected into the thorax. The piston was slightly retracted before the pipe was withdrawn, and not the least trace of moisture appeared. The part where the puncture was made was carefully watched for

* This question in relation to the transmission of syphilis had previously been often suggested by various authors, but it is much more fully discussed by Mr. Hutchinson.

* Kirkes' Physiology, 3rd edition, p. 681. Carpenter's Manual of Physiology, 3rd edition, pp. 154-5 and 526.

† It is, however, only fair to add that in the later editions of his work, Dr. Kirkes in a note expresses the following strong opinion:—"Although in the text mention is made only of the passage of materials from the blood of the mother into that of the fœtus, yet there can be no doubt of the existence of a mutual interchange of materials between the blood of both fœtus and parent, the latter supplying the former with nutriment, and in turn abstracting from it materials which require to be removed." The most recent expression of Dr. Carpenter's opinion is to this effect. After giving the common account of the function of the placenta as furnishing materials for the nutrition of the embryo and as a respiratory organ, he adds, "And it is probable, too, that the placenta is to be regarded as an excreting organ, serving for the removal, through the maternal blood, of excrementitious matter, whose continued circulation in the blood of the fœtus would be prejudicial to it."

some seconds by Mr. Crowfoot and myself, and we both were fully satisfied on that point. That portion of the uterus which had only partially extruded was now carefully replaced, without any protrusion of the fœtus, then the rest of the uterus, and lastly the fœtus first operated on was returned into the abdomen, and the wound was closed by sutures.

The bitch lay on her side motionless, and breathing tranquilly for eight minutes from the time of the first operation. In about nine minutes slight spasms appeared. These gradually increased in intensity, and continued, with scarcely any intermission, for eighteen minutes. In twenty-eight minutes from the time of the injection the dog was dead.

Five minutes after her death, the abdomen was reopened. There were two other fœtuses, besides those two which had been injected—four in all. While the two which had received the strychnia revealed no signs of life, the other two were still alive and vigorous. They lived for some time after separation from the mother, and one which was suffered to escape from its membranes respired and otherwise displayed such evident signs of full development, such as crying, that any doubt of the near approach of natural labour which could have been entertained after a mere inspection of the fœtuses were completely set at rest. The parts were found in the abdomen as they had been replaced, and the fœtus which was operated on in the uterus still remained there.

Now, I am satisfied that in these experiments none of the solution escaped from the fetus through the puncture, because I ascertained that, if proper precaution had been adopted in the injection, none escaped upon pressure. Moreover, I had learned, from another set of experiments, that when the solution is allowed to come into direct contact with the maternal tissues, as when injected into the uterine or peritoneal cavity, or when allowed to escape from the fetus, its symptoms are never delayed for a period at all approaching the length of time which elapsed between the closure of the abdomen and their manifestation in these experiments. The usual period is two minutes, and this is rarely extended to five. The animal is in most instances dead before that period.

But that this source of fallacy did not arise, I have more than once unintentionally obtained still better evidence in another way. Some of my experiments, the earlier ones more especially, were attended with a negative result. Fœtuses were injected and returned into the mother, but no visible effects on her of the poison followed. Prolonged exposure and rough manipulation when the fœtuses were small and feeble, had been fatal to their circulation. But I now see the importance of the negative results which these experiments yielded. The solution could not have escaped from them, or in any way have come into contact with the maternal tissues.

More recently I have performed the following experiment:—

Experiment 2.—I removed two fœtuses, within a day or two of their full term, from the uterus of a cat, immediately after its death from chloroform, having previously placed ligatures on the fœtal portion of the cords. They both were lively. I injected ten minims of the solution into the abdominal cavity of each by perforating the walls with the point of the syringe in the usual manner. When the syringe was withdrawn, the punctures remained dry, and the spots were scarcely visible. No fluid exuded upon pressure. Then, without in any way securing those punctures, I introduced the two fœtuses alive and tetanic into the abdominal cavity of another cat under chloroform, and allowed them to remain there for more than twenty minutes. Not the slightest symptom of strychnia was produced in the cat.

We are naturally reminded by the negative result of these experiments of the impunity with which a mother may carry a dead and decomposing fetus. In neither case is there any longer a circulation.

In the following experiment the possibility of the fallacy occurring, which has just been alluded to, was prevented:—

Experiment 3.—A cat, far advanced in pregnancy, was rendered insensible by chloroform. The abdomen was opened, and the uterus exposed. It was carefully divided at a part to which a placenta was not attached, and a vigorous fœtus extracted in its membranes, which were removed from it. It was carefully supported on a napkin, and into the abdominal cavity about ten minims of the solution were injected. The portion of integument around the puncture was then carefully pinched up and secured by a ligature, so as to prevent the possibility of any escape of the solution. A second fœtus was then extracted, and treated exactly in the same manner. Both, with the portion of the uterus, were then returned into the abdomen, which was closed with sutures.

For ten minutes from the period of the first injection, the

cat lay on her side breathing tranquilly. Then slight spasms ensued in the hinder extremities; these gradually increased, and at length passed into violent and general ones. In seven minutes more the cat was dead.

The abdomen was then re-opened, and the ligatures placed upon the punctures in the fœtuses were found still perfectly secure. Both the injected fœtuses were yet alive. Within a few minutes after they were injected, they exhibited decided spasms, and these continued for a long period after the death of the mother frequently to recur. The other fœtuses were not affected.

(To be concluded.)