XIII. *A Description of a very unusual Formation of the human Heart. By Mr.* James Wilson, *Surgeon. Communicated by* Matthew Baillie, *M. D. F. R. S.*

Read May 3, 1798.

THE heart is an organ of so much importance in the animal œconomy, and is so immediately concerned in the support of life, that any unusual deviation from its natural form and situation in the human body, has always been considered as a subject of some interest by the physiologist; such deviations have, therefore, not unfrequently been submitted to the consideration of this and other learned Societies. Many circumstances respecting the circulation of the blood, and respiration, wholly unknown to our ancestors, have lately been ascertained; but we are not as yet arrived at a perfect knowledge of these important actions. Difficulties yet remain; more information may still be acquired; and the reasoning upon these subjects will be less liable to fallacy, in proportion to the number of facts which have been observed, and the accuracy of the observations. These are the reasons which have induced me to lay before this Society, a description of a monstrosity in the human heart, very singular in its nature, and which, I believe, has not hitherto been observed or described. I have consulted the works of those authors who were the most likely to have

recorded such cases, but I have not been able to meet with a description of any which have been at all similar.

It is well known to most of the Members of this Society, that the circulation of the blood throughout the body, and exposure of it to the atmospheric air in respiration, seem, in most animals, to be necessarily connected; but are not equally so in all. They are so much connected in the human subject, and in most quadrupeds, that after birth there is a double heart; *viz.* one for the circulation of the blood throughout the body, to be subservient to the various purposes of life and growth; the other for its circulation through the lungs, where it undergoes a change which is essential to its general circulation through the body: these two circulations, in the natural state, bear an exact proportion to each other. Instances, however, have occurred, even in the human subject, where this exact proportion has not been preserved; yet life has been prolonged for some years, but in a feeble and imperfect state. In some of these instances, the pulmonary artery has been smaller than usual, so that much less than the natural quantity of blood was exposed to the influence of the air in the lungs; in others, the foramen ovale has not been closed, but a considerable communication has remained between the two auricles; and, in others, there has been a communication between the two ventricles, from a deficiency in the septum. The effect of all these deviations is the same, upon the blood in the general circulation, *viz.* that a part of the blood is not exposed to the air in the lungs; so that it is less pure as it circulates over the body. A more remarkable deviation in the structure of the heart, than any to which I have just alluded, has been lately published by Dr. BAILLIE, in his Morbid Anatomy. In this heart, the aorta

arose from the right ventricle, and the pulmonary artery from the left; the reverse of what ought, in the regular course of circulation, to have taken place; (the veins were as usual;) and no communication was found between the one vessel and the other, except through the remains of the ductus arteriosus, which was not larger than a crow quill, and a small part of the foramen ovale, which still continued open; yet this child lived for two months. In the following case of monstrous formation of the heart, there is this very great singularity, that nature seems to have substituted, very exactly, the circulation which takes place in some amphibious animals, for that which is natural to the human species.

The infant had arrived at its full time, and lived seven days after its birth. Instead of the usual integuments, muscles, *&c.* a membranous bag appeared to protrude on the upper and fore part of the abdomen, extending from the last bone of the sternum some way below the middle of the belly, and outwards, so as to be nearly circular: the navel-string seemed to enter this membrane near its middle, and to wind superficially, for some little way, towards the left side; it then dipped into the abdomen, at the place where this membrane joined the usual coverings. Within this bag, the appearance of which was very nearly similar to that of the chorion and amnios which envelop the fœtus at birth, but thicker in consistence, a tumour was perceived, possessing considerable motion, from the nature of which, no doubt was entertained that it was the heart.

During the short period of the child's life, it was seen and examined by a number of professional men. Upon its death, the tumour was carefully opened by Mr. MORELL, in the pre-

sence of Dr. POIGNAND; when the heart, as was previously suspected, appeared to be situated in the epigastric region of the abdomen, and to be imbedded, as it were, in a cavity formed on the superior surface of the liver. In this state, the child was sent to Dr. BAILLIE, by whose desire I injected the heart, and laid its principal vessels bare, so as to bring their uncommon distribution and course into view: a preparation of them still remains in Dr. BAILLIE's possession.

A considerable part of the tendinous portion of the diaphragm appeared to be wanting, as likewise the lower part of the pericardium, which is usually affixed to it. The thorax being laid open on each side of the sternum, the two pleuræ were seen passing from that bone to the spine, and covering the lungs, as usual. The lungs appeared perfectly natural in colour, and nearly so in shape; but were larger and fuller than usual, in consequence of more room being afforded for them in the thorax, from the peculiar situation of the heart. In the space corresponding to the anterior mediastinum, was the thymus gland, considerably longer than in other children, and extending downwards the whole length of the sternum; behind this, was a peculiar arrangement of blood-vessels.

The heart, instead of consisting of four cavities, as in the natural structure, consisted of a single auricle and ventricle, which were each of them large in their size. A large arterial trunk arose from the ventricle, and ascended into the thorax, between the pleuræ, immediately behind the thymus gland: it soon divided into two large branches, one of which continued to ascend, forming the aorta; the other passed backwards, and proved, upon examination, to be the pulmonary artery.

The aorta, having reached the common place of its curva-

ture, formed it in the same manner as it usually does; sent off the vessels belonging to the head and upper extremities; descended before the vertebræ, and passed into the abdomen between the crura of the diaphragm. From the place where it began to form the arch, it was in no respect different from the aorta of any other infant, except that no bronchial artery was sent to the lungs, from it or any of its ramifications.

The vessel which proved to be the pulmonary artery, almost immediately divided into two branches; one going to the lungs of the left, the other to the lungs of the right side. Upon measuring accurately the circumference of the aorta, where it separated from the original trunk, it was found to be exactly one inch and a quarter. Upon measuring the circumference of the pulmonary artery, in the same manner, it was found to be fifteen sixteenths of an inch; so that it was five sixteenths of an inch less than the aorta.

The vena cava inferior, having been partly surrounded by the substance of the liver, entered the lower and back part of the auricle. The subclavian vein of the right side crossed over to the left of the mediastinum, where it joined the left subclavian, and formed the vena cava superior. This passed down on the left of the ascending, and before the descending, part of the aorta; it was then joined by a trunk formed by two large veins, which came out of the lungs, and which were situated immediately behind the pulmonary arteries: the union of this trunk with the vena cava superior was continued into a large vessel, which gradually expanded itself into the auricle. The vena azygos ascended on the left side; received some branches which passed under the aorta from the right, and then entered the upper and back part of the vena cava superior: there were

no bronchial veins. From there being neither bronchial arteries nor veins, it would appear that the pulmonary arteries and veins, in addition to their usual offices, performed those of the bronchial vessels.

The liver was not divided on its upper surface by the suspensory ligament, but had a considerable cavity scooped, as it were, out of its substance; which, in shape, was adapted to, and contained, the heart: it was also, in some other particulars, rather different from its natural shape, but not sufficiently so to require being minutely described. The rest of the infant was examined, but was not found to be dissimilar to any other. These circumstances are expressed by the accompanying figures of the parts when dissected; (Tab. XVIII.) in taking of which, much attention was paid to render them very accurate.

It is a well ascertained fact, that the blood receives a florid hue from the influence of the air on it in the lungs; and this change is supposed to be effected by the combination of a certain quantity of oxygen gas with it. In passing from the arteries to the veins, in every part of the body except the lungs, it loses the florid hue, and becomes darker: the florid blood is that which is employed for the purposes of supporting life. In the natural circulation, it is well known, that the whole of the blood conveyed to, and circulating in, the pulmonary artery, is of a dark colour; and the whole of it, when returned by the pulmonary veins, is florid.

It is obvious, in the case which I have described, that there always must have been florid and dark-coloured blood mixed, and circulating in the arteries. It would seem also, upon the first reflection, that the quantity of dark-coloured blood would be the greatest, in the same proportion as the capacity of the

aorta was larger than that of the pulmonary artery. It is therefore necessary to recollect, that a considerable proportion of the blood carried to the lungs was already florid or oxygenated; and also, that the lungs in this infant were larger in proportion, than in children of the same age: a smaller quantity of blood, therefore, was to be oxygenated, and a larger surface than usual was appropriated for this purpose. It appears also, from experiments, (such as making a person breathe air in which there is a greater proportion of oxygen gas than in our atmosphere,) that the blood can combine with more of it than it does in natural respiration; it therefore is not an improbable supposition, that a larger quantity was combined here. A small drawback must be allowed, for the quantity of oxygenated blood used in the support and secretions of the lungs, and which is usually conveyed to them by the bronchial artery; but this quantity is too small to require more than this slight observation of it. The blood also which passed to the lungs, must have been again conveyed to the heart sooner, from the shortness of its circuit; and must have entered the heart with a quicker or stronger current, than that blood which passed to, and was returned from, the more remote parts of the body; as, in this child, the pulmonary artery and aorta were filled by the contraction of the same ventricle. In the hearts of other children, some time after birth, the muscular fibres of the right side are much fewer in number than in the left.

If these circumstances are admitted as fact, *viz.* that the blood circulating through the lungs of this child was combined with a larger proportion of oxygen gas, and was returned in a quicker and stronger current into the auricle than that returned by the venæ cavæ, it seems reasonable to infer, that this

blood, mixing and blending with the dark or unoxygenated blood, would render the whole nearly as much oxygenated as it usually is found in the left side of the heart, and in the aorta; therefore, that the blood circulating in the arteries of this child would be fully equal to the support of life. Previous to birth, this peculiarity of structure could not affect its health or growth, as the placenta then answers the purpose which the lungs do afterwards; and the single ventricle seemed as equal, from its size, to propel the blood on to the placenta, as both ventricles in the natural state are, by means of their communication through the ductus arteriosus.*

The inference which has been drawn seems further confirmed, from the colour and heat of this child, during life, being not perceptibly different from those of other children. In all those cases of malformation of the heart where the foramen ovale, or the ductus arteriosus, has continued open; or where the septum of the ventricles has been perforated, and the pulmonary artery small, (and at the same time two ventricles,) it has been observed, that the body had a livid colour, and, in general, that there was a deficiency of heat.

From the particular inquiries which I made, concerning the heat and colour of this child, of the professional gentlemen who saw it during life, and of the nurse who attended and

* It is here not unworthy of remark, that the circulation in this child, after its birth, was in several circumstances similar to the circulation in other children previous to that period. A child, before birth, may be said to have a single heart; as both the auricles communicate together, by means of the foramen ovale; and the pulmonary artery communicates with the aorta, by means of the ductus arteriosus. Hence, in the fœtal heart, the blood returned from the body, which is of a dark colour, and the blood returned from the placenta, which is florid, are poured into the same auricle; the blood which is sent to the placenta is therefore already in part oxygenated.

dressed it, I found that the heat, so far as could be judged by the feeling, (for it was not tried by the thermometer,) was in no respect different from that of other children; and that the colour of the skin was perfectly natural, except that, on the day on which it was born, and a short period before its death, the lips occasionally had something of a livid appearance; but that this did not last any time, as they were generally pale. This occasional lividness would happen to a child in that state, should the heart and circulation be in no way different from what they naturally are.

I could meet with no other remarkable circumstances, either in the history of the mother during pregnancy, or in the child after birth. It cried occasionally, like other children, but seemed weak, and in pain; it slept; it sucked heartily, even a few hours before its death, and had apparently healthy evacuations of urine and fæces.

Its death can be satisfactorily accounted for, from another cause than the extraordinary formation of its heart and blood-vessels. The membranous covering, on the fore part of the abdomen, did not appear to possess sufficient vascularity to retain its life after birth; for it immediately lost its living principle, and became putrid and mouldy in parts. Previous to the child's death, a process of separation had begun, between it and the living parts to which it was connected, and a line of inflammation was distinctly seen. Had this process been completed, and the slough thrown off, the heart would have been exposed; but, before this, the heart itself had inflamed; which was proved from its being found covered with a coat of coagulable lymph recently thrown out, and from this inflammation its death must have arisen.

Had the heart been covered with the usual parietes of the abdomen, it is probable, notwithstanding its situation, that this child might have lived in a tolerable state of health for years; but must constantly have been exposed to have its heart injured by some external accident, from its not being defended by the ribs and the sternum.

The formation and disposition of the heart and vessels, in this child, resemble much those which are found in the frog, and some other amphibious animals; but this infant could not, like them, be amphibious. Those animals are extremely tenacious of life, so that they live some time, even after their heart and lungs are removed from their bodies; and, as their circulation can go on without respiration, it is therefore not wonderful that they often live a considerable time without change of air. Life, in the human species, depends equally on both these actions; for death takes place, if either of them should stop. The circulation of the blood in this infant would have met with no impediment, had it been immersed in water; but, unless respiration went on, which in that state it could not do, the blood could undergo no change in the lungs; and this change is equally essential to the support of life, as the circulation of the blood.

EXPLANATION OF THE FIGURES. (Tab. XVIII.)

Fig. 1. represents the heart, blood-vessels, liver, &c. as they appeared when dissected; part of the ribs, the sternum, thymus gland, lungs, &c. having been removed.

AA. The heart, consisting of one auricle and one ventricle.

B. A large arterial trunk, arising from the ventricle.

C. The aorta, arising from this trunk.

D. The pulmonary artery, arising from the same trunk.

E. The vena cava superior, descending on the left side.

F. F. The pulmonary veins, entering into the auricle with the vena cava superior.

G. The vena azygos, ascending on the left side.

H. The diaphragm, adhering laterally to the margin of the chest, but deficient on the fore part, towards the sternum.

I I. The liver.

K. The cavity on the upper surface of the liver, in which the heart was in part situated.

L. The membranous covering turned downwards.

M. The umbilical vein.

Fig. 2. represents the heart. The aorta and pulmonary artery are cut off near their origin, to shew the pulmonary veins, and vena cava superior, entering the auricle.

A. The auricle.

B. The ventricle.

C. The trunk from which the aorta and pulmonary artery arose.

D. A large vessel entering the auricle, and receiving the blood from the pulmonary veins and vena cava superior.

E. The trunk formed by the pulmonary veins.

F. The vena cava superior.

G. The vena azygos.

H. The right subclavian vein.

I. The left ditto.

Fig. 1.

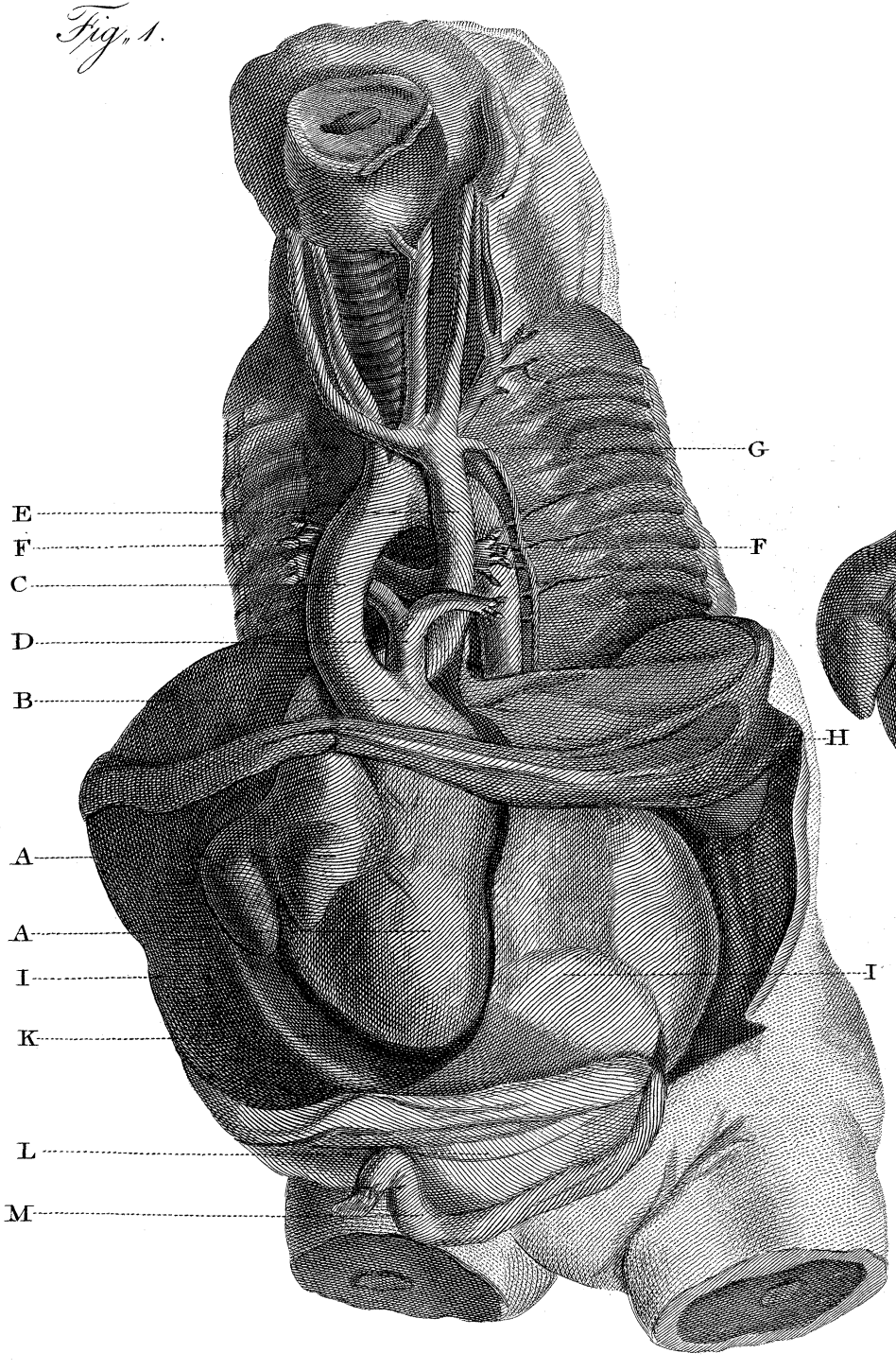

Fig. 2.