A

TREATISE

ON THE

ANIMAL ŒCONOMY.

A DESCRIPTION OF THE SITUATION OF THE TESTIS IN THE FŒTUS, WITH ITS DESCENT INTO THE SCROTUM.

A DISCOVERY in any art not only enriches that with which it is immediately connected, but elucidates all those to which it has any relation. The knowledge of the construction of a human body is essential to medicine, therefore every improvement in anatomy must throw additional light on that branch of science. These improvements strike more forcibly if they are on subjects quite new or little understood; and this effect is well illustrated by the advantages which pathology has derived from the discovery of the lymphatics being the absorbent system; and likewise by that case of hernia, where the intestine lies in contact with the testicle; which has been perfectly explained by the discovery of the original seat of the testicle being in the abdomen.

Several years before Haller's Opuscula Pathologica were published, my brother informed me, that in examining the contents of the abdomen of a child, stillborn, about the seventh or eighth month, he found both the testicles lying in that cavity, and mentioned the observation with some degree of surprise. By this we are enabled to account for a circumstance that sometimes happens in the scrotal hernia, as depending on the discovery that the testis is formed in the abdomen, and which we could never explain to our satisfaction till the publication of the Opuscula, to which Dr. Hunter alludes, (Commentaries, page 72,) in the following words:

"In the latter end of the year 1755, when I first had the pleasure of

reading Baron Haller's observations On the Hernia Congenita*, it struck my imagination[a] that the state of the testis in the fœtus, and its descent from the abdomen into the scrotum, would explain several things concerning ruptures and the hydrocele, particularly that observation which Mr. Sharp had communicated to me, viz. that in ruptures the intestine is sometimes in contact with the testis. I communicated my ideas upon this subject to my brother, and desired that he would take every opportunity of learning exactly the state of the testis before and after birth, and the state of ruptures in children. We were both convinced that the examination of those facts would answer our expectation, and both recollected having seen appearances in children that agreed with our supposition, but saw now that we had neglected making the proper use of them.

"In the course of the winter my brother had several opportunities of dissecting fœtuses of different ages, and of making some drawings of the parts; and all his observations agreed with the ideas I had formed of the nature of ruptures, and of the origin of the tunica vaginalis propria in the fœtus. But till those observations were repeated to his satisfaction, and were sufficiently ascertained, he desired me not to mention the opinion in my lecture; and therefore, when treating of the coats of the testis, and of the situation of the hernial sac, &c., I only put in this temporary caution, that I was then speaking of those things as they are commonly in adult bodies, and not as they are in the fœtus: and at last, when I was concluding my lectures for that season, in the end of April 1756, with a course of the chirurgical operations, I gave a very general account of my brother's observations, and showed both the drawing of fig. 2, which was then finished, and the subject from which it was made."

The following observations on this subject were taken from my notes,

* *Alberti Halleri Opuscul. Patholog.*, Lausan. 1755, 8vo, page 53, &c.

[a] [Although Haller was in doubt as to the exact period of the descent of the testis, and in error as to the cause of that phenomenon, yet he accurately describes, in the original paper here alluded to, the original relations of the gland to the peritoneum and abdominal viscera, and the formation of the tunica vaginalis, and thus applies the facts which he had discovered to the explanation of the disease he was considering. "Herniarum, ni fallor, congenitarum modus hinc elucescit, quo generantur. Patulus est processus peritonæi sub renibus positus, qui expectat testem invitatque aperto ostio, atque eo deorsum ex solita lege pulso urgetur, inque scrotum una descendit. Cum autem his in corporibus testes eodem cum intestinis sacco omnino contineantur, nihil est singularis sive inexpectati, si ea in apertum saccum a levi vi depressa fuerint." (*Opusc. Patholog.*, p. 56.) In this paper there are references to the older authors who had noticed the abdominal position of the testes in the fœtus.]

and published by Dr. Hunter in his Commentaries, to which I have added some practical remarks.

"Until the approach of birth, the testes of the fœtus are lodged within the cavity of the abdomen, and may therefore be reckoned among the abdominal viscera. They are situated immediately below the kidneys, on the fore part of the psoæ muscles, and by the side of the rectum, where this intestine is passing down into the cavity of the pelvis; for in the fœtus, the rectum, which is much larger in proportion to the capacity of the pelvis than in the full-grown subject, lies before the vertebræ lumborum as well as before the os sacrum. Indeed the case is pretty much the same with regard to all the contents of the pelvis; that is, their situation is much higher in the fœtus than in the adult. The sigmoid flexure of the colon, part of the rectum, the greatest part of the bladder, the fundus uteri, the Fallopian tubes, &c. being placed in the fœtus above the hollow of the pelvis in the common or great abdominal cavity.

"While the testis remains in the abdomen its shape or figure is much the same as in the adult, and its position or attitude the same as when it is in the scrotum; that is, one end is placed upwards, the other downwards; one flat side is to the right, the other to the left; and one edge is turned backwards, the other forwards; and the vessels enter the posterior edge alike in both the fœtus and adult. As the testis is not so immediately inclosed in the surrounding parts while it is in the loins, its position may be a little variable, and the most natural seems to be when the anterior edge is turned directly forwards; but as the least touch of anything will throw that edge either to the right side or to the left, then the flat side of the testis will be turned forwards. It is attached to the psoas muscle all along its posterior edge, except just at its upper extremity; and this attachment is formed by the peritoneum, which covers the testis and gives it a smooth surface, in the same manner as it envelopes the other loose abdominal viscera.

"The epididymis lies along the outside of the posterior edge of the testis, as when in the scrotum, but is larger in proportion, and adheres backwards to the psoas. When the fœtus is very young, the adhesion of the testis and epididymis to the psoas is very narrow, and then the testis is more loose, and more projecting; but as the fœtus advances in months, the adhesion of the testis to the psoas becomes broader and tighter.

"The vessels of the testis, like those of most parts of the body, commonly rise from the nearest larger trunks, viz. from the aorta and cava, or from the emulgents.

"The artery generally rises from the fore part of the aorta, a little

below the emulgent artery, and often from the emulgent itself, especially in the right side of the body, which may happen the rather, because the trunk of the aorta is more distant from the right testis than from the left. Sometimes, but much more rarely, the spermatic artery springs from the phrenic, or from that of the capsula renalis. Besides the artery which rises from the aorta, or emulgent, &c., the testis receives one from the hypogastric artery, which is sometimes as large as the other. It runs upwards from its origin, passing close to the vas deferens in its way to the testis. The superior spermatic artery sometimes passes before the lower end of the kidney; and both these arteries run in a serpentine direction, making pretty large but gentle turnings. They are situated behind the peritoneum, and both run into the posterior edge of the testis, between the two reflected laminæ of that membrane, much in the same manner as the vessels pass to the intestines between the two reflected laminæ of the mesocolon or mesentery.

"The veins of the testis are analogous to its arteries, but commonly change sides with the arteries respecting their origins from the emulgents. The superior spermatic vein, to begin with its trunk, rises commonly in the following manner: on the right side, from the trunk of the vena cava, a little below the emulgent; and on the left side, from the left emulgent vein. The reason of this difference between the right and left spermatic vein, no doubt, is because the cava is not placed in the middle of the body; so that by the rule of ramification which is observed in most parts of the body, the cava is the nearest large vein of the right side, and the emulgent is the nearest large vein of the left side. But the difference is inconsiderable; and accordingly we sometimes find the right spermatic vein coming from the right emulgent vein; and several other varieties are produced, which, so far as I can observe, follow no precise rule. There is likewise a spermatic vein, which rises from the internal iliac, and runs up to the testis with the inferior spermatic artery. Both the spermatic veins run behind the peritoneum with their corresponding arteries, and go into the posterior edge of the testis, where they are lost in small branches.

"The nerves of the testis, like its blood-vessels, come from the nearest source; that is, from the abdominal plexuses of the intercostal, especially the inferior mesenteric plexus. They run to the testis, accompanying its blood-vessels, and are dispersed with them through its substance. The testis, therefore, with respect to its nerves, may be reckoned an abdominal viscus; and this observation will hold good when applied to the full-grown subject, as well as to the fœtus; for those branches of the lumbar nerves which are commonly said to be sent to the testis, passing through the tendon of the external oblique muscle, in reality

go not to the testis itself, but to its exterior coverings, and to the scrotum."—p. 75.

The testicle receiving its nerves from the plexuses of the intercostal, accounts for the stomach and intestines sympathizing so readily with it and its particular sensation, and for the effects arising in the constitution upon its being injured.

"The epididymis begins at the outer and posterior part of the upper end of the testis, immediately above the entrance of the blood-vessels, where it is thick, round, and united to the testis. As it passes down it becomes a little smaller and more flat, and is only attached backwards to the testis, or rather indeed to its vessels; for its anterior edge lies loose against the side of the testis forwards; and at its lower end it is again more firmly attached to the body of the testis, so that in the fœtus there is a cavity or pouch formed between the middle part of the testis and the middle part of the epididymis, more considerable than is commonly observed in full-grown subjects. As the body grows, the epididymis adheres more closely to the side of the testis; and its greatest part is made up of one convoluted canal, which becomes larger in size and less convoluted towards the lower end, and at last is manifestly a single tube running a little serpentine. That change happens at the lower end of the testis, and there the canal takes the name of vas deferens.

"The vas deferens is a little convoluted or serpentine in its whole course, but is less so as it comes nearer to the bladder; instead of running upwards from the lower end of the testis, as it does when the testicle is in the scrotum, while that remains in the abdomen, it runs downwards and inwards in its whole course, so that it goes on almost in the direction of the epididymis, of which it is a continuation. It turns inwards from the lower end of the epididymis, under the lower end of the testis, and behind the upper end of a ligament or gubernaculum testis (which I shall presently describe); then it passes over the iliac vessels, and over the inside of the psoas muscle, somewhat higher than in adult bodies, and at last goes between the ureter and bladder towards the basis of the prostate gland."—p. 77.

In those animals where the testicles change their situation the cremaster muscle, which should be named *musculus testis*, has two very different positions in the fœtus and in the adult, the first being the same as in those animals whose testicles remain through life in the cavity of the abdomen; we must therefore conclude that the same purposes are answered by this muscle in the fœtus as in those animals.

The use of this muscle, when the testicle is in the scrotum, appears to be evidently that of a suspensory; for I find this muscle is strong in

proportion to the size of the testicle and pendulous situation in other animals. But what purpose it answers in the fœtus, or in animals whose testicles remain in the abdomen, is not easily imagined, there being no apparent reason why such a muscle should exist[a].

The cremaster, or musculus testis, appears to be composed of the lower fibres of the obliquus internus and transversalis muscles in the fœtus, turning upwards, and spreading upon the anterior surface of the gubernaculum, immediately under the peritoneum; it appears to be lost on the peritoneum, a little way from the testicle. This, although now inverted, is more evidently seen in adult subjects who have had a hydrocele or rupture; in such cases the muscle becomes stronger than usual, and its fibres can be traced spreading on the tunica vaginalis, and seem at last to be lost upon it, near to the lower end of the body of the testicle.

The nerves which supply this muscle are probably branches from the nerves of the obliquus internus and transversalis muscles[b]; for the same cause which throws the abdominal muscles into action produces a similar effect on the musculus testis; which circumstance appears to be most remarkable in the young subject. When we cough or act with the abdominal muscles, we find the testicles to be drawn up; the musculus testis and abdominal muscles taking on the same action from the same cause[c].

"At this time of life the testis is connected in a very particular manner with the parietes of the abdomen, at that place where in adult bodies the spermatic vessels pass out, and likewise with the scrotum. This connexion is by means of a substance which runs down from the lower

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[a] [The cremaster does not in fact exist in the true *testiconda*, as the elephant, hyrax, seal, walrus, the Cetaceous and Monotrematous Mammalia; in these the testes are merely supported by their vessels and a fold of peritoneum analogous to the broad ligaments of the uterus and ovaries; but when the cremaster is met with in apparent *testicanda* it is always in relation to a partial or temporary escape of the testis from the abdomen, as in bats and most insectivorous Feræ, and in many of the Glires, as the rats, squirrels, beaver, porcupine, &c.]

[b] [The first lumbar nerve, which gives many small branches to the transversalis abdominis, sends off a branch which, in conjunction with smaller branches from the second lumbar nerve, forms the 'external spermatic nerve' from which the cremaster is supplied.]

[c] [As the cremaster is supplied from common or spinal nerves, it is not surprising that it should in some cases, like the occipito-frontalis muscle, be under the control of the will. Mr. Marshall observes, in his work On Recruits, "Some individuals have the voluntary power of contracting and relaxing the cremaster muscle; others can elevate the testicle on one side but not on the other; and I have seen a few persons who could voluntarily raise a testicle, but had not the power of letting it return into the scrotum."]

end of the testis to the scrotum, and which at present I shall call the ligament, or gubernaculum testis, because it connects the testis with the scrotum, and seems to direct its course through the rings of the abdominal muscles. It is of a pyramidal form; its large bulbous head is upwards, and fixed to the lower end of the testis and epididymis, and its lower and slender extremity is lost in the cellular membrane of the scrotum. The upper part of this ligament is within the abdomen, before the psoas, reaching from the testis to the groin, or to where the testicle is to pass out of the abdomen; whence the ligament runs down into the scrotum, precisely in the same manner as the spermatic vessels pass down in adult bodies, and is there lost. The lower part of the round ligament of the uterus in a fœtus very much resembles this ligament of the testis, and may be plainly traced down into the labium, where it is imperceptibly lost. That part of the ligamentum testis which is within the abdomen is covered by the peritoneum all round except at its posterior part, which is contiguous to the psoas, and connected with it by the reflected peritoneum and by the cellular membrane. It is hard to say what is the structure or composition of this ligament; it is certainly vascular and fibrous, and the fibres run in the direction of the ligament itself, which is covered by the fibres of the cremaster or musculus testis, placed immediately behind the peritoneum. This circumstance is not easily ascertained in the human subject; but is very evident in other animals, more especially in those whose testicles remain in the cavity of the abdomen after the animal is full grown.

"In the hedgehog the testes continue through life to be lodged within the abdomen, in the same situation as in the human fœtus; and they are fastened by the same kind of ligament to the inside of the parietes of the abdomen at the groin. Now in that animal I find that the lowermost fibres of the internal oblique muscle, which constitute the cremaster, are turned inwards at the place where the spermatic vessels come out in other animals, making a smooth edge or lip by their inversion, and that then they mount up on the ligament to the lower end of the testis[a]. Sometimes in the human body, and in many other animals, and very often in sheep, the testes do not descend from the cavity of

[a] [The apparent anomaly of this, as of almost every other natural structure, disappears when we attain the requisite amount of knowledge respecting the conditions under which it exists. The testes of the hedgehog, like those of the mole, (see p. 29,) are subject to remarkable periodical enlargement at the season of copulation, when they are drawn down by the cremaster to the external ring. In this situation they are favourably placed to be affected by the expulsive actions of the diaphragm and abdominal muscles, by which they are eventually protruded and the cremasteric pouch is inverted. As the testes diminish in size their muscular covering contracts upon them and returns them into the abdomen.]

the abdomen till late in life, or never at all. In the ram, when the testis is come down into the scrotum, the cremaster is a very strong muscle; and, though it be placed more inwards at its beginning, it passes down pretty much as it does in the human body, and is lost on the outside of the tunica vaginalis; but in the ram, whose testis still remains suspended in the abdominal cavity, I find that the cremaster still exists, though it is a weaker muscle; and instead of passing downwards, as in the former case, it turns inwards and upwards, and is lost in the peritoneum that covers the ligament which attaches the testis to the parietes of the abdomen, which in this state of the animal is about an inch and a half in length. In the human fœtus, while the testis is retained in the cavity of the abdomen, the cremaster is so slender that I cannot trace it to my own satisfaction, either turning up towards the testis or turning down towards the scrotum. Yet, from analogy, we may conclude that it passes up to the testicle; since in the adult we find it inserted or lost on the lower part of the tunica vaginalis, in the same manner as in the adult quadruped[a].

"The peritoneum, which covers the testis and its ligament or gubernaculum, is firmly united to the surfaces of these two bodies; but all around, to wit on the kidney, the psoas, the iliacus internus, and the lower part of the abdominal muscles, that membrane adheres very loosely to all the surfaces which it covers. Where the peritoneum is continued or reflected from the abdominal muscles to the ligament of the testis it passes first downwards a little way, as if going out of the abdomen, and then upwards, so as to cover more of the ligament than is within the cavity of the abdomen. At this place the peritoneum is very loose, thin in its substance, and of a tender gelatinous texture; but all around the passage of that ligament the peritoneum is considerably tighter, thicker, and of a more firm texture. When the abdominal muscles are pulled up so as to tighten and stretch the peritoneum this membrane remains loose at the passage of the ligament while it is braced or tight all around; and in that case the tight part forms a kind of border or edge around

[a] [By such a pre-arrangement of the relations of the cremaster to the testis the necessity for the latter to overcome in its passage outwards the resistance of the inferior fibres of the transversalis abdominis and obliquus internus is obviated. It cannot reasonably be doubted that the cremaster exists, as such, in the human fœtus prior to the descent of the testis, since it is indubitably present and attached to an abdominal testis in animals where no mechanical cause could have operated to produce this disposition of the muscular fibres. Besides, the use of the cremaster as a supporter and compressor of the testis is obviously too important for such a connexion to have been allowed to result from the gland accidentally, as it were, pushing before it some opposing fibres of the abdominal muscles in its progress outwards, as Carus imagines. See his Comparative Anatomy, by Gore, vol. ii. p. 347.]

the loose double part of the peritoneum, where the testis is afterwards to pass. This loose part of the peritoneum, like the intro-suscepted gut, may, by drawing the testis upwards, be pulled up into the abdomen, and made tight, and then there is no appearance of an aperture or passage down towards the scrotum; but when the scrotum and ligament are drawn downwards, the loose doubled part of the peritoneum descends with the ligament, and then there is an aperture from the cavity of the abdomen all around the fore part of the ligament, which seems ready to receive the testis. This aperture becomes larger when the testis descends lower, as if the pyramidal or wedge-like ligament was first drawn down in order not only to direct but to make room for the testis which must follow it. In some fœtuses I have found the aperture so large that I could push the testis into it as far as the tendon of the external oblique muscle.

"From this original situation within the abdomen the testis afterwards descends to its destined station in the scrotum; but it becomes difficult to ascertain the precise time of this descent, as we hardly ever know the exact age of our subject. According to the observations which I have made, it seems to happen sooner in some instances than in others; but generally about the eighth month. In the seventh month I have commonly found the testis in the abdomen; and in the ninth I have as commonly found it in the upper part of the scrotum. The descent being thus early, and the passage being almost immediately closed, are the principal means of preventing the hernia congenita.

"At the before-mentioned period the testis moves downwards till its lower extremity comes into contact with the lower part of the abdominal parietes: when the upper part of the ligament, which hitherto was within the abdomen, has sunk downwards, it lies in the passage from the abdomen to the scrotum, and in that which is afterwards to receive the testis. As the testicle passes out it in some degree inverts the situation of the ligament passing down beyond it; what was the anterior surface of the ligament while in the abdomen, now becoming posterior and composing the lower and anterior part of the tunica vaginalis, on which the musculus testis is lost. This is more evident in those animals whose testicles can readily be made to pass up from the scrotum to the abdomen. The place where the ligament is most confined, and where the testis meets with most obstruction in its descent, is the ring in the tendon of the external oblique muscle; and accordingly I think we see more men with one testis or both lodged immediately within the tendon of that muscle than who have one or both still included in the cavity of the abdomen, which I shall take notice of hereafter.

"After the testis has got quite through the tendon of the external

oblique muscle it may be considered as now in a way easily to acquire its determined station, though it commonly remains for some time by the side of the penis*, and only by degrees descends to the bottom of the scrotum; and when the testis has descended entirely into the scrotum its ligament is still connected with it, and lies immediately under it, but is shortened and compressed.

"Having now given an account of the original situation of the testes, of the time of their descent from the abdomen, and of the route which they take in their passage to the scrotum, I shall in the next place describe the manner in which they carry down the peritoneum with them, and then explain how that membrane forms the tunica vaginalis propria in common, and the sac of the hernia congenita in some bodies.

"While the testis is descending, and even when it has passed into the scrotum, it is still covered by the peritoneum, exactly in the same manner as when within the abdomen, the spermatic vessels running down behind the peritoneum there as they did when the testis lay before the psoas muscle: that lamella of the peritoneum is united behind with the testis, the epididymis, and the spermatic vessels, as it was in the loins, and likewise with the vas deferens; but the testis is fixed posteriorly to the parts against which it rests, being unconnected and loose forwards, as while it remained in the abdomen. In coming down, the testis brings the peritoneum with it; and the elongation of that membrane, though in some circumstances it be like a common hernial sac, yet in others is very different. If we can imagine a common hernial sac reaching to the bottom of the scrotum, covered by the cremaster muscle; and that the posterior half of the sac covers and is united with the testis, epididymis, spermatic vessels, and vas deferens; and that the anterior half of the sac lies loose before all those parts, it will give a perfect idea of the state of the peritoneum, and of the testis when it comes first down into the scrotum. The testis therefore, in its descent, does not fall loose, like the intestine or epiploon, into the elongation of the peritoneum, but slides down from the loins, carrying the peritoneum with it; and both that and the peritoneum continue to adhere, by the cellular membrane, to the parts behind them, as they did when in the loins. This is a circumstance which I think may be easily understood, and yet that does not appear to be the case; for I find students very generally puzzled with it, imagining that when the testis comes first down it should be loose all round, like a piece of the gut or epiploon in

* [This is the permanent situation of the testis in the Quadrumana, in which also, as in the human fœtus at the period above mentioned, the tunica vaginalis communicates with the abdominal cavity.]