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Over de musculatuur van de pars intramularis tubae fallopii en haar functionele betekenis.

Vasen, Ludwig Christiaan Leon Marie

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Frequent attempts have been made to discover in the region of the pars intramuralis tubae a sphinctermechanism, which might impede or even prevent the passage of noxious material from the lumen of the uterus to the abdominal cavity. Considerable time ago, anatomical structures were observed in animals indicating that the tubal lumen can be periodically closed in its intramural part. In 1928 ANDERSEN demonstrated that, in several animals, at the site of the tubal uterine ostium mucosal formations, such as papillae or villi exist, which are capable of completely closing the tubal lumen in this region. In the first chapter it is shown, that this finding was confirmed by LEE (1925, 1928), LOMBARD KELLY (1927), ALDEN (1943), STRAUSS (1954) and others.

Investigations into human tubes soon revealed, that a different mechanism of closure had to be sought for in man, because at the site of the human tubal uterine ostium special mucosal formations are absent. In man, a thick muscular wall, surrounding the relatively long and narrow intramural part of the tubal lumen, is very conspicuous and suggestive of a sphinctermechanism.

On the other hand, however, one must not overlook the fact, that, evidently, the intramural part of the tube has also an entirely different function, viz. the permitting or even the promoting of the passage of the fertilized ovum in the direction of the uterine cavity, and of spermatozoa in the opposite direction.

In our opinion the failure, so far, to find the anatomical substratum of the above mentioned important functions of the intramural part of the tube is chiefly due to the fact, that, until recently, the exact anatomical structure of the uterine wall and of the free part of the tube was not clearly understood. Therefore, in the second and the third chapter a review is given of the most important publications regarding the structure of the muscular wall of the tube and the uterus. It became evident, especially by HORSTMANN's (1952) investigations,

that three layers can be distinguished in the musculature of the tube, which by this author were named: *subperitoneal musculature*, *vaso-muscular layer* and *autochthonous musculature* of the fallopian tube.

In the outer, subperitoneal layer, the course of the fibres is chiefly a longitudinal one. It is HORSTMANN's opinion, that this layer is closer connected with the peritoneum than it is with the autochthonous musculature of the tube, mainly for the reason that a part of its fibres continues subperitoneally into the broad ligament (fig. 2, page 15). In the middle layer of the wall, the vasomuscular layer, large vessels are present. They show a sheath, consisting of muscle fibres, which, for the most part, run parallel to the longitudinal axis of the vessels. These vessels, the course of which is mainly perpendicular to the longitudinal axis of the tube, show an extreme development in the pars ampullaris tubae. According to the opinion of KNEER (1949) and HORSTMANN (1952), they play an important role in the segmental division of this part of the fallopian tube. The autochthonous musculature, so called because exclusively this muscular tissue originates from the wall of the MULLERIAN duct, is much stronger developed in the pars isthmica than it is in the pars ampullaris. In the isthmical part of the fallopian tube this layer can be divided into an inner zone, consisting of nearly longitudinal fibres, and an outer zone, in which the fibres show a spiral course. Without interruption, the muscular fibres pass from the outer into the inner zone.

Particularly from the comparative anatomical investigations of SOBOTTA (1891) but also from those papers, which were concerned with embryological investigations, it became clear to us, that in the uterine muscle probably three layers, similar to those in the wall of the fallopian tube, can be distinguished. In the uterus of an adult female, however, these layers are undoubtedly not so sharply bounded as is the case in the wall of the fallopian tube. This may be one of the reasons why only as late as in 1930 GOERTTLER was able to compose an acceptable diagram of the course of the muscular fibres in the wall of the uterus (fig. 4, page 33). Notwithstanding the fact, that later on this diagram was proved not to be entirely correct in every detail, undoubtedly GOERTTLER's examination has been of great value.

In the fourth chapter the literature concerning the intramural part of the human fallopian tube is reviewed. Nowhere we found a description of special mucosal formations in this part of the human

fallopian tube. The most striking feature was, that, according to general opinion, the autochthonous musculature of the isthmus tubae continues to the level of the ostium uterinum tubae without modifying its structure. Surrounding this intramural musculature of the tube, but clearly separated from it, muscular tissue would be present very similar or even identical with that of the myometrium (fig. 7, pag. 47). A sphincter mechanism, whether in the shape of an anatomical preformed muscle, or of a so-called functional sphincter has not been demonstrated convincingly.

In the fifth chapter the results of the present investigation are dealt with. They can be summarized as follows:

1. Our investigation of adult and neonatal uteri revealed, that each of the three layers of the tubal wall continues without interruption into the uterine wall (fig. 29, page 79). Doing so, the mass of each layer increases conspicuously, its structure, however, remaining unchanged. As the wall of the fallopian tube, so the myometrium can, therefore, be divided into a *subperitoneal musculature*, which is connected with the peritoneum; a *vasomuscular layer*, which contains the larger vessels with their enveloping sheaths of muscular fibres and the *autochthonous musculature* of the uterus, originating from the wall of the MULLERIAN duct. The muscular layers of the uterus, however, are less distinctly bounded than the similar ones in the wall of the tube, because many muscle fibres of one layer merge with those of the adjacent layer.
2. According to our opinion, therefore, a clear separation, generally described between the intramural autochthonous musculature of the tube and the surrounding uterine muscular tissue, does not exist. The autochthonous musculature of the tube, indeed, is quite continuous with the inner muscular layer of the myometrium, which was named by us "autochthonous musculature of the uterus" and is of the same origin.
3. The *subperitoneal muscular layer* constitutes a loop of muscular tissue surrounding the distal end of the intramural tubal lumen. Contraction of this loop will cause local constriction and even obstruction of the tubal lumen (fig. 8, 9, 10 and 11, page 63 and 64, and fig. 12, page 67).
4. A similar effect can be expected from one or two vascular rings, present in the *vasomuscular layer*. They likewise enclose the

intramural part of the tube (fig. 15, 16, 17 and 18, page 69 and 70, and fig. 19, 20 and 21, page 72). The vessels, which constitute these rings, like all arteries and veins in the uterine and tubal wall, are surrounded by muscular sheaths, the fibres of which run virtually parallel to the longitudinal axis of the vessels (fig. 13 and 14, page 67).

5. Of the three separate layers, it is the *autochthonous musculature*, that shows the most complicated structure. It was found to consist of four systems of muscle bundles, the course of which is shown in the figures 23, 24 and 25, page 74 and 75. Three different components can be distinguished in this course and the autochthonous muscle layer may, therefore, be divided into three zones. The muscle bundles in the outer and inner zone run more or less parallel to the longitudinal axis of the fallopian tube, those in the middle zone form circular patterns surrounding the tubal lumen. This unusual structure enables not only the muscular layer to exert a constricting effect on the larger part of the intramural tube, but also to effect, by means of peristaltic waves, the transportation of the ovum in the direction of the uterine cavity and that of spermatozoa in the opposite direction.

In particular the passage of the relatively large ovum through the narrow intramural tubal lumen will be facilitated in this way. The muscle fibres of the autochthonous musculature, after passing from the middle zone to the inner zone, run in the direction of the uterine cavity. Consequently a peristaltic wave produced in the same direction is always bound to be preceded by dilatation of the tubal lumen.

Fig. 29, page 79, presents an attempt to demonstrate in a single drawing the structure of each of the three layers of the wall of the intramural part of the tube.

6. Neither in the literature, nor in our own investigation mucosal swellings or special mucosal formations, which might explain closing of the lumen, were found in the intramural part of the human tube.

Basing ourselves on these facts and on data, obtained by tubal insufflation and hysterosalpingography, it is concluded in the sixth chapter, that the surrounding musculature apparently plays a more important role in the variable patency of the intramural

lumen of the tube than the mucosa does. This opinion is confirmed especially by the investigations of TULZER (1958), and of FIKENTSCHER and SEMM (1958).

In the same chapter the possibility is discussed, that even without contraction of the surrounding muscular tissue the lumen of the intramural part of the tube is nearly continuously closed. Only in case of increased pressure in the cavum uteri, combined with closure of the cervical canal, as is artificially realized in cases of tubal insufflation and hysterosalpingography, or by peristaltic contractions, it would be possible, that passage of material occurs from the cavum uteri towards the free part of the tube (endometriosis!). In our opinion these hypotheses can explain sufficiently the facts, that a passage of noxious material from the uterine lumen to the abdominal cavity so seldomly occurs and that a selection is exercised on the spermatozoa, particularly by the intramural part of the tube.

In the second part of the sixth chapter the clinical importance of the results of our investigation was demonstrated in discussing some of their clinical aspects.