THE ÆTIOLOGY OF TUBAL PREGNANCY.

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PERUSAL of the literature on the ætiology of tubal pregnancy produces a mass of conflicting evidence. In this paper an attempt has been made to classify this evidence, and to reduce it more or less to "*pro and con*."

The conditions which have been considered to be the causes of tubal pregnancy may be divided up under eight headings:—

1. Salpingitis and perimetritis.
2. Persistence of infantile conditions in the tube.
3. Polypi, diverticula, etc., in the tube.
4. Puerperal atrophy of the tube.
5. Atavism, reversion to a lower developmental type of tube.
6. "External wandering" of the ovum.
7. "Internal wandering" of the ovum.
8. Abnormalities of the ovum itself.

Besides these, mental shock or excitement during coitus, causing peristalsis in the tube has been considered to be a cause of tubal pregnancy.

The evidence for and against these various theories will be considered, the authorities quoted being taken, as far as possible, in chronological order.

1. *Salpingitis and Perimetritis.* The theory which has found most adherents is that which assigns the causation of tubal pregnancy to salpingitis and perimetritis.

Virchow,³³ in 1850, was apparently the first to suggest, from his experience in the post-mortem room, pelvic inflammation as a cause of tubal pregnancy.

Catarrhal inflammation of the tubes, resulting in the loss of cilia, was suggested by Schroeder in 1872.

Martin,¹³ in 1881 and 1886, considered tubal inflammation to be the cause of tubal pregnancy. Later, as will be seen below, he changed his views.

Lawson Tait,³¹ in 1889, looked on desquamative salpingitis as being responsible for the occurrence of tubal pregnancy. He considered that the uterus was the seat of normal conception, and

that the function of the ciliated lining of the Fallopian tube was to prevent spermatozoa from entering the tube. The impregnated ovum required a raw, denuded surface to settle upon, and the provision of such a surface was one of the results of salpingitis.

Olshausen,¹⁷ in 1890, considered that old inflammation with its results, loss of epithelium or rigidity of the infiltrated tube wall leading to diminished peristalsis, was a cause of tubal pregnancy.

Orthmann,²⁰ in 1890, described the microscopical appearances of the uterine end of the pregnant tubes which he had examined. In the majority of cases these were characteristic of catarrhal salpingitis. He discussed Werth's theory that these changes might be due to the irritation produced by the neighbouring developing ovum. Orthmann preferred to consider that catarrhal salpingitis was the cause of the changes in the mucous membrane, muscle and intramuscular connective-tissue, and also of the intramuscular branchings of processes from the tubal lumen, pointing out that the usual accompanying peritoneal changes, leading to adhesions, twisting of the tube, etc., were also found. He held that catarrhal salpingitis, with its results, was the essential cause of tubal pregnancy. As regards the irritation theory, he thought that the decidua-like proliferations of the peritoneal cells might be due to the irritation produced by the developing ovum.

Prochownick,²³ in 1895, reports a case in which the part of the tube between the ovum and the uterus contained sero-pus, in which numerous living gonococci were found. In another of Prochownick's cases gonorrhœa and tubal pregnancy both resulted from the first coitus. On both sides of the ruptured sac the tube contained pus in which gonococci were found. However, as salpingitis does not immediately follow infection with gonorrhœa this case cannot be considered to prove that an ovum may settle in an acutely inflamed tube.

Schauta,²⁴ in 1896, was able to make a careful examination, in 46 out of 49 cases operated on by himself, as to the presence of salpingitis. In 32 out of the 46 cases there were, apart from perimetritic adhesions, undoubted signs of chronic salpingitis on the non-gravid side, and of such gravity in 2 of these that he removed the non-pregnant tube as well as the pregnant. He considers that salpingitis is a great cause of tubal pregnancy—catarrhal inflammation of the uterus, usually ascending gonorrhœa, attacks the tubes. The tubal mucous membrane, however, is not all affected at once, but gradually and by a process of extension. So, in the neighbourhood of the spot where the ovum becomes imbedded, especially towards the ampullary

end, quite normal mucous membrane may be found. A patent ostium abdominale and normal condition of the greater part of the tubal mucous membrane can be admitted without weakening the connection between catarrh of the tubes and tubal pregnancy.

Dührssen,³ in 1897, wrote a long paper based on 37 cases of his own. He says: "If endosalpingitis be a cause of tubal pregnancy, this endosalpingitis being usually due to an ascending process from the uterus, one would expect to find the evidences of inflammation more marked at the uterine end, less at the abdominal end." His own investigations convinced him that this differing intensity of inflammatory changes is found. In one of his cases cilia were present on the abdominal side of the ovum, absent on the uterine side. In 24 out of 35 cases, *i.e.*, in 68·6 per cent. of his own cases, Dührssen found evidence of tubal disease existing before the pregnancy, and in many of these cases he considered that the disease must have been of long standing. Dührssen considers it very rare for a woman with healthy genital organs to suffer from tubal pregnancy. Cases in which no disease of the tubes has been found may often be explained by the fact that only macroscopical examination has been made. He asks: "Is the pre-existing inflammatory alteration in the tube the cause of tubal pregnancy?" If all the cilia were lost, pregnancy of any sort, excepting ovarian, would probably be impossible, because the ovum would not enter the tube. Dührssen has frequently tried to find spermatozoa in the tubes of young women with healthy adnexa, during his numerous vaginal fixations, but has not succeeded, though he once found them in pathologically altered tubes. Do spermatozoa normally enter the tubes? If so, tubal pregnancy may occur if the ovum is impeded in its journey through the tube. If they do not normally enter the tubes the want of cilia which prevents the ovum coming down the tube to the uterus would favour the entrance of spermatozoa. Dührssen asks: "If these changes in the tube are the result of pregnancy, why are similar changes not seen in the uterus in intra-uterine pregnancy?"

Engström operated for tubal pregnancy on four women whom he had previously treated for salpingitis.

Van Obt¹⁶ found inflammatory changes, in most cases attributable to puerperal causes, in 19 out of 22 cases of tubal pregnancy.

Küstner⁸ found pus in a pregnant tube, close to the gestation sac. He looks on the loosening and hyperæmia of the tubal mucous membrane remaining after salpingitis as being comparable to the menstrual congestion in the way of making the mucous membrane suitable for implantation of the ovum.

Mandl and Schmit,¹² in 1897, found that in 24 out of 77 cases there had undoubtedly been previous gonorrhœa. They point out that tubal pregnancy is very rare in animals as compared with its frequency in women, and that inflammatory diseases of the tubes are also very rare in animals.

Glitsch,⁵ in 1900, discusses the ætiology of tubal pregnancy. His own cases, he says, point to inflammatory conditions as a cause. In 17 out of 43 cases there were definite evidences of inflammation of the non-pregnant tube. He agrees that many adhesions are only consequences of tubal pregnancy. He concludes—

1. There is no one single cause of tubal pregnancy. Usually when tubal pregnancy occurs there is a sort of predisposition on which acts some more or less accidental exciting cause (*Gelegenheitsursache*).

2. The most common cause is inflammatory change in the tubes and neighbouring tissues. All other causes, such as infantile type of tube, polypi, tumours, etc., and external and internal wandering of the ovum are comparatively rare.

3. The cause of the inflammation is usually infection by micro-organisms, most commonly gonococci, sometimes puerperal infection or tubercle.

Opitz¹⁹ is the latest upholder of the theory that salpingitis is a cause of tubal pregnancy. His paper, which appeared in 1902, is based on examination by serial sections of the part of the tube between the ovum and the uterus in 23 cases. In every case he found evidences of old salpingitis. He lays great stress on the changes found in the tubal mucous membrane. His description of these changes is very much the same as that given by Orthmann. The folds are thickened, not merely because they are œdematous; on the other hand, the stroma is denser than it is normally. The folds are united to one another by adhesions of old standing with formation of *culs-de-sac*. Besides these *culs-de-sac* there are numerous prolongations of the lumen into the muscular tissue of the tube, these prolongations usually running at right angles to the long axis of the tube. There are also signs of inflammation, old adhesions, on the outer side of the tube in almost all cases. Opitz considers that the œdema and infiltration with leucocytes noticed in the tube wall by many observers are consequences of pregnancy and not results of salpingitis, and is of opinion that we ought to be able to distinguish between recent and old inflammatory changes in the wall, and also between recent and old adhesions. The above-mentioned changes in the mucous membrane are more marked the nearer we approach

to the uterus. Opitz considers that the acute inflammation must have passed off before implantation of the ovum can occur. Although he did not examine his specimens in the fresh state, he saw evidences of cilia being still present. He does not consider that peristalsis of the tube could assist, or want of peristalsis hinder, the passage of so small a body as the human ovum. He suggests that the ovum may itself have some power of motion, citing the occurrence of amœboid movements in the segmentation-spheres.

Against the theory that salpingitis is a cause of tubal pregnancy several writers must be considered:—

Werth, in 1888, held that the changes found in pregnant tubes were a result rather than a cause of the tubal pregnancy.

Zedel,³⁸ in 1893, examined the uterine end of the tube in four cases of tubal pregnancy, and found cilia present in all. In three other cases, with a different method of preparation, he was able to see active movement of the cilia. He quotes Veit, who also saw the cilia moving in three cases.

Martin,¹³ who had formerly considered that tubal inflammation was a cause of tubal pregnancy, in 1893 looks on the changes in the tube as being much more probably consequences than causes. He considers that if there has been endosalpingitis there must be a *restitutio ad integrum* or, at any rate, an almost complete recovery, before pregnancy can occur in the tube. He agrees with Wyder that contact between the ovum and spermatozoa occurs physiologically in the uterus, and that spermatozoa only exceptionally pass beyond the internal ostium of the tube. Where the meeting occurs there the ovum remains. If the soil at that point is favourable development progresses, if not the ovum dies. Wandering of an impregnated already enlarged ovum is inconceivable. He does not bring forward evidence to prove these statements.

Strassmann²⁹ considers that the tube is the usual meeting place for the spermatozoon and ovum.

Again, in 1895, Martin¹⁴ writes that he considers that as long as a chronic interstitial salpingitis exists the woman is sterile, so neither uterine nor extra-uterine pregnancy will occur. He explains Ahlfeld's experience at Giessen and Marburg, where he only saw one case of tubal pregnancy in nine years, as due to the fact that country patients are less willing to submit themselves to examination and operation than are patients in large towns. Upholders of salpingitis as a cause of tubal pregnancy explain Ahlfeld's experience as due to the fact that gonorrhœa is less common in country districts and small towns than in large towns.

Prochownick,²³ in 1895, found that in one out of his eight cases comparison of the mucous membrane of the uterine end of the pregnant tube with that of a healthy tube from a virgin showed no differences. In two other cases, although the history pointed to previous tubal catarrh, no evidence of this could be found microscopically.

Pagny,²¹ in 1897, considers that salpingitis is unfavourable to the occurrence of tubal pregnancy. In only four out of 20 of Pinard's cases could he find evidence of previous inflammation.

Bland-Sutton,³⁰ in 1896, considers that a healthy Fallopian tube is more likely to become pregnant than one which has been inflamed.

Kreisch,⁷ in 1899, discusses inflammation of the tubes as a cause of tubal pregnancy. His specimens do not lead him to consider that this is the only cause. He considers that the causes which lead to tubal implantation of the ovum are many and various, and with careful examination, macro- and microscopical, can generally be found.

Braun-Fernwald,² in 1902, discussing tubal inflammation as a cause, points out that the fact that the non-pregnant tube is in a condition of hydrosalpinx cannot by itself be taken as proof that salpingitis was present before the pregnancy, and was the cause of the pregnancy being tubal. A large hæmatocele might seal up the end of a healthy tube, thus leading to hydrosalpinx.

2. *Persistence of the Infantile Condition of the Fallopian Tubes.* Freund,⁴ in 1888, considered that persistence of the infantile type of tube, with spiral windings, was a cause or the cause of tubal pregnancy.

This theory received support, in 1893, from Abel, who considered that in women who had repeated tubal pregnancies the tubes had retained their infantile conformation, and that in these cases tubal is the usual form of pregnancy.

Against this theory, Martin,¹⁴ in 1895, says that he has not often seen the kinking of the tube described by Freund, and that when it does occur it will usually disappear on removal of the contained ovum, *i.e.*, the kinking is a consequence, not a cause, of tubal pregnancy. Some patients who have had repeated tubal pregnancies have also had normal uterine pregnancies, a fact which argues against Abel's above-mentioned theory.

Dührssen,³ in the paper quoted above, points out that if Freund's suggestion that persistence of the infantile type of tube is a cause of tubal pregnancy were correct we would expect to meet with tubal pregnancy most frequently in primigravidæ. Tubes of the so-called

"infantile type," *i.e.*, which are markedly tortuous, are usually as thick as one's thumb. This thickening is the result of inflammation. Again, Freund states that in the tubes described by him the median curves are very seldom preserved. It is noteworthy that tortuosity due to salpingitis is usually most marked at the uterine end. Uterine pregnancy subsequent to tubal does not seem to be of such rarity as Abel declares it to be.

Opitz¹⁹ points out that in rabbits the tubes are much more sinuous than in the so-called infantile condition, but rabbits' ova, which are both relatively and absolutely far larger than human ova, pass down the tube into the uterus without difficulty.

3. *Diverticula, Polypi, etc., in the Tube.* Several observers, *e.g.*, Leopold^{9 10} and Wyder,³⁷ have described cases in which polypi in the tube seemed to be responsible for the arrest of the ovum, and the consequent tubal pregnancy.

Dührssen³ describes a polypus which he found immediately between the ovum and the uterus, completely filling the lumen of the tube. He quotes other cases, and throws doubt on the connection between the polypus and the tubal pregnancy in most of them.

Kreisch⁷ considered that in one of his cases the polypous condition of the tubal folds prevented the ovum from reaching the uterus.

Henrotin and Herzog,⁶ in 1899, described a very interesting case of extra-uterine pregnancy in an accessory pavilion which did not communicate with the main tube. They quote several other cases, in most of which the accessory communicated with the main tube. They also describe a case of tubal pregnancy in a diverticulum.

Opitz¹⁹ considered that in one of his cases the ovum had been caught in a diverticulum.

Mandl and Schmit,¹² in 1897, published an interesting series of experiments bearing on the question of atresia of the tube as a cause of tubal pregnancy. They experimented on rabbits, guinea-pigs, and a bitch, thus:—

1. Both tubes were ligatured at their junction with the uterine cornu in 8 animals, 1 to 3 days *post coitum*. In no case did tubal pregnancy occur.

2. Only one tube was ligatured, as above, in 4 animals. The tube and uterine horn on the ligatured side were found empty, the other horn pregnant, in every case.

3. One uterine horn was tied in one case in the middle, in another case in its upper one-third, in 2 other cases near its junction with the tube. Both tubes were found empty, the unligatured horn and the portion of the other horn above the ligature pregnant, in every case.

4. One tube was ligatured, removed 4—10 days later and examined by serial sections. The tubal mucous membrane was everywhere normal, there was no decidual reaction and the ovum was found to be degenerating.

Their deductions from these experiments were that the mere fact that the tube is not patent cannot of itself be the reason why tubal pregnancy occurs. They consider that (i.) the ovum must be hindered in some way from passing on into the uterus, and (ii.) the tube must be capable of decidual reaction. They do not agree with Clarence Webster's^{34*} explanation of the reason why some tubal mucous membranes can produce decidua while others cannot. They ask: "Does the tubal mucous membrane in the human female always form decidua when the ovum for any reason is prevented from reaching the uterus?"

4. *Puerperal Atrophy of the Tubes*. Dührssen,³ in 1897, suggested puerperal atrophy as a cause of tubal pregnancy. He was struck by the fact that, of his own cases, 7 out of 29 women suffered from tubal pregnancy within a year after the termination of an intra-uterine pregnancy. In one case no trace of inflammation could be found, and the patient became pregnant again, the pregnancy this time being intra-uterine, within a year after the operation. His observations have convinced him that there is a marked atrophy of the tubes after uterine pregnancy, whether the patient suckles or not. The tube wall is not so compact as usual, spaces being found in it. The nuclei of both muscle and connective-tissue cells are smaller and narrower than usual. There is a striking increase in the width of the lumen, and atrophy of the folds throughout the whole length of the tube. The muscle is atrophied, therefore there is diminished peristalsis. The lumen is widened, therefore, together with the diminution of peristaltic movements, the entrance of spermatozoa is favoured, and the ovum is not carried on into the uterus.

The views of Opitz¹⁹ on the effect of peristalsis on the ovum have been quoted above.

5. *Atavism*, reversion to a lower developmental type of tube. Clarence Webster,³⁴ in 1895, considers that some tubes can produce decidua, others cannot. "Decidual tissue is, it must be believed, essential to the attachment and development of the young ovum" . . . "Among those animals (some non-mammalians) possessing a genital tract, the least specialised condition is that in which there is no distinction between oviduct and uterus, in which the tract is bilateral and in which the ova may develop practically along its whole extent."

* *Vide infra*.

. . . "When we come now to the human female, in which the single uterus exists, we find that the decidual changes induced by pregnancy in the great majority of cases take place only in the uterine mucosa where the ovum normally grows. However in some cases . . . the tubal mucosa can, in great or small extent, respond to the genetic influence as well as that of the uterus. This is probably because of some developmental fault whereby there is a reversion either of structure or reactive tendency in the tubal mucosa to an earlier type in mammalian evolution. I mean that in which a larger portion of the Müllerian ducts showed decidual reaction. Because of these occasional changes in the Fallopian tube conditions are brought about capable of establishing with a fertilised ovum that relationship which is essential to its development." . . . "Ectopic pregnancy probably only occurs when fertilisation takes place above the part of the mucosa showing the decidual reaction. In this connection we are able to understand the part played by such conditions as inflammation, displacements, tumours, etc., in the tube or outside it, which lead to some interference with the free continuity of the tube lumen."

Patellani,²² in 1896, considers that human tubes may be looked on as not being in quite functional activity. "If a portion of Müller's duct remains in an earlier phylogenetic stage as regards its morphological development (Freund's spiral windings in adult women), this section of the genital tract will correspond as regards function also to the same part of the genital tract of the lower animals."

Moericke,¹⁵ in 1900, discards the theories that the implantation of the wandering ovum in the tube is brought about by simple obstruction to its progress, and that perimetritis and gonorrhœal salpingitis are responsible for the occurrence of tubal pregnancy. From his "developmental and social studies" he is inclined to agree with Clarence Webster as regards atavism. He thinks that such conditions as bad hygiene are much more responsible than gonorrhœa. Tubal pregnancy is far more common among the poor than among the rich. He considers that the ovum can implant itself on the tube if the latter is developmentally defective.

Against the "atavism" theory Opitz¹⁹ maintains that as there is no animal whose tubes can serve as "brood-cavity" for the developing ovum, there can be no question in the higher animals of a "throw-back" to an earlier period of development if the ovum be implanted in the tube.

6. "*External Wandering*" of the Ovum, i.e., wandering in the peritoneal cavity external to the uterine cavity. It has often been noticed that the ovary on the side corresponding to the pregnant tube

does not contain a recent corpus luteum, while there is a recent corpus luteum in the other ovary. As the ovum in these cases had to make a longer journey than usual it was suggested that it became during this journey too large to pass through the tube.

Sippel,²⁷ in 1892, suggested that the *size* of an ovum which has gone beyond the usual time without entering the uterus is not of so much importance as the facts that (i.) its surface has become rough, and (ii.) it has already acquired the property of exciting the specific stimulus which causes the formation of a decidua. Recognising the value of recent work on the subject, Sippel,²³ in 1901, modifies this suggestion thus:—"The ovum has acquired the power of boring its way through epithelium." Sippel claims that cases of ectopic pregnancy in which the ovum is implanted on the fimbria ovarica, *e.g.*, a case recorded by Martin, prove that impregnation of an ovum in the abdominal cavity is possible.

Anyone who denies the connection between external wandering of the ovum and tubal pregnancy must say, as the two comparatively often occur together, either (i.) that external wandering is a common occurrence, or (ii.) that the impregnated ovum does not come from the follicle which forms the corpus luteum. The former suggests that the arrangement of the genital organs is faulty, the latter goes directly against our knowledge of facts. How does the external wandering of the ovum occur? Possibly peristaltic action of a coil of gut determines the movement of the ovum from one side to the other, or the current produced by the cilia on one side may be weak.

Lode's¹¹ experiments with ascaris ova have proved the existence of such a current. If there be a weak current on one side this fact would help to explain the possibility of the spermatozoa reaching the abdominal cavity.

Sippel throws doubts on the value of Mandl and Schmit's experiments on the following grounds:—(i.) It is not *certain*, in spite of some reported cases, that extra-uterine pregnancy can occur in such animals as those they employed; (ii.) it is not certain that the ova had been impregnated before the ligatures were applied.

Lode,¹¹ in 1894, injected ascaris ova, selected after trial of various small bodies, into the peritoneal cavity of rabbits. At a subsequent post-mortem examination both ends of the tubes, the whole length of the uterus and the vagina were found to contain no ova, the middle part of the tubes contained numerous ova. The animals were not on heat. The experiments were only successful when performed on sexually mature animals.

As proof that "external wandering" alone is not sufficient to

cause tubal pregnancy Küstner⁸ records a case in which a woman became pregnant two years after he had removed her gravid right tube and enlarged left ovary. This second pregnancy was intra-uterine. Küstner removed the ovary of one side and ligatured or resected the tube of the other side in several rabbits. Extra-uterine pregnancy did not follow, though uterine pregnancy occurred frequently in the next few years.

Opitz¹⁹ found the corpus luteum on the same side as the pregnant tube in 15 out of 18 cases.

7. "*Internal Wandering*" of the Ovum, i.e., passage of the ovum from one tube to the other across the uterine cavity. v. Schrenck²⁵ describes one case in which a tube contained two ova of different ages, the younger ovum being the nearer to the uterus. (The writer has been unable to find v. Schrenck's paper.) Wyder also describes one case, but the ovum was situated not in the tube itself, but at the junction of the uterus with the tube.

8. *Abnormalities of the Ovum itself*. Olshausen¹⁸ suggests that in cases where twin tubal pregnancy occurs the ova impede each other's passage through the tube.

Kossmann,^{6a} noting the frequency with which the ovaries present some abnormal appearance in cases of tubal pregnancy, suggests that these pathological ovaries may have supplied pathological ova. With regard to this suggestion it is interesting to note that Opitz¹⁹ found the corpus luteum cystic in 7 out of 15 cases.

For obvious reasons most writers have not considered the question of the ætiology of ovarian pregnancy. Opitz¹⁹ considers that there are two possibilities—(i.) there is oöphoritis with resulting density of the tunica albuginea, and consequently there is only a minute aperture formed through which the spermatozoon enters, while the ovum does not escape; (ii.) the escaping ovum may be caught by adhesions and held in situ.

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