

THE TECHNIQUE OF TUBAL STERILIZATION¹

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THE subject of this paper was suggested by the action of the last General Assembly of the State of Iowa, which passed a law legalizing the sterilization of certain of its mental and moral delinquents "by vasectomy, or by ligation of the fallopian tubes," the object being to prevent the transmission of the torch of life by the mentally and the morally unfit. The law specifically states that the sterilization of women shall be by ligation of the fallopian tubes, but it is not specified whether the approach shall be by the abdominal or by the vaginal route, this point being left to the judgment of those whose duty it may be to carry out the provisions of the law.

The literature on this subject is very scanty in the English language, but relatively abundant in the German, less so in the French, and in the Italian. We shall see that the framers of the Iowa law, as well as practically all American writers that have reported cases of tubal ligation, were not very familiar with the work done in Germany.

It is not my purpose to discuss the moral, the sociological, or the legal phase of this question. I will confine myself to the technique of tubal sterilization.

At the outset, I might say that many methods of tubal sterilization have been suggested—simple division; single ligation with catgut or

with silk; double ligation with catgut or silk, with or without intervening division with a knife, scissors, or the actual cautery; sometimes with a cone shaped excision or destruction by cautery of the mucous lining of the tube; crushing of one or more centimeters of the tube without ligation; double ligation with crushing between the ligatures; and crushing of the tube with ligation in the furrow. It has been suggested to close the divided ends of the tubes with musculo-muscular and sero-serous sutures, with end-to-end approximation by additional sero-serous sutures; the divided ends of the proximal segment have been ligated and buried under the peritoneum, or they have been brought forward and fastened in the wall of the vagina, or in the inguinal canal. A rather dainty operation is that in which the serous covering of the tube is divided by an incision parallel with the tube, the oviduct pulled out, divided, the distal ends of the proximal segment being buried in the folds of the broad ligament, the proximal end of the distal segment opening freely into the peritoneal cavity. Still more dainty is that in which a three or four millimeter incision is made over the tube, two or three centimeters of the oviduct drawn out, and excised, sutures not being necessary, as the divided ends of the oviduct recede, and a firm, impervious cord remains. The mucous membrane of the uterus has been destroyed by means of steam. Earliest

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of all was the suggestion to attempt to close the pars uterina of the tube by means of an intra-uterine porte caustique, and later the actual attempt to accomplish the same end by means of an intra-uterine galvano-cautery.

The one efficient operation is the removal of all or the greater portion of the tube with the horn of the uterus, including, of course, the pars uterina of the tube, the uterine defect being closed by means of musculo-muscular and sero-serous sutures.

The tube has been approached through an anterior or a posterior transverse or a sagittal colpotomy, through the inguinal canal, and by way of the median abdominal route.

I shall briefly review some of the reports on animal experimentation, next the results of ligation of pathological tubes, and, lastly, the results of the operations on normal human tubes.

Ronsse made a series of experiments on the tubes and on the bicornate uteri of rabbits which he believed fully proved that simple division, simple ligation, or ligation with division, was sufficient to prevent conception. Further, he found that a cyst always developed laterad to the point at which the uterine cornu was ligated, or divided without ligation. From these observations he concluded that the secretion in the cornua flows toward the vagina. In the tube, a single ligature or a single division was never, but double ligation or double division was always followed by hydrosalpinx. From this latter observation Ronsse concluded that the secretion in the tube passed either peripherad or centrad when there was a single ligature, or a single division; but when two ligatures were applied to the tube, or when the tube was divided at two points, a cyst always formed between the two ligatures or between the two points of division, because, he concluded both simple ligation and simple division, by sealing the end of the tube, completely and permanently prevented the passage of fluid, hence also permanently prevented the passage of ova and of spermatozoa. He believed that the fluid which accumulated in the tube was a normal secretion rather than the result of inflammation or disturbed circulation. These animals were all killed within a very short time after the operation, before the swelling incident to the trauma could possibly have subsided, and hence can not be of great value.

Ronsse operated on six women, doing either a single ligation or a simple division, and in none of these six women had conception occurred within a year.

While the work of Ronsse is most interesting it is difficult to believe that his conclusions are warranted either by his experiments or by the results of his operations.

The animal experiments of Friedmann are of a different type, and most interesting. In experiments 1 and 2, the tubes of a large rabbit were ligated with catgut. Six weeks later the animal was killed, the ligatures had disappeared, the tubes were patulous, and fluid readily passed through them. In experiments 3 and 4, on a large rabbit, the ligatures had cut through, and the tubes were patulous. Experiments 5 and 6 were on a grown cat; the tubes were crushed and ligated in the furrow, catgut being used in one case, silk in the other. Both animals were paired at the next season and both had young. Experiments 7 and 8 were the same on bitches. Both animals were paired at the next season and both had young. In experiment 9, on a rabbit, the tubes were crushed and a ligature placed on either side of the crushing forceps; young followed the next mating. In experiment 10, on a rabbit; the tubes were crushed with a smooth Langenbeck needle holder; conception was not prevented. In experiment 11, on a rabbit, the tubes were crushed, catgut ligature in the furrow; the animal was killed in six weeks; the tubes were not patulous. Experiment 12, same as above; young after the next mating. Experiment 13, the same as above; young after the next mating. Experiment 14, on a bitch; tubes were crushed with difficulty; silk ligature in furrow; mated two months later; young. Experiments 15, 16, and 17 were on bitches; the same procedure, the same results following the mating. Five similar experiments were on cats, with the same results. Friedmann maintains that the proper crushing of the tube is a procedure of great delicacy; it is easy to use too much force and divide the tube. These experiments are quite conclusive so far as rabbits, cats, and bitches are concerned, and certainly tend to show that ligation is of very questionable efficiency in closing the tube in women. Friedmann had in view especially the function of the tube, while Fraenkel made careful study of the microscopic and anatomic results of his experiments.

Fraenkel made 33 attempts to close the tubes or cornua of rabbits by ligation, using silk, catgut, or a rubber band. In these 33 there were but two successes. In some cases the tubes were unchanged, and the ligatures were still attached to the tube by a short band of tissue, having simply cut through, the tube reuniting. Tubo-abdominal fistulae resulted in many ligations, the

ligature cutting into and opening the lumen of the tube. In 29 attempts to close the cornua, none were successful. In two double ligations of the tube, there resulted three tubo-abdominal fistulæ. Feeling that he had demonstrated the fact that ligation, whether single or double, did not close the tube, Fraenkel next made a series of experiments with section, with and without ligation. In simple section, the lumen of the canal may be retained in both divided ends, or the continuity of the canal may be perfectly restored. Resection of from one to two and one half centimeters of the tube usually resulted in double tubo-abdominal fistulæ. A series of experiments in which he cauterized the cut surfaces of the tube, or cauterized its lumen for a short distance, or cauterized the pars uterina of the tube, a patulous canal resulted in all cases. In 12 of 16 cases, Fraenkel found adhesions between the bladder and the large or the small intestine. Hydrosalpinx was present in 26 animals. Fraenkel concludes as follows: "Our attempts to close the tubes are discouraging. We have made perfectly well animals sick, and have exposed them to the possibility of a fatal illness. Our experiments on the cornua gave the same result." Fraenkel advises against ligation because of the liability of the knot to break into the tube, or the ligature may cut completely through the tube, leaving tubo-abdominal fistulæ. He says complete excision of the tube with a cone shaped excision of the pars uterina, with careful suture of the uterine defect, is the only safe procedure.

Kossman tells of his experience in ligating the oviducts of young pullets that began to lay six weeks later, the ligatures having become encrusted with lime salts and broken.

All of these animal experiments, except those of Ronsse, indicate that ligation is an entirely inadequate procedure, and that ligation with division or excision is but little safer.

I shall next refer briefly to the results of ligation, with or without excision of a portion or all of the tube, incidental to operations on women undertaken for pathological conditions.

Ries reports three cases in which diseased tubes had been removed, and in all of which, at a second operation some months later, the tubes were patulous without a trace of ligature. Braun-Fernwald reports Falaschi's experience—the ligation of both tubes in connection with a Cæsarean section, with subsequent pregnancy.

Gordon reports two cases in which the operator removed both ovaries and both tubes, but pregnancy followed in both cases, in the one about

three years, and in the other fifteen months after the operation. Gordon remarks that "some ovarian tissue must have been left, but how did the ovum reach the uterus?" The ligated tube must have become patulous.

Sutton reports a double ovariectomy, the right tube being divided with a cautery, and ligated close to the uterus; the left tube, divided with a scissors and ligated close to the uterus. The patient was delivered of a child about twenty months later, and of a second child about twenty months after the first. Of course, a particle of the ovary must have been left.

Dudley reports three living children and three pregnancies of women from whom he had removed one half of the tubes and a portion of the ovaries. Dudley does not state that he ligated the tubes.

Schmidt ligated and removed the left tube and the left ovary, and all of the right tube except one and one half centimeters because of hydrosalpinx. Pregnancy several years later.

Belser reports a case in which Zweifel made a double ligation and intervening division of both tubes, with subsequent pregnancy. Pape (Belser) reports a double ligation with division of the tubes. Some months later the uterus and tubes were removed because of hæmorrhage incident to an abortion subsequent to the tubal ligation. A careful anatomic and microscopic examination demonstrated that the tubes had reunited in the most perfect manner ("tadellos zusammen geheilt"). Belser's case from the Zurich clinic is instructive. As an incidental operation, both tubes were double ligated and divided. Some months later, the woman was operated for a tubal pregnancy.

In connection with a second Cæsarean section, Abel made a double ligation of both tubes with intervening division. The third Cæsarean section was done three years later, both tubes having reunited, one of them being permeable throughout its entire length.

Pissemsky demonstrated two tubes which had been ligated with silk after a first Cæsarean section; after the second Cæsarean section both tubes were removed; one was found closed and the other patulous, both ligatures being in place.

Vecchi reports a most interesting experience. Incidental to a Cæsarean section, he ligated both tubes with strong Florence silk, drawing the knots tightly to surely occlude the lumen of the tube. Eight months later the patient was again pregnant, and at the second Cæsarean section, feeling that a tubal ligation did not suffice to prevent conception, Vecchi removed the tubes with the ovaries, which gave him an opportunity

to make a careful microscopic study of the results of the previous tubal ligation. He found that both sutures had cut through the tube, that the loops of silk were intact, that the divided ends of the right tube were sealed over with peritoneum, but that the left tube had reunited and was patulous throughout its entire length.

McWalter reports a case in which lactation and menstruation continued, with a brief cessation, after the removal of both tubes and one ovary, an observation not surprising, as tubal ligation does not interfere with menstruation.

Fritsch in connection with a laparotomy ligated both tubes, using silk, and drawing the sutures very tight. The woman became pregnant three years later.

Lambach, incidental to an operation for retroversion, ligated both tubes with silk, drawing the knots very tight. Term pregnancy three years later.

Allen, in a woman of thirty-two, removed a large ovarian cyst on one side, and ligated the tube with silk on the other side. Term delivery fifteen months later.

These results of the removal or ligation of tubes incidental to other operations are but typical, are quite well known and are appreciated by surgeons, and they but confirm the animal experiments of Friedmann, Fraenkel, and others.

Before taking up tubal sterilization as an independent operation, I wish to refer to sterilization by atmocauter, or the destruction of the mucous membrane of the uterus by means of steam at a temperature of 105 to 115°. This procedure is especially recommended by Cramer. The mucous membrane of the cervix must not be destroyed, but all parts of the mucous membrane of the body of the uterus must be reached. He tells of bad results, of severe colic, necessitating a hysterectomy, etc. He closes a long article by stating that this is the best method of producing sterilization, especially in tuberculosis and in heart disease. Pincus and Baisch recommend the same procedure. Cramer reports five cases, three for tuberculosis, and two for heart disease.

The first independent operation for tubal sterilization of the human female was performed by Koch, in 1878. His thought was to bring about a closure of the pars uterina of the tube by means of an especially constructed intrauterine galvano-cautery. Without dilating the cervix, he introduced this cautery into the tubal angle of the uterus and applied the current for 45 seconds, hoping to so cauterize the uterine part of the tube that subsequent sloughing and contraction would efficiently seal the same. Koch

himself stated that the efficiency of the method was not proven, since subsequent failure to conceive may well have been due to other causes. This method found no imitators, and most rightfully so, because it should seem very difficult to accurately estimate actual effect of such a galvano-cautery.

Kehrer, in 1897, performed the first tubal ligation involving the peritoneum. His approach was by way of an anterior colpotomy. He placed two ligatures about the tubes, one quite close to the cornu, without intervening division. There was considerable hæmorrhage from the uterus, in one case, requiring several sutures. There was slight collapse after the operation. Kehrer recommended the procedure for certain physical conditions which made pregnancy a very serious matter. In this first paper he reports but one operation. Later, he reported another, both patients subsequently becoming pregnant.

Spinelli, the first Italian writer to take up the subject, one year after the appearance of Kehrer's article in Germany, suggested that the peritoneal cavity be entered by way of a posterior transverse colpotomy. A forceps guided by the index finger served to bring the tube into view. If normal, a silk ligature was passed about the tube; if diseased, the tube was excised, and a ligature placed about the uterine end. Another method suggested by Spinelli was to enter the peritoneal cavity by way of an anterior sagittal colpotomy, two ligatures to be placed about each tube, with intervening division. If diseased, the tubes should be excised.

Van Meter states that in his first operation for tubal sterilization he placed a single ligature on one tube, and two ligatures on the other tube with intervening division. Later, he ligated the uterine end of the tubes only, leaving the distal end free. In what he terms his perfected operation, he makes a little slit over the tube, hooks up the oviduct, divides the same, covers the uterine end with a few catgut sutures and leaves the other end free in the abdominal cavity.

Werner in a very brief article insists that double ligation of the tube with excision of one or two centimeters between the ligatures suffices to prevent conception.

Morris, at a clinic, presented an 80 lb. patient whose sufferings were such during two pregnancies that neither she nor her husband desired a repetition. In answer to a question propounded by himself, "What can we do that is morally right?" he answered, "Tie a silk thread about each oviduct near the fimbriated extremity; the ligature will become encapsulated and close the

oviduct. If, later, the patient wish more children, we can easily make a simple abdominal incision and a simple splitting of the closed end of the oviduct will free it again for action."

As already intimated, American writers on this subject seem blissfully unfamiliar with the many failures of tubal ligation in Germany.

Kirschhoff suggested the most dainty procedure of all. He would make a very short incision through the peritoneal covering and parallel with the tube, then with a forceps or a hook he would draw out three or four centimeters of the oviduct, and excise the same. Sutures are not necessary, and subsequent conception is impossible, as a firm fibrous cord is said to result.

Fritsch applied two ligatures with intervening excision. His experience in a prior case had taught him that a single ligature is inefficient.

Arendt performed 16 tubal ligations in connection with vaginal fixation, using silk or formalin catgut. Pregnancy soon followed in one of these cases. If undertaken as an independent operation, he would enter the abdominal cavity by way of a posterior colpotomy. Arendt had not operated on the tubes to prevent conception except in connection with vaginal fixation. He does not consider ligation safe.

Rühl insists that neither the operation of Kehrer, (double ligation with intervening section,) nor that of Fritsch, (double ligation with intervening excision,) sufficed to prevent conception, but added the danger of extra-uterine pregnancy. Rühl removed both ovaries and tubes, ligating the latter with silk. Two years later he reopened the abdomen and found the end of one tube wide open. With the ovaries remaining, pregnancy would have been probable and extra-uterine pregnancy possible. For these reasons, Rühl suggested that the divided ends of the tubes be fixed into the vaginal wall, either in the median colpotomy incision, or in a smaller lateral incision, if the tube ends were too short to reach to the median incision. This procedure would give spermatozoa an opportunity to make the round, ultimately returning to the vagina. It ought to be efficient, but has been called unphysiological and has not been imitated.

Halban in a Cæsarean section, opened the uterus by means of a transverse incision, removing two or three centimeters of the tube at the same time, covering the ends with peritoneum.

Casalis reports a case in which he crushed both tubes from the vagina, using a pair of very strong pressure forceps; the woman was pregnant six months later.

Friedmann crushed the tubes, ligated with cat-

gut in the groove, believing that the lumen of the tube could not be restored.

Kossman does not consider single ligation of the tubes efficient, but would divide with a cautery. If the division be made with a knife or a scissors the mucous lining of the tube will protrude, preventing closure, an opening will remain and the passage of ova and spermatozoa will not be prevented. Kossman does not believe that Rühl's method of sewing peritoneum over the tube is safe, but that division with the cautery is the most efficient. Whenever possible, he advised the crater-like destruction of the mucous membrane of the tube with a cautery designed for this particular purpose.

Asch states that every possible surgical means has been suggested to prevent conception, from the artificial growth of a polypus in the cervix to a panhysterectomy. Asch would grasp the tube with a forceps at the junction of its inner and middle third, place a ligature on either side of the forceps, the ligature in the outer side of the forceps to be returned under the tube and tied to control hæmorrhæ, but not including the tube. The ligature on the inner side is tied to occlude the tube. The layers of the mesosalpingium should now be separated and the uterine end of the tube buried by passing the two ends of the ligature from the freshened toward the serous surface, one in either direction. Subsequent traction and ligation would draw the tube downward and close the peritoneum over the same. Asch prefers to approach the tube by means of a posterior sagittal colpotomy, sometimes by an anterior colpotomy.

Menge, in severe prolapse of the uterus in which he considers it advisable to perform an Alexander-Adams operation, suggested that the distal half of the tube be excised from the inguinal canal, and the ends of the remaining part be fastened to the aponeuroses of the external oblique muscle in the inguinal canal. Blietz reported six such cases operated by Menge and Kroenig.

Neumann after commenting on the failures of ligation and excision tried to improve the technique by grasping the tube near the uterus with a Pean forceps, making traction and so directing his knife as to remove a wedge shaped piece of the cornu of the uterus with the entire pars uterina of the tube. The smooth defect in the uterus is to be closed with a running catgut suture, and the remaining portion of the tube attached over the line of sutures to make the closure more sure.

Offergeld states that ligation is entirely unsafe ("völlig unsicher"). Double ligation with division between the ligatures had been followed by many

failures and also some success. The material used is a matter of no moment. Rühl believes that extra-uterine pregnancy may be favored by division. The operation is not free from danger because of possible adhesions and cystic degeneration of the uterine portion of the tube. Offergeld next tried double ligation with excision of the tube, which was followed by many failures, even when the ends were covered with peritoneum. Offergeld does not consider the method of Kirschoff, (subserous removal of 3 or 4 centimeters of the tube,) as effective. Excision of the tube with destruction with a thermo-cautery is not efficient. The amount of the tube removed is immaterial. Offergeld states that division of the tube with burial of the end under the peritoneum ("retroperitonealer Versenkung") has been followed by so many failures that the method is not safe. Fixation of the tube in the inguinal canal in connection with the Alexander-Adams operation is mistrusted because the end may become loosened. Offergeld condemns atmocausis.

Neumann, Pfannenstiel, Fraenkel, and others suggest that the uterine end of the tube be removed with a deep, wedge-shaped piece of the uterus, the uterine defect to be closed with a musculo-muscular and sero-serous suture. Excision of the tube with the wedge-shaped piece of the cornua through a posterior colpotomy is associated with severe hæmorrhage, and the suturing is very difficult. Through an anterior colpotomy the hæmorrhage is also severe. Offergeld prefers the abdominal route. The section or the excision of a portion of the tube between the ligatures may result in tubo-abdominal fistulæ, making conception possible. Single ligation or double ligation of the tube with intervening division or excision give no guarantee of success.

Vecchi reports a case of double ligation of both tubes, the ligature being drawn tight, incidental to a Cæsarean section. A second Cæsarean section being necessary one year later, Vecchi removed both ovaries and both tubes. He found that both ligatures had cut through, the loops being intact, but on one side the canal was patulous. Vecchi's patient had suffered from infantile paralysis in early youth, both lower extremities had been involved, recovery on one side being complete. There was also some pelvic deformity which made Cæsarean section necessary.

Van Tussenbroeck, Kouwer, and Treub object to tubal sterilization as an independent operation, comparing it to the consuetio, and to the infibulation of barbarous times.

Reifferscheid and Chrobak advised total extirpation of both tubes.

Rissmann reports a case in which he entered the peritoneal cavity by way of a posterior sagittal colpotomy, in which pregnancy had not followed. He noted that peritoneal sutures are apt to separate, that the wedge removed from the uterus must be deep enough to remove all of the tube and the muscular layer of the uterus must be brought together, two layers of sutures must be used, a musculo-muscular and a sero-serous.

Küstner insists that the desire of a patient to be sterilized can never be a sufficient reason. He never operates unless pregnancy is a serious menace to life. He tells of two cases in which he removed three centimeters of the tubes with cone-shaped excision of the cornu. The hæmorrhage was severe, the uterine cornu was sutured, but both cases were followed by pregnancy. Küstner chides himself for having heeded the wishes of the patient to operate from below. He prefers the abdominal route. The only efficient method is to excise the tube, including a deep, cone-shaped excision of the pars uterina, the uterine defect to be closed with musculo-muscular and sero-serous sutures.

In regard to the place which tubal sterilization should occupy, local surgical conditions aside, I can recall but two cases in my own practice in which this procedure should have been seriously considered. The one was a deformed imbecile upon whom a Cæsarean section was done; the other a young woman whose first, a term pregnancy, had been complicated by a paresis of all four extremities, and her second, and interrupted and fruitless pregnancy, by a paresis of like distribution amounting almost to paralysis, from which she has not fully recovered in a year. To sterilize a woman because she has tuberculosis or a heart lesion seems repugnant. I am not a sociologist, and shall not discuss the right of the state to sterilize its delinquents, although I am not convinced that it has such a right.

I should conclude:

1. That animal experiments, the ligation or excision of pathological tubes, and the results of like operations on normal tubes prove conclusively that tubal ligation with or without excision is not an efficient measure to prevent conception.

2. The only operation which gives a promise of success is excision of all or a part of the tube with a deep, wedge-shaped excision of the uterine cornu, including the pars uterina of the tube, the uterine defect to be closed with a musculo-muscular and a sero-serous row of sutures.

3. The anterior abdominal approach is the easiest, the simplest, and the safest.

4. Granting that the state has the right to ster-

ilize its mental and moral delinquents, tubal ligation as legalized in Iowa, considering its remote possibility of success, and its ever-present although vanishing danger, is an unjustifiable operation, entirely without promise as a means of lessening the procreation of the unbalanced.

5. In medical practice, tubal sterilization is but rarely justifiable, because it does violence to the most deeply rooted of all instincts, after that of self-preservation.

6. Considering the almost fiendish pertinacity with which the female economy conserves the function of the fallopian tubes, the efficiency of vasotomy or vasectomy may also be questioned.

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