TUBAL STERILIZATION.

Pregnancy Following Bilateral Salpingectomy, A Report of Two Cases and a Complete Review of the Literature,

By Alfred Heineberg, P. D., M. D.,
Philadelphia,

Associate in Gynecology, Jefferson College; Obstetrician, Jewish Maternity Hospital; Assistant Gynecologist, St. Agnes and Mount Sinai Hospitals.

It is not the intention of this paper to discuss the sociological, moral, or legal aspect of the problem of tubal sterilization, but the surgical phase only. The purpose of so doing is to emphasize the necessity for the selection of the surest and least objectionable method of producing sterility in the female, when once it has been decided that such a procedure is desirable. My interest in this subject was aroused by the occurrence of pregnancy in two patients in whom I performed bilateral salpingectomy for the relief of chronic inflammation. This unexpected sequel emphasized the fact that, if sterility had been the object sought, the operations would have had to be classed as failures. Pregnancy has unexpectedly occurred in many patients after operations upon the Fallopian tubes performed for the express purpose of producing sterility; and in others who were subjected to bilateral salpingectomy for the relief of tubal disease. The study of the operative methods employed in all reported instances of failure; a review of other methods proposed for tubal sterilization; and the consideration of the animal experimentation, should assist us in the selection of that method which promises the surest result. After a complete review of the literature, it has seemed to me that the following classification would be helpful.

Group I comprises all cases in which operations upon the Fallopian tubes failed to produce sterility. It includes those cases in which sterilization was the object sought and others in which, from the nature of the operation, sterility was to have been expected.

Group II includes cases in which a second operation upon the same patient demonstrated the failure of the first operation to occlude the tubes. In these cases no pregnancy had resulted, although there was no hindrance to its occurrence.

Group III includes cases in which operative methods, different from those used in Groups I and II, were employed for the production of sterility, but in which neither failure nor definite success was reported.

Group IV consists of the review of the experiments done upon animals to determine the value of several methods.

In the first group there are recorded twenty-five failures to produce sterility by the following procedures: A. Ten failures after simple ligation of both tubes. B. Three failures after double ligation and section or resection of the tube between the ligatures. C. One failure after crushing and ligation of both tubes. D. Eight failures after bilateral salpingectomy with ligation of the uterine stumps of the tubes. E. Three failures after bilateral salpingectomy with cuneiform resection of the uterine cornua.

Ligation of the tubes. With the exception of the three cases reported by Gordon (1) and Sutton (2), the reported failures which occurred before 1897 followed simple ligation of the tubes. The uncertainty of this method is attested by the following reports: In sixteen cases of vaginal fixation of the uterus performed by Arendt (3) in 1897 he ligated both tubes with silk or formalin catgut. In one case pregnancy soon followed. Fritsch (4) in 1897, during a laparotomy, ligated both tubes with silk. The patient became pregnant three years later. As a result of this experience he recommended double ligation with section of the tube, but found this to be no more effective. During a Cæsarean section, Pissemsky (5) in 1897 ligated both tubes with silk. The patient became pregnant again and was subjected to a second Cæsarean operation, during which both tubes were removed. He found one tube patulous, the other closed and the silk sutures *in situ*. Vecchi (6) in 1905 had an almost identical experience with that of Pissemsky. At a second Cæsarean section in the same patient he also removed the tubes which had been securely ligated during the first operation. The ligatures had cut completely through the tubes. The divided ends of the left tube had reunited and the tubal canal had been reestablished. The ends of the right tube were occluded and separated by peri-

toneum. Kossman (7) in 1898 reports a failure after ligation with catgut. Lambach (8), reported by Littig (9) in 1912, ligated both tubes with silk, incidental to an operation for retroversion; term pregnancy occurred three years later. Taylor (10) in 1904 had a rare experience, which demonstrates conclusively the untrustworthiness of tubal ligation. During two successive Cæsarean sections in a rhachitic dwarf, he ligated both tubes; the patient, nevertheless, became pregnant again and was subjected to a third Cæsarean section, at which operation bilateral salpingectomy with cuneiform resection of the uterine cornua was done.

The uncertainty of simple tubal ligation has apparently not been duly appreciated by American gynecologists. Leonard (11) reports two failures from the gynecological clinic of Johns Hopkins Hospital in patients operated upon as late as 1909. These failures occurred in a series of twenty-three patients, in whom sterilization was attempted. He could trace only fourteen of these patients at the time of his report. Five of the fourteen were over forty years of age at the time of operation.

In the two cases of failure the tubes had been doubly ligated with silk. The first patient who was operated upon in 1908 was delivered of a full term child one year later; and the second (operation, 1908) suffered three miscarriages within a period of four years after the operation.

Morris (12), in 1904, in an article, Artificial Sterility, recommended: "Tie a silk thread about each oviduct near the fimbriated extremity; the ligature will become encapsulated and close the oviduct." As late as 1911 Werner (13) asserts that double ligation of the tube and resection of two or three cm. may be relied upon to prevent conception.

Failures after division or resection of the tube between two ligatures. Recognizing that no reliance could be placed upon simple tubal ligation for the production of sterility, Kehrer (14), in 1897, recommended double ligation of the tube near the uterus and section between the ligatures. His first operation was done through an anterior colpotomy. He apparently was not familiar with three cases reported the previous year by Gordon and Sutton, in which removal of the tubes and ligation of the uterine stump had resulted in failure. Priority in advocating double ligation and section is alleged by Kossman in a pamphlet in 1896. Later he proposed division of the tube with the actual cautery between ligatures, and cauterization of the mucous membrane and muscularis if they protrude beyond the serous coat of the divided end. A similar method to that of Kehrer was proposed a year later by Spinelli (15). Two years after the appearance of Kehrer's paper, Abel (16) reported having done double ligation and division of both tubes in 1894 at the time of a second Cæsarean section in a patient. She became pregnant again and was delivered by a third Cæsarean section three years later. Abel found that both tubes in this patient had reunited, but that in only one was the canal patulous throughout. Three other failures are reported by Belser (17). Two of the three women became pregnant in the stump of the ligated and divided tube. A modification of this method suggested by Braun-Fernwald (18) and Rühl (19) consists in burying the proximal portion of the ligated and resected tube beneath the peritoneum of the broad ligament. That this modification cannot be relied upon is pointed out by Reiferscheid (20), who reports a failure after its employment; as follows: At a second Cæsarean section in a woman with a markedly contracted pelvis, two cm. of each tube were resected and the uterine stump buried within the broad ligament. She became pregnant again in one year. After a similar operation done by Smythe (21) the patient became pregnant in seven months. While the technic of subperitoneal concealment of the proximal end of the divided tube proposed by Asch (22) is simpler than some others, it cannot be more efficient. He operates usually through a posterior sagittal colpotomy, sometimes through an anterior colpotomy. Findley (23), following the teaching of Selheim (24), fails to appreciate the uncertainty of ligation and resection of the tube when in a recent article he proposes it as part of a "combined operation for the interruption of pregnancy and sterilization."

Crushing of the tubes, even if followed by ligation in the groove as suggested by Friedmann (25), is no surer than simple ligation or resection. Cassalis (26) reports one failure in ten operations in which both tubes were crushed by a powerful forceps through a colpotomy opening. The patient became pregnant six months after the operation.

Bilateral salpingectomy with ligation of the uterine stumps of the tubes does not appear to render sterility any more certain than do the foregoing methods. Most of the reported failures occurred after operations in which removal of the tubes formed only a part of the operative measures instituted for the relief of pelvic inflammatory disease. Gordon (1896) reports pregnancy occurring in two patients from whom both tubes and ovaries were thought to have been removed and the stumps of the tubes ligated. The first patient menstruated irregularly after the operation and became pregnant three years later. The second patient menstruated regularly, beginning three months after the operation, and became pregnant after fourteen months. At the time of a double ovariotomy, Sutton (1896) ligated both tubes near the uterus and divided the right one with a cautery, the left with a scissors. The patient underwent two subsequent pregnancies, with normal labors, twenty and forty months respectively after the operation. In a case of chronic pelvic inflammation, Schmidt (27) removed the left ovary and both tubes, ligating the stumps with silk. Pregnancy occurred four years later. Polak (28) and Leonard each report the rupture of an interstitial pregnancy occurring in the small remaining portion of a tube after bilateral salpingectomy and ligature of the stumps. Polak's case is of particular interest for the reason that the patient "had been married seventeen years, and had not previously been pregnant owing to a gonorrhea which she had contracted from her husband shortly after marriage." Freeman (29) attended a patient who had a normal labor 400 days after ligature and removal of both tubes, one ovary, and part of the other. During a Cæsarean section Brodhead (30) removed (?) both ovaries because

of multilocular cystic change, and excised the tubes after ligation about one inch from the uterus. The patient menstruated irregularly after the operation and became pregnant within two years.

To these failures after bilateral salpingectomy and ligature of the stump I wish to add two which occurred in my own practice.

CASE I. H. K., aged twenty-one years, consulted me in February, 1913. She had been suffering for two months with pain in the right iliac region, intermittent in character and aggravated by exercise. There had been no nausea or other symptoms referable to the stomach or intestines. Bladder symptoms were also absent. Menstruation had been established at twelve years; it was regular (twenty-eight day type) painless, and from two to three days' duration. The last period had occurred two weeks previous to the consultation. She had been married three years, and had been pregnant three times, each pregnancy having been terminated at about the third month by induced abortion. Bimanual examination disclosed an irregular inflammatory mass in each tuboovarian region, larger on the right side. At operation, three days later, both Fallopian tubes and the right ovary and vermiform appendix were removed. The left ovary was adherent to the inflamed tube, but was not so badly diseased as to necessitate removal. The tubes were ligated near the uterus with chromic catgut and the portion distal to the ligatures was excised. The patient made an eventful recovery. She became pregnant thirty months later and suffered no inconvenience as the result of the operation.

CASE II. R. F., aged twenty-five years, married, consulted me in July, 1909, suffering from uterine hemorrhage. She had been well until the previous month, when she aborted in the fourth week of gestation. The bleeding which began with the abortion continued in slight amount and was not associated with pain or other discomfort. She had been married four years and had been delivered with forceps two and a half years before. On examination the uterus was found to be retroverted, and its mobility impaired. A mass on either side was diagnosed as consisting of diseased tubes and ovaries.

At operation, August 17, 1909, the uterus was curetted. Through a median suprapubic incision the uterus was liberated from adhesions to the prolapsed and inflamed tubes and ovaries. Both tubes were occluded and both ovaries cystic. The tubes and right ovary were excised, and the uterine stump of the tubes was ligated. The left ovary was resected. The round ligaments were shortened by the method of Montgomery. The patient made an uneventful recovery and, twenty months later, gave birth to a living child.

Bilateral salpingectomy with cuneiform resection of the uterine cornua is considered to be the surest method of producing sterility through operation upon the tubes. It was first proposed by Neumann (31), in 1898, and shortly afterward received favorable commendation from Rose (32). Günther (33) reported five successes after its adoption. All the writers upon the subject agree that in performing the operation great care should be exercised to make the wedge shaped section of the uterine cornu deep enough to remove all of the interstitial portion of the tube and to close the opening in the uterus with two layers of sutures; the deep sutures to approximate accurately the cut surfaces of the uterine muscle, the superficial ones to bring together the cut edges of the peritoneum of the broad ligament over the repaired muscle. Notwithstanding the observance of all such precautions, failures are reported by Küstner (34), Polak, and Häberlin (35). Küstner observed failures in two patients in whom during the performance of vaginal fixation of the uterus he removed a wedge shaped section of both uterine cornua and about three cm. of each tube. Severe hemorrhage occurred in both cases during the operation and pregnancy followed a few years later. Because of the hemorrhage, the difficulties to be overcome, and the uncertainty of success when the operation is done through vaginal section, Küstner advocates the abdominal route. The most conclusive evidence of the value as well as the possibility of the failure of cornual resection is to be found in the experience of Häberlin. He resected the tubes and uterine cornua in forty-one patients for the purpose of rendering them sterile, and was successful in forty of them. In some of the patients the operation was done through a colpotomy, and the others through abdominal section. He expresses a preference for the latter method.

In Group II of this classification are recorded several cases in which a subsequent operation in the same patient revealed the failure of the previous operation to produce a permanent occlusion of the tubal canal. While no pregnancy had occurred in any of them, there was found an unobstructed passage between the uterine and peritoneal cavities, and pregnancy might have occurred. Rühl performed bilateral salpingo-oophorectomy, ligating the uterine stumps of the tubes with silk. Two years later he reopened the abdomen and found one tube patulous. As a result of this experience, he suggested that the ligated tubal stump be buried beneath the peritoneum of the broad ligament. Ries (36) reports three similar cases which came under his observation. In the first patient bilateral salpingo-oophorectomy with ligature of the stump was done. At a subsequent abdominal section he found one tube open. The second patient had both tubes and the right ovary removed, and at second operation presented a uteroperitoneal fistula at each cornu. Vaginal hysterectomy, performed in the third patient some months after a bilateral salpingectomy, demonstrated an unobstructed canal in the remaining stump of each tube. Similar experiences are reported by Bovee (37) and Fränkel (38).

Group III of this classification includes methods some of which are modifications of the foregoing and some others which present elements of novelty. While apparently satisfactory results have followed their application, the number of cases in which each method was used is not sufficient to stamp it with unqualified approval. In commenting upon Kehrer's paper, Beuttner (39) proposed resection of a portion of the muscularis and mucous coat of the tube after an incision through its serous coat. The cut ends of the muscularis are then to be occluded by suture, covered with serous membrane, and attached to each other. He recommended abdominal instead of vaginal incision. The method of Kirschoff (40) is similar. It consists in subserous resection of three or four cm. of the tube through a small incision in its peritoneal covering parallel to its long axis. He asserts that sutures are not necessary, as adhesion of the inner surfaces of the tubal peritoneum produces a fibrous cord which occludes and permanently separates the divided ends. Van Meter (41) makes the same resection, but sutures the muscularis first to occlude the lumen of the tube. When Cæsarean section is performed through a transverse incision in the fundus, the method of

sterilization used by Halban (42) should be as effective as cornual resection. He excises the interstitial portion and three cm. of the tubes by extending the incision well into each cornu. In closing he first introduces a musculomuscular suture and covers the repaired muscle by suturing the peritoneum over it. Taussig (43) also combines cornual resection with removal of about two cm. of the uterine end of the tube, but goes further. After closing the opening in the cornu, he ligates the proximal end of the remaining portion of the tube and buries it deeply within the broad ligament. He then draws a loop of round ligament over the repaired cornu and attaches it to the upper posterior surface of the uterine fundus. His method does not appear to offer the degree of surety of salpingectomy and careful cornual resection.

Rissmann (44) proposed wedge shaped resection of the cornua, but to leave the rest of the tube undisturbed so that the tube might be repaired and its canal restored if the patient subsequently desired to become pregnant. With the same purpose in view Selheim buries the entire tube beneath the peritoneum of the broad ligament so that if desired it may later be restored to its former peritoneal position without injury to itself. It is difficult to imagine the tube remaining within the broad ligament for any length of time, without undergoing changes which would render it unserviceable for further transmission of spermatozoa. To accomplish temporary sterilization Holzapfel (45) divides the tube at the junction of the middle and outer third; resects about two cm. of the uterine portion after carefully dissecting off its peritoneal coat. The end is then ligated with fine catgut, covered with the dissected peritoneum, and buried within the broad ligament. The cut end of the outer portion is ligated and allowed to remain within the peritoneal cavity. This operation presents the same uncertainty as do all others in which the uterine cornu is not resected and sutured. If restoration of the tubouterine canal at a later date is to be considered in the production of sterilization the operation of De Tarnowsky (46) appears to be the most satisfactory. The steps are as follows: "Amputate the tubes on either side one fourth inch from the uterine cornua. With a fine rat toothed forceps or a probe invaginate the distal half of each stump and close the lumen with two catgut sutures. This produces a seroserous adhesion which will effectively close the canals. On the posterior uterine wall make two parallel vertical incisions one inch long and one half inch apart. These incisions should not be over one fourth or one fifth inch deep. With a curved forceps burrow between these incisions, creating a canal of sufficient size to contain the two tubes. With the same curved forceps remaining in the new canal, grasp the opposite tube and draw it through the canal so that it emerges on the opposite side. Reintroduce the forceps from the opposite side and repeat the same procedure with the remaining tube. In the new canal the tubes should be parallel to each other, one lying above the other, the cut extremity of each tube emerging on the opposite side of the new canal. Make a small cuff by everting the tubal mucosa (it is sometimes necessary to make two small incisions before being able to evert satisfactorily) and secure the cuffs to the margins of the new canal by fine catgut stitches which may be present. Test the patency of both tuber by means of a fine probe." Rockey's (47) operation differs from this, in that he does not draw the ends of the tubes through incisions in the posterior wall of the uterus, but simply attaches them to the surface of the uterus with sutures. The operation of Menge and Kroenig as described by Blietz (48) presents some points of difference from the others. In correcting retroversion and prolapse of the uterus by the Alexander-Adams operation, they opened into the peritoneal cavity by two inguinal incisions, removed the outer half of each tube, and attached the remaining portion to the aponeurosis of the external oblique. Unaware of this report, Stettin (49) proposed practically the same procedure.

In Group IV the results of experiments carried out upon animals with the object of determining the most positive method of tubal sterilization, with but few exceptions, corroborated the clinical experience in the human being. The early workers in this field were Kossman, Landau (50), Woskressensky (51), Josephon (52), and Ratschinsky (53). The more recent contributions to the subject are those of Fränkel, Ronsse (54), Friedmann, and McIlroy (55). Kossman's experiments, performed in 1875, consisted in ligating the Fallopian tubes of young pullets with heavy silk ligatures. In six weeks they began to lay. Examination of the tubes at autopsy revealed that the ligatures had broken as the result of swelling of the tissues and had become incrusted with lime salts. Fränkel experimented upon twenty-six rabbits, on which he performed thirty-three operations upon the tubes and twenty-nine upon the uterine cornu in his attempts to obliterate the tubal canal. Only two successes followed the thirty-three operations upon the tubes, while the operations upon the cornu all resulted in failure. The character of the failures following the several methods is interesting. 1. After single or double ligation with silk, catgut, or rubber, he found that the tube had been cut through by the ligature and the ends had either reunited or had reopened and formed a tuboabdominal fistula. 2. After section of the tube with or without ligation the canal in each end was found to be patulous or the ends had reunited and the continuity of the canal had been restored. 3. Resection of one to 2.5 cm. of the tube between ligatures was frequently followed by tuboabdominal fistula. 4. Cauterization of the interstitial portion of the tube resulted in failure in every instance. He concluded that the only certain method of tubal sterilization consists in total extirpation of the tube, including the interstitial portion in the uterine cornu, and careful closure of the cornual defect. The results in Friedmann's experiments in twenty-two animals corroborate those of Fränkel. He operated upon rabbits, cats, and bitches, chiefly by crushing the tubes and ligating in the furrow with catgut or silk sutures. Seventeen of the animals became pregnant after the operation. Autopsies performed six weeks after the operation in the five remaining animals (rabbits) disclosed patulous tubal canals in four of them, and complete obliteration in only one. Ronsse's conclusions dif-

fer from those of Kossman, Fränkel, and Friedmann. He experimented upon the tubes and uterine cornua of rabbits by performing simple ligation; simple division; division or resection between ligatures. All the animals were subjected to autopsy shortly after the operation. He found complete occlusion of the tube in all. In addition to the occlusion in cases in which operation upon the cornua had been done, there developed a cyst lateral to the point of ligation or division. Those whose tubes were doubly ligated presented a hydrosalpinx between the ligatures. Because of the occlusion and the cyst formation, he concludes that the passage of ova and spermatozoa would have been permanently prevented. He believed that the fluid which accumulated in the tube was a normal secretion, rather than the result of inflammation or disturbed circulation. Since the animals were all killed, however, before the swelling incident to the trauma could possibly have subsided, his results cannot be considered as convincing.

From this résumé of the clinical and experimental experience with tubal sterilization, I believe that we may fairly arrive at the following conclusions:

1. There is no method of tubal sterilization which affords absolute security against conception.

2. Simple ligation of the Fallopian tubes with either single or double ligatures has been followed by the largest number of reported failures.

3. Excision of a wedge shaped section from each cornu of the uterus, followed by careful closure of the opening with musculomuscular and seroserous sutures has yielded better results than any other method.

4. In the light of our present knowledge it seems unwise to advocate any other method than cornual resection. These conclusions are in accord with those arrived at in previous reviews of this subject by Charles (56), Geissler (57), Günther (58), Mironow (59), Offergeld (60), Perdrizet (61), Pestalozza (62), and Sarwey (63).

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