

**THE AMERICAN**  
**JOURNAL OF OBSTETRICS**  
**AND**  
**DISEASES OF WOMEN AND CHILDREN.**

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VOL. LVIII.

OCTOBER, 1908.

NO. 4

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**ORIGINAL COMMUNICATIONS.**

AN EXPERIMENTAL STUDY ON HEMORRHAGE FOLLOWING SECTION OF THE UTERINE AND OVARIAN VESSELS IN DOGS AND ITS POSSIBLE BEARING ON RUPTURED PREGNANCIES.\*

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(With illustrations\*)

PHYSIOLOGISTS have estimated the total quantity of blood in the human body at about 7.7 per cent. of the body-weight. Thus, a woman weighing 130 pounds would have a blood content of about ten pounds.

Now "just what percentage of loss"—to quote from Howell—can be borne by the human being has not been determined, but it is probable that a healthy individual may recover without serious difficulty from the loss of a quantity of blood amounting to as much as 3 per cent. of the body-weight." This, in a woman of 130 pounds, would be a loss of four pounds, or approximately 1,650 c.c. We question whether so large an amount or, at any rate, much more blood is found in the average patient of the above weight as a result of the hemorrhage resulting from a ruptured ectopic gestation.

During the past nineteen months we have been conducting a series of experiments on dogs to see if it might not be possible to throw some light on this phase of the subject from the standpoint of hemorrhage.

These experiments, so far as we have gone, (thirty-one exper-

\*Read before the American Gynecological Society, at Philadelphia, May 26 to 28, 1908.

iments) seem to show that, in dogs at least, hemorrhage from large internal vessels ceases before it is sufficient to prove fatal. No dog succumbed to the hemorrhage following excision of the ovary, division of the broad ligament with section of the left uterine vessels, section of the uterine vessels on both sides and other lesions. In none of these cases did the dog succumb to the hemorrhage although we probably subjected our animals to as great a risk of bleeding to death as is incurred by the average woman suffering from a ruptured tubal pregnancy.

Before taking up in some detail the findings in our experimental work I would like to briefly recall to your memory the anatomy of the parts. In the bitch the uterus consists of the body or corpus and its two long horns or oviducts; in the latter fetal development takes place. The oviducts are connected anteriorly with the very short, slender Fallopian tubes; the outer ends of the latter lie very near the ovaries, which are situated posterior and dorsal to the kidneys. Each uterine artery is a branch of the pudic, the latter being one of the two main divisions of the internal iliac; they are vessels of considerable size, even as compared with the corresponding arteries in women. The ovarian vessels, on the other hand, are quite small. (V. Figs. 1 and 2.)

With these anatomical differences in mind, a résumé of the cases is herewith presented:

The experiments carried out may be divided into the following series:

1. Division of the uterine and ovarian vessels.
2. Division of the uterine vessels producing shock. Secondary operation on dog while in a condition of shock.
3. Division of the uterine vessels and observations on the blood-pressure and hemoglobin.
4. Division of the uterine vessels and observation on the pulse, respiration and hemoglobin with special reference to the time of the clotting of the blood.
5. Division of the vessels, observations on the pulse, respiration and hemoglobin before and after bandaging and before and after applying weights to the lower abdomen.
6. Division of the uterine vessels with the dog in the upright position; observations on the pulse, respiration and hemoglobin.

#### EXPERIMENTS.

*Series No. 1. Division of the Uterine and Ovarian Vessels.*  
In this series we have carried out excision of the ovary, divi-

#### EXPLANATION OF PLATES.

The diagrams afford a comparison between the uterine artery in the human being and that in the dog. FIG. I, which shows the artery in the human subject, is a composite picture of the diagrams in Corning's and Gray's Anatomies. FIG. II, which shows the distribution of the uterine and ovarian arteries in the dog, was made after injecting the blood-vessels.

It will be seen that in the human being, at the points at which the uterine comes off from the anterior branch of the internal iliac, there is a much sharper angle than in the dog.

In order to show the course of the uterine artery in the dog the uterus with the oviducts was placed over the symphysis pubis.

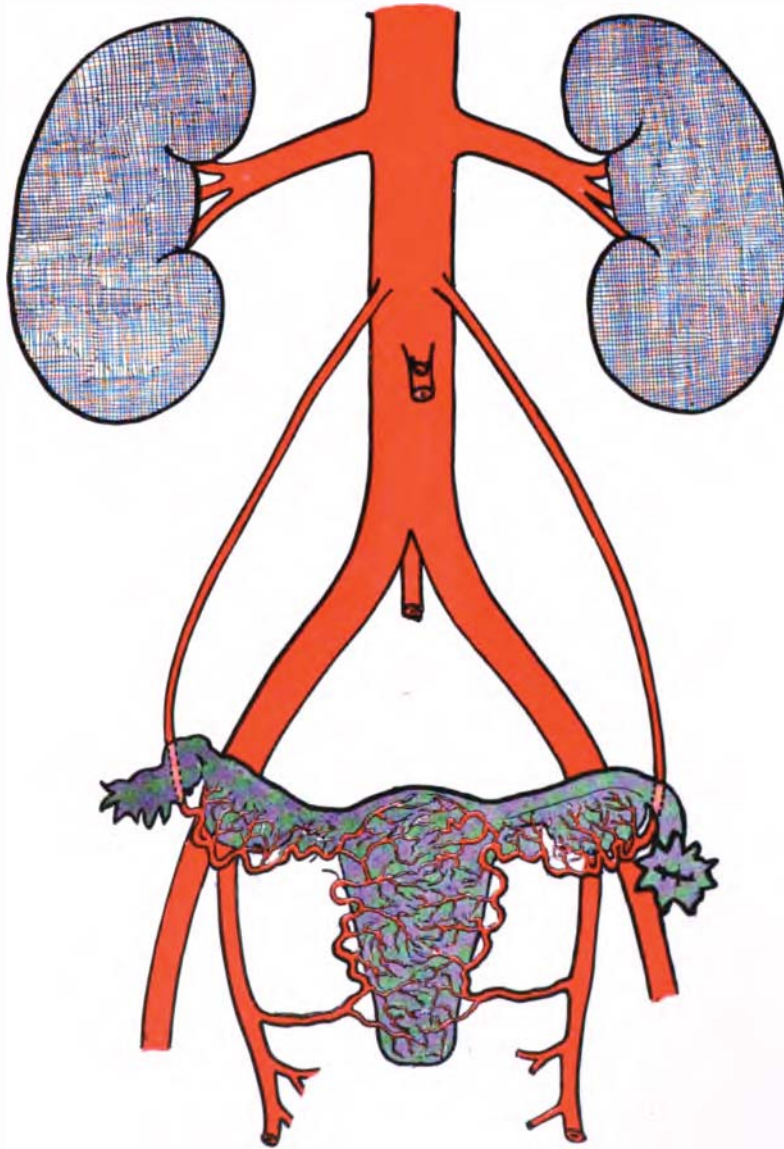


DIAGRAM OF THE DISTRIBUTION OF UTERINE AND OVARIAN ARTERIES  
IN THE HUMAN SUBJECT.—*Robb.*



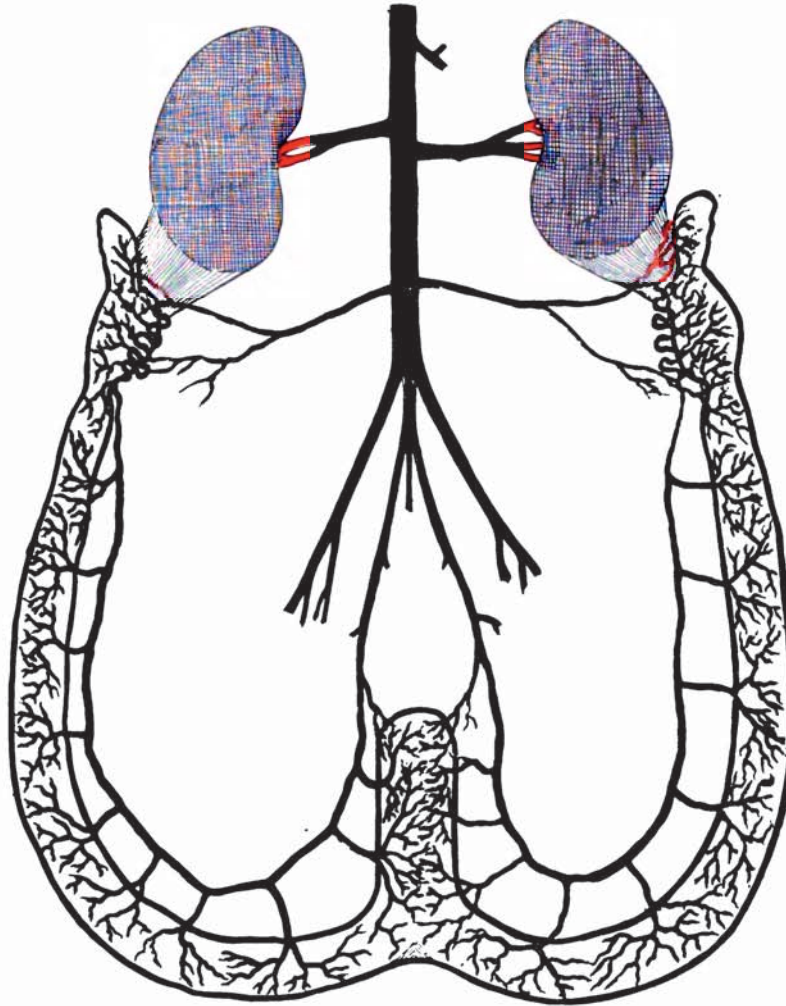


DIAGRAM OF THE DISTRIBUTION OF UTERINE AND OVARIAN ARTERIES  
IN THE DOG.—*Robb.*

sion of the broad ligament with section of the left uterine vessels, section of the uterine vessels on both sides and other lesions. In none of these cases did the dog succumb to the hemorrhage.

Dog No. 1.—Well nourished. Weight 6.5 kilos.

January 11, 1907. Ether anesthesia. The abdomen was opened through a median incision 6-7 cm. long. Pelvic organs apparently normal. The outer end of the right oviduct was cut through, and the right ovary excised. There was no free bleeding at the site of the injury. The incision was closed in layers. There was but little variation in the pulse throughout the operation. Quick recovery from ether and an uneventful convalescence.

Dog No. 2.—Well nourished. Weight about 12 kilos.

January 25, 1907. Ether anesthesia. Median incision 4 cm. long. Pelvic organs apparently normal. The right broad ligament was cut through its entire extent, the uterine vessels being severed. There was active arterial hemorrhage, the blood welling up into the abdominal wound. Incision quickly closed in layers. At the end of the operation the mucous membranes showed a distinct blanching. Pulse 140, of small size. Dog conscious thirty minutes after being put to bed. A good deal of vomiting during first six hours.

January 26. Dog is up and walking about, showing no signs of pain. This dog escaped from her cage several days later. She had made a good recovery, so far as we could judge.

Dog No. 3.—Good condition. Weight about 10 kilos. "In heat."

January 30. Ether anesthesia. Median incision 4 cm. long. Pelvic organs congested. Outer end of left oviduct cut through and left ovary excised. The left uterine vessels were now cut across. Free bleeding from the latter and also from the ovarian. Incision quickly closed in layers. At end of operation pulse of rather small volume, rate not obtained. Dog conscious soon afterward.

February 2. Condition good. Dog disposed to remain quiet.

February 6. Dog bright and active, taking her food well.

Dog No. 4.—Well nourished. Weight about 10 kilos.

February 2. Ether anesthesia. Median incision 4 cm. long. Pelvic organs normal. The uterine vessels on both sides were cut across. Very free bleeding. Incision quickly closed in layers. Pulse rapid, but of fairly good volume. Dog conscious before leaving the table. Given morphine gr.  $\frac{1}{4}$  hypodermically at once. Thirty minutes later dog was standing and drinking water greedily.

February 6. Dog suffered apparently but little from operation. To-day seems bright but is not disposed to move about much.

February 16. Dog made an uninterrupted recovery.

Dog No. 5.—Feb. 6. In good condition. Weight about 10 kilos. Normal pelvic organs. The left ovary was excised, and the uterine vessels on both sides were cut. There was the usual



free hemorrhage. Immediate closure in layers. Dog conscious on reaching bed. Pulse not very rapid and of good volume. Seen thirty minutes later, dog had changed position, but was then perfectly quiet.

February 9. Dog had been doing well. Yesterday was eating. To-day does not appear so bright. Does not object to being moved. Pulse and temperature normal.

February 16. Rapid improvement since last note. Dog now active.

Dog No. 6.—This is the same animal used in Experiment No. 1 (q.v.).

February 9. Dog had made a complete recovery from first operation. Ether anesthesia. Abdomen reopened through former incision. No free fluid or clotted blood found in peritoneal cavity. A few delicate adhesions about the pelvic structures. The right oviduct was enlarged and bent upon itself. In the left oviduct were two fusiform swellings, the one about 1.5 cm. from the corpus uteri, the size of a pigeon's egg; the other in the outer half of the oviduct, almost as large as a duck's egg, apparently filled with clear fluid. The uterus and oviducts were now removed *in toto* by one continuous cut of the scissors from side to side. Bleeding was profuse. Immediate closure in layers. At end of operation pulse hard to obtain; respirations shallow. Dog able to open her eyes. Seen fifteen minutes later dog was standing on all fours, lapping water.

February 16. Dog did not appear to be suffering from operation. A few hours afterward was walking about in her cage. No sedative was given. At present seems to be in good condition.

February 25. Dog has apparently made her second complete recovery. Incision well healed.

Dog No. 7.—Same animal as No. 3 (q.v.). The first operation had been made seventeen days before. The left ovarian and uterine vessels were cut. Dog has made complete recovery. Now bright and lively.

February 16. Ether anesthesia. Abdomen reopened through former incision. No blood found in peritoneal cavity. A few light omental adhesions. No pulsation could be detected in the stump of the left uterine artery, nor was there any clot around it. The right uterine vessels were now cut, and temporary closure of the abdominal cavity was made by placing clamps on the edges of the divided peritoneum. At the beginning of the operation the pulse-rate was 128. The dog was now kept under a light anesthesia. Fifty minutes after cutting of vessels the pulse began to show an increased rate, being at this time 136. A steady rise continued during the next thirty minutes, at the end of which time the rate was 156. The clamps were now removed from the peritoneum, and the blood found in the pelvis was carefully removed with gauze sponges. After gentle application with a gauze sponge at the cut end of the artery cessation of the bleeding resulted at the end of about ten minutes. Twenty minutes later a subcutaneous infusion of salt solution (400 c.c.)

was given. This was nearly all taken up in thirty minutes. It was given to see if the subsequent rise in the blood-pressure would bring on a recurrence of hemorrhage from the uterine artery. No such effect was produced at the end of thirty minutes after the absorption of the saline solution. Gentle squeezing of the end of the vessel, however, was sufficient to expel the clot, which had formed, and fresh bleeding began. The experiment was brought to a close at this point, the uterine artery ligated, and the incision closed in layers at once. The pulse-rate at the end of  $3\frac{1}{2}$  hours consumed in the observation was 144.

February 25. Dog has done well from day of operation. Is now as active as ever. The amount of blood lost during the experiment was estimated approximately and found to be 240 c.c.

Dog No. 8.—Young bitch. Poorly nourished. Weight about 4 kilos. Mucous membranes pale.

February 25. Median incision 6.5 cm. long. Uterus very small, the oviducts slender, cord-like structures. Evisceration of both ovaries, the uterus and oviducts *in toto*. There was very free bleeding from all the vessels. Immediate closure in layers. But slight change in pulse during operation. Fifteen minutes later dog appeared to be having a hard, shaking chill. Was conscious, but not able to hold up her head.

February 26. Dog is bright, but moves about very little.

March 1. Dog appears to be gaining rapidly. Is now walking about her cage. Very anemic. Ether anesthesia. Abdomen reopened through previous incision. No free blood in peritoneal cavity. Omentum and intestines adherent in places to bladder, pelvic wall and rectum; all easily separated. Around the stump of the uterus a small blood-clot was adherent. No other clots present. Forcible manipulations of the stumps of the uterine vessels produced no active bleeding, only an oozing. Dog went into sudden collapse. Revived by artificial respiration.

Dog No. 9.—In good condition. Weight about 4.5 kilos.

February 26. Ether anesthesia. Median incision 6.5 cm. long. Total evisceration of intra-abdominal genitalia as in previous animal. Profuse hemorrhage. Immediate closure in layers. Mucous membranes became greatly blanched. At close of operation pulse-rate was 180, shortly afterward becoming almost imperceptible. Soon after reaching bed dog was conscious, but made no attempt to move.

March 2, Dog is bright and fairly active. Mucous membranes quite pale. Ether anesthesia. Abdomen reopened through previous incision. No fluid or clotted blood present in peritoneal cavity. Stump of corpus uteri brought up and found surrounded by a small clot. No distinct pulsation to be made out in uterine vessels. Well-marked oozing caused by active manipulations of pelvic structures, increased by freshening cut surfaces of previous operation. Closure in layers. Pulse rapid, but of good volume at end.

Dog. No. 10.—In excellent condition. Weight 17.5 kilos.



March 15. Ether. Median incision. Uterus very small for so large an animal (has never been pregnant). Uterine vessels cut on both sides. Bleeding by no means so free as in previous cases. Closure in layers. Pulse good at close.

March 18. Dog appears as well as before operation.

Dog No. 11.—In fairly good condition. Weight about 6 kilos. Considerable enlargement of both thyroids.

March 18. Ether. Median incision. Pelvic organs normal. Uterine vessels of average size. Cut on both sides. Bleeding very free. Immediate closure. Pulse rapid, but of pretty good volume.

March 19. Dog to-day is bright and playful. Abdomen reopened under ether; one to three drams of bloody fluid present, and a small blood-clot on each broad ligament at site of cut ends of uterine vessel. Removal of clot on right side brought on active arterial hemorrhage. Genital organs now excised *in toto*, the corpus uteri being cut across below level of previous division of uterine vessels. There was profuse bleeding, probably two ounces escaping from abdominal cavity before closure was made. At the end of operation pulse was rapid and of small size. Mucous membranes greatly blanched. Dog able to hold up her head on reaching cage, but making no attempt to rise.

March 20. This morning dog appears to have recovered well from yesterday's operation. Gets around well. While ether was being administered again dog ceased breathing, and all measures for resuscitation failed. About 6 c.c. of fluid and clotted blood found between bladder and intestines. Intestinal serosa pale.

Dog No. 12.—Young bitch in fairly good condition. Weight 5 kilos.

March 21. Ether. Median incision. Uterus quite small, but vessels of good size for age of dog. Right uterine vessels cut. Free arterial hemorrhage. Immediate closure. Pulse of good volume, not very rapid.

March 22. Dog all right to-day. Ether. Abdomen reopened; 8-10 c.c. of bloody fluid and blood-clots present. Left uterine vessels were cut and bled freely.

March 23. Dog seems rather weak to-day, but is able to get around well. Abdomen reopened. About the same amount of blood present as found yesterday. Manipulation of uterus and broad ligaments caused fresh bleeding from uterine vessels. Dog conscious at close.

March 26. Dog somewhat dull to-day. Incision infected and gaping. Killed by forced anesthesia. Several cubic centimeters of purulent fluid found in pelvis. (Portion of femoral vein removed for study.)

Dog No. 13.—In good condition. Weight about 9 kilos.

March 25. The abdomen was opened in the median line. Each oviduct was occupied by four fetal sacs. It was estimated that the dog was about one-third along with her pregnancy, the period corresponding to the third month of gestation in the human being. The blood-vessels in the broad ligament were di-



lated, the uterine artery measuring 2 mm. in diameter at the junction of the oviduct and the body of the uterus. The right uterine vessels were incised at this point, the bleeding was profuse, and the abdomen was closed while the bleeding was going on. After the closure of the abdominal incision the femoral pulse could just be made out. The mucous membranes were very pale. Fifteen minutes later the dog lay stretched out with her eyes open and breathing quietly, but the femoral pulse could not be made out.

March 26. The dog appears dull, but walks around without any difficulty. Pulse small, 140 to the minute. She was given a subcutaneous infusion of 200 c.c. of normal saline solution.

March 27. Condition of dog good. Pulse 104, regular and of fairly good size. Abdomen was reopened and several cubic centimeters of bloody fluid and clots were found. The proximal ends of the cut uterine vessels were closed, but good pulsation was present in the artery. The fetal sacs of the left side were brought out and opened with longitudinal incisions, which were further torn apart with forceps. These tears were made from the dorsal sac inward on the inferior, the superior, the anterior, and the posterior surfaces of the oviduct respectively. This procedure was followed by rather free bleeding from one torn sac. The abdomen was closed. One hour following the operation the dog was still prostrated—with a pulse 120, but of fairly good volume.

March 28. Dog in excellent spirits, quite active. Abdomen reopened under ether narcosis. A small quantity of fluid and clotted blood present. Good pulsation present in proximal stump of right uterine artery. Distal portions of the right vessels severed again and the fetal sac adjacent to the body of the uterus on this side torn apart. All the left sacs were again cut open in different places, and the left uterine vessels were severed. There was the usual free hemorrhage. Dog conscious on reaching bed, pulse very rapid and small.

April 2. Dog rather dull yesterday and to-day, but gets around well. Has shown no symptoms of pain. This morning the abdomen was reopened for the fourth time within a period of nine days. Several cubic centimeters of dark bloody fluid were present. Bladder much distended. Omentum adherent to fetal sacs. The left uterine vessels were thrombosed in their severed ends. Definite pulsation in the artery could not be made out on either side. The uterus, together with the fetal sacs, was now removed. The bleeding from the freshly cut uterine and ovarian vessels was very free. Abdomen closed. At the end of the operation the femoral pulse was 140 to 150, irregular and small. Mucous membranes much blanched. A tight binder was placed around the abdomen and the dog left in the Trendelenburg position. Three hours later the condition was about the same. Three hundred and twenty-five cubic centimeters of a saline solution given subcutaneously, with slight improvement of the pulse.

April 3. Twenty-four hours after the last operation the dog was found in much better condition, able to be on her feet and taking nourishment readily. Pulse 120, regular and of fairly good volume.

Dog No. 14.—Small fox-terrier bitch, pup, black and white, with yellow face. Weight 10 pounds.

February 10, 1908. 12.00, anesthetic started. Pulse 160. Two inch median incision made. Right ovary, uterus and oviducts excised. No ligatures placed. Wall incision closed in layers. Pulse at end of operation 140. Dog placed in pen.

5.00, Pulse 160. Dog drinking water this afternoon, and when taken out of pen walks back.

February 11. Dog eating and apparently in good condition, but remains rather quiet.

February 13. Dog sluggish, eats a little, drinks water, walks about a little, but seems to want to be quiet.

February 15. Dog ate last night apparently as usual. Found dead this morning.

*Autopsy.* Wound looks clean but has not united firmly. Under the incision there is a mass of clotted bloody fluid matting the bowels together, and uniting them to abdominal wall. No firm adhesions found here. There is some free dark bloody fluid in abdomen. (Smears taken later from this and stained, showed long coarse square-ended bacilli. Cultures on agar showed no growth.) The intestines are matted together in semi-solid blood-clots. The omentum is matted into a mass on the left side. Intestines clear. Liver, spleen and pancreas appear normal. Heart and lungs normal. The uterine stump is covered with a firm blood-clot and a few fine adhesions.

We have recently carried out two experiments to determine what effect would be produced by cutting the uterine veins alone. It has been said that the bleeding from a ruptured ectopic is for the most part venous in character, and will keep up indefinitely if the vein alone is injured. In neither of our experiments were we able to prove that such is the case, as in each instance as will be seen by consulting the details of the experiments, the dogs recovered.

The two dogs experimented upon are numbered 30 and 31 respectively, as the experiments were carried out recently, but they can best be introduced in this series of experiments.

Dog No. 30.—June 6, 1908. Brindle bull bitch. Weight 17 pounds.

11.15. Pulse 128.

12.00. Anesthetic started.

12.15. Pulse 180. Resp. 80. Hemoglobin 88.

12.17. Abdominal incision made.

12.20. Pulse 160. Resp. 96. Hemoglobin 88.

12.21. Left uterine artery cut and tied. Right uterine veins cut—the artery being left intact.

12.25. Pulse 168. Resp. 84.

12.30. Pulse 160. Resp. 92.



- 12.38. Pulse 180. Resp. 90. Hemoglobin 84.  
 12.45. Abdomen closed. Morph. sulph. gr.  $\frac{1}{2}$  given hypo.  
 12.55. Hemoglobin 80.  
 1.00. Pulse 108. Resp. 88.  
 1.45. Pulse 104. Resp. 44. Hemoglobin 82.  
 June 7. 2 P. M. Dog active, running about so that bandages are completely off. Wound left unprotected. Hemoglobin 82.  
 June 12. Uneventful recovery.  
 June 23. Perfectly recovered.  
 Dog. No. 31.—June 16, 1908. Long black-haired bitch.  
 Weight 16 pounds.  
 11.15. Anesthetic started.  
 11.30. Pulse 180. Resp. 40. Hemoglobin 100.  
 11.35. Hemoglobin 102.  
 11.37. Incision made.  
 11.40. Pulse 132. Resp. 32.  
 11.46. Right uterine vein cut.  
 11.50. Pulse 136. Resp. 28.  
 11.52. Left uterine vein cut. Both arteries left intact and pulsating.  
 11.55. Pulse 102. Resp. 20. Hemoglobin 95.  
 12.03. Abdomen closed.  
 12.10. Morph. sulph. gr. 1 hypo.  
 12.25. Hemoglobin 94.  
 1.35. Pulse 160. Resp. 20. Hemoglobin 94.  
 June 17. Dog active—eating.  
 June 23. Uninterrupted recovery.  
*Résumé.*—In this series we have sixteen observations.  
 I would like to call attention to the experiments carried out in

Dogs No. 7 and 13 as they are of rather unusual interest.

In Dog No. 7 after cessation of the bleeding we injected subcutaneously 400 c.c. of normal salt solution. This procedure seemed to exercise a general beneficial result but brought about no recurrence of the hemorrhage. This observation would go toward refuting the view of Fritsch, who says "To give subcutaneous saline infusions before the operation is wrong. I advise them directly after the operation."

Dog No. 13, who was about one-third along with her pregnancy, was operated upon four times within a period of nine days. At the first operation the right uterine vessels were incised. At the second operation (two days after the first) the fetal sacs on the left side were opened by longitudinal incisions. At the third operation (day after second operation) the distal portions of the right uterine vessels were severed again, and the fetal sacs on the right side were torn open, the left sacs were again cut open in different places and the left uterine vessels were severed. At the

fourth operation (five days after the third operation) the uterus together with the fetal sacs were removed. (No vessels were tied or clamped at any of the operations). Twenty-four hours after the last operation the dog was able to be on her feet and took nourishment readily.

*Series No. 2. Division of the Uterine Vessels Producing Shock. Secondary Operation on Dog while in a Condition of Shock.*

Dog No. 14.—February 7. Black and white short-haired bitch, spotted black and white face. Weight 26 pounds.

9.55. Anesthetic started.

10.25. Operation started. Pulse 200. Resp. 88. Three-inch median incision. Oviducts and uterus very vascular, bladder distended.

10.45. Right uterine vessels cut. Pulse 204.

10.50. Apex beat of heart cannot be felt.

10.55. Apex beat of heart cannot be felt. Mucous membranes paling. Resp. 140. Anesthetic stopped.

10.56. Resp. 72; Cheyne-Stokes type.

11.00. Apex beat not palpable. Tongue and mucous membranes gray.

11.05. Apex beat not palpable. Tongue and mucous membranes gray. Dog seems to be coming out from anesthetic.

11.10. Dog well out from under anesthetic. Tongue blanched. Pulse not perceptible.

11.15. Apex beat feeble. Pulse about 140. Color of mucous membranes better.

11.20. Abdomen opened again. Three ounces of bloody fluid sponged out. Bladder tapped, emptied and dropped back into cavity. The oviducts and incised vessel manipulated. The cut vessels were found oozing, but not markedly.

11.23. Apex beat feeble. Resp. 64; good.

11.24. Apex beat feeble. Resp. 100.

11.25. Pulse taken at left uterine artery, 200 per minute.

11.30. Apex beat feeble. Resp. good. Mucous membranes improving in color.

11.40. Apex beat palpable, but rate cannot be counted. Resp. 32. Apparently failing. Artificial respirations begun and continued until 11.55.

11.55. Dead. A fairly good-sized clot was found at point at which right uterine vessels had been severed.

*Résumé.* In this dog the right uterine vessels were severed and the abdomen was closed while the vessels were bleeding. After an interval of 35 minutes the dog's pulse was 204, and it fell to 140 before the abdomen was opened again. On opening the abdomen the second time we manipulated the abdominal contents in very much the same manner as would be carried out in doing an operation for a ruptured ectopic pregnancy.



The abdomen was then closed. In thirty-five minutes after this the dog expired, either from the effects of the operation, or of the anesthetic, or from a combination of these factors. This experiment, while only a single observation, is at least suggestive that the addition of shock to shock—which is precisely what we bring about when we submit a woman to an immediate operation for ruptured tubal pregnancy—is very likely to prove fatal.

*Series No. 3. Division of the Uterine Vessels and Observations upon the Pulse, Respirations, Blood-pressure and Hemoglobin.*

Dog No. 18.—February 28. Brown long-haired bitch pup. Weight 12 pounds. Before starting anesthetic pulse 132.

11.20. Anesthetic started.

11.40. Pulse 162. Resp. 46

12.00. Pulse 180. Resp. 52. Hemoglobin 120.

Mercury manometer connected with femoral artery. Blood-pressure 130 mm. of mercury.

12.05. Pulse 182. Resp. 80.

12.06. Abdominal incision made.

12.10. Morph. sulph. gr.  $\frac{1}{2}$  hypo. Uterine vessels on one side were cut.

12.15. Blood pressure 100 mm. of Hg.

12.20. Pulse 108. Resp. 60. Hemoglobin 98.

12.25. Pulse 124. Resp. 66.

12.30. Pulse 104. Resp. 120.

12.35. Pulse 132. Resp. 180. Hemoglobin 110.

12.40. Pulse Resp. 108.

12.45. Pulse 134. Resp. 162. Blood-pressure 90 mm. of Hg.

12.50. Pulse 120. Resp. 168. Hemoglobin 98

12.52. Abdomen reopened and clot removed from cut end of vessels.

1.15. Pulse 128. Resp. 168.

1.30. Morph. sulph. gr.  $\frac{1}{2}$  hypo.

1.40. Abdominal wall closed.

3.00. Dog walking around.

February 29. Dog appears to be feeling fairly well to-day.

March 3. Dog no very active. Acts as if she were toxic.

March 4. Died to-day. Abdominal wound gangrenous, having completely broken down. No free fluid nor blood in abdominal cavity. Over the cut end of vessels there is a well-formed clot. Between the uterus and bladder there are a few fine adhesions. Liver and spleen enlarged and soft. Other organs apparently normal.

Dog. No. 15. February 12. White bull bitch. Weight 34 pounds. Before operation pulse 180-200. Hemoglobin 127.

11.32. Both uterine and ovarian vessels cut.

11.35. Morph, sulph. gr. 1 hypo.

11.48. Pulse 180. Resp. 60.

11.55. Pulse 152. Resp. 90 (shallow).

12.00. Hemoglobin 115.

- 12.10. Pulse 140. Resp. 72.  
 12.15. Pulse 132. Resp. 60. Hemoglobin 115.  
 12.25. Morph. sulph.  $\frac{1}{2}$  gr. hypo. Pulse 132. Resp. 50.  
 12.30. Abdomen reopened and six ounces of bloody fluid sponged out.  
 12.35. Pulse 140.  
 12.45. Pulse 136. Resp. 30.  
 1.00. Pulse 120. Resp. 30.  
 Dog remained dazed and sleepy all afternoon.  
 February 13. Dog lively. Seems to be feeling well.  
 February 17. Dressings removed. Incision broken down. Edges edematous and a bloody serous fluid discharging from wound. Rbc. 6,956,000. Hemoglobin 110.  
 February 18. Dog lively, eating, feeling well.  
 February 20. Wound nearly closed. Dog doing very well.  
 March 2. Before operation pulse 160.  
 10.20. Anesthetic started.  
 10.35. Pulse 186. Resp. 28.  
 10.45. Morph. sulph. gr.  $\frac{1}{2}$  hypo.  
 10.50. Ether discontinued.  
 11.00. Began opening neck to insert cannula in left carotid artery. Pulse 198. Resp. 42. Hemoglobin 130.  
 11.10. Morph. sulph. gr.  $\frac{1}{2}$  hypo. Resp. 28.  
 11.20. Mercury manometer connected with left carotid artery. Blood pressure 120 mm. of mercury.  
 11.25. Abdominal incision made.  
 11.30. Morph. sulph. gr.  $\frac{1}{2}$  by hypo.  
 11.32. Right uterine vessels cut on uterine stump.  
 11.34. Abdominal wall closed with hemostatic forceps.  
 11.37. Pulse 180. Resp. 42. Blood-pressure 120 mm. of Hg. Hemoglobin 120.  
 11.45. Pulse 172. Resp. 48.  
 11.50. Blood-pressure 110. Hemoglobin 115.  
 12.15. Abdomen opened. Pretty well filled with bloody fluid. A fairly well organized clot found over the cut end of right uterine vessels. There was no active bleeding until after pelvic contents had been manipulated, then the blood welled up out of abdominal incision.  
 12.25. Closure of abdominal wound begun.  
 12.30. Morph. sulph. gr.  $\frac{1}{2}$  hypo. Pulse 168. Resp. 32. Blood-pressure 110. Hemoglobin 115. Dog remained sleeping remainder of afternoon.  
 March 3. Dog lies quietly this morning.  
 March 5. Dog feeling well, walking around.  
 March 15. Dog perfectly recovered.  
 April 23. Hemoglobin 105 per cent.  
*Résumé.* In Dog No. 1 of this series the blood-pressure had dropped from 130 mm. of mercury to 100 mm. of mercury within five minutes after the uterine vessels had been cut, and in 30 minutes more the blood-pressure was 90 mm. of mercury.



During this period of time the hemoglobin fell in all 22 points (from 120 to 98).

In another experiment (this dog had been operated upon five days previously), both ovarian and uterine vessels having been cut, the hemoglobin fell from 127 to 115 in forty-three minutes. Five days after the operation the hemoglobin was 110. Eleven days afterward a second operation was carried out similar to that upon Dog No. 1 of this series. The blood-pressure which was 120 mm. of mercury, one hour after section of the right uterine vessels, fell to 110. The hemoglobin at the beginning of the experiment was 130 and fell to 115 an hour after the cutting of the vessel.

As might be supposed the blood-pressure falls slightly and the hemoglobin drops as usual immediately after division of the vessels. As soon, however, as the bleeding ceases the hemoglobin stops going down and remains stationary for a time, and the blood-pressure rises.

*Series No. 4. Division of the Vessels and Observations of the Pulse, Respiration and Hemoglobin with Especial Reference to the Time of the Clotting of the Blood.*

Dog No. 16.—February 18. Fox-terrier and bull bitch. Weight 16 pounds. Before starting anesthetic pulse 156. Respirations not taken. Hemoglobin 130.

9.55. Anesthetic started.

10.05. Pulse 180. Resp. 60.

10.25. Operation started. Pulse 176. Resp. 68.

10.35. Pulse 160. Resp. 60.

10.37. Left uterine vessels cut. Pulse 176. Resp. 52

10.45. Pulse 200+. Resp. 56.

10.55. Pulse 240?. Resp. 52.

11.00. Morph. sulph. hypo. gr.  $\frac{1}{2}$ . Hemoglobin 110.

11.05. Pulse 176. Resp. 32.

11.15. Pulse 160. Resp. 28. Hemoglobin 110.

11.30. Pulse 154. Resp. 24. Hemoglobin 110.

Bleeding in pelvis now practically ceased. There are numerous small blood-clots between intestines and bladder and over cut end of left uterine vessels.

11.45. Pulse 140. Resp. 33. Hemoglobin 110.

11.50. Pulse 132. Resp. 32.

11.54. Morph. sulph. gr.  $\frac{1}{2}$  by hypo.

11.55. During last fifteen minutes there has been no fresh bleeding. Clots are firmer. Dog is resting quietly. Femoral pulse is regular and of good volume. Pulse and respiration about the same as at 11.50. Four ounces of bloody fluid sponged from abdominal cavity. There is a well-formed clot over the proximal cut end of uterine vessels. Clot removed and active bleeding started again (weight of this clot 1 gram).

- 12.50. Dog remained sleeping all afternoon.
- February 19. Dog takes liquids, but not very active.
- February 20. Dog walking around. Has eaten solid food to-day.
- Hemoglobin to-day 115.
- February 27. Dog's condition has gradually improved, although she is considerably emaciated. Bandages removed to-day leaving open a raw granulating broken down wound.
- February 28. Dog was walking around this morning. Found dead this afternoon.
- Autopsy.* On opening the abdomen three loops of small intestines were found adherent to the abdominal wall immediately under the wound. Abdominal wall incision had completely broken down except the peritoneal layer. Muscle and skin layers widely retracted. No free fluid in abdominal cavity. No blood found. A few fine adhesions behind the bladder. Right uterine vessels seemed normal. Left uterine vessels thrombosed. Liver somewhat swollen. Other organs appear normal.
- Dog No. 17.—February 21. Black and white fox and sky terrier bitch. Weight 21 pounds. Before anesthetic was started pulse 128.
- 10.30. Anesthetic started (ether).
- 11.10. Operation started. Hemoglobin 140.
- 11.15. Anesthetic stopped. Pulse 160. Resp. 56.
- 11.16. The uterine vessels on both sides cut, the stumps being dropped back into abdominal cavity with catgut guides attached to the broad ligaments.
- 11.20. Morph. sulph. gr.  $\frac{1}{2}$  by hypo. Resp. 48.
- 11.25. Pulse 196. Resp. 64. Hemoglobin 130.
- 11.30. Morph. sulph. gr.  $\frac{1}{2}$  by hypo.
- 11.35. Considerable vomiting and straining, then dog became very quiet.
- 11.35. Pulse 168. Resp. 150. Hemoglobin 125.
- 11.45. Pulse 200. Resp. 200.
- 11.50. Pulse 180. Resp. 180. Hemoglobin 125.
- 12.00. Resp. 150.
- 12.05. Pulse 156. Resp. 138.
- 12.10. Pulse 152. Resp. 104.
- 12.15. Abdomen reopened. Pulse 154. Resp. 66. No bleeding found. There are large clots on the left side. On drawing up the uterus and separating the clot on the left side the bleeding recommences. Same occurs on removing small clot from the right side.
- 12.30. Pulse 112. Resp. 56.
- 12.40. Abdominal wall closed.
- 4.00. Pulse 140. Dog slept all afternoon.
- February 22. Dog active and feeling good. Hemoglobin 125. Dog made a very rapid recovery. Skin incision healed perfectly, and this dog was used again April 24 as Dog No. 20.
- Résumé.* In this series we endeavored to trace some con-



nection between the pulse, respirations and the hemoglobin values and the formation of the blood-clot, or in other words, the cessation of the bleeding.

In the first dog of this series, in eight minutes after the left uterine vessels had been cut the pulse had risen from 200 to 240, and the respirations were 52. In twenty-three minutes after the severance of the vessel the hemoglobin had fallen twenty points, but taken fifteen to thirty minutes later the hemoglobin showed the same reading. After the hemoglobin ceased going down the pulse and respirations began to improve, the pulse going to 154 and the respirations to 24. On reopening the abdomen we found a number of clots lying between the intestines and the bladder and around the cut ends of the vessels. One clot which weighed 1 gram was removed and active bleeding started up again. The abdomen was again closed. On Feb. 28, ten days after the operation; she developed a septic peritonitis from the infected abdominal incision and died.

We have carried out this experiment frequently enough in dogs to make us feel reasonably certain that from the hemoglobin readings alone we can tell the time at which the clot has formed in the vessels. In every instance in which the hemoglobin ceases to go down and the reading remains stationary (and this in our experience always occurs) and the abdomen is reopened a well-formed clot will be found occluding the vessels. I believe that the hemoglobin readings will be found very useful in cases of intra-abdominal hemorrhage from a ruptured ectopic pregnancy, and that when we see that the hemoglobin remains stationary we can feel confident that we are doing the best for the patient in not operating at once.

The experiments in this group of dogs may be divided into three distinct portions: (1) In the first the pulse and respirations become very rapid after the division of the uterine vessels, the pulse becoming in some instances so fast that it is practically impossible to count it. During this time the hemoglobin will fall from 10 to 20 points. This portion of the experiment occupies about 20 minutes. (2) During the next fifteen to twenty minutes the dog looks as if it would die, but the hemoglobin remains practically stationary. If the abdominal cavity is now reopened a well defined blood-clot will be found about the incised vessels and the pedicle, and the bleeding will have ceased. (3) During the third fifteen to twenty minutes the pulse and respiration start to improve again, and the dogs begin to show

evidences of reacting. As a rule, from then on the recovery is without incident.

*Series No. 5. Division of Vessels, Observations on the Pulse, Respirations and Hemoglobin before and after Bandaging and after Applying Weights to the Lower Abdomen.*

Dog No. 19.—March 13. Small brown short-haired bitch pup. Weight 8 pounds.

10.45. Pulse 190. Resp. 48. Hemoglobin 85-90 per cent.

10.46. Abdominal incision.

10.50. The uterine vessels on both sides cut.

11.00. Abdomen closed (skin clamps used).

11.05. Pulse 200. Resp. 48. Hemoglobin 90. Tight pressure bandages applied.

11.10. Morph. sulph.  $\frac{1}{2}$  gr. by hypo. Dog vomited almost immediately.

11.20. Pulse 150. Resp. 20. Hemoglobin 90.

11.35. Pulse 96. Resp. 24.

12.35. Pulse 100. Resp. 12.

3.00. Pulse 108. Resp. 12. Dog drinking water. Pulse very irregular.

March 14. Dog not so quiet. Pulse 160, irregular.

March 15. Dog quiet. Pulse 156, more regular.

March 21. Dog walking around. Wound appears clean. Fresh dressings applied.

March 25. Edges on wound not so clear as on the twenty-first. Fresh dressing.

March 30. Dressing removed. Dog licks wound. Wound looks better.

April 5. Dog emaciated but seems to be doing fairly well.

April 10. Dog emaciated but has considerable abdominal distention.

April 12. Abdomen markedly distended. Skin clamps still in place. Dog not very active. Hemoglobin 90.

*Autopsy.* Dog killed with ether. Abdominal cavity contains a considerable amount of purulent fluid. Bladder markedly distended. Omentum adherent to abdominal wall along the old incision which had completely healed. Lymphatics of intestines white and stand out distinctly. Liver yellow, fatty, swollen. Spleen soft and swollen. Heart and lungs appear normal. Smears from abdominal fluid show many pus-cells, in some of which a few cocci can be found.

Dog No. 20.—March 13. Brown long-haired bitch pup, white belly. Weight 10 pounds. Pulse before starting anesthetic 168.

11.40. Anesthetic started.

11.42. Pulse 168. Resp. 60.

11.48. Abdominal incision made. Hemoglobin 85.

11.50. Pulse 200. Resp. 92.

11.55. The uterine vessels on both sides cut. Pulse 190. Resp. 80. Hemoglobin 87.



- 12.00. Morph. sulph. gr.  $\frac{1}{2}$  by hypo. Pulse 188. Resp. 68.  
 12.05. Pulse 144. Resp. 48. Hemoglobin 80.  
 12.10. Anesthetic stopped and abdomen closed. Pulse 116.  
 Resp. 40.  
 12.26. (Before pressure bandage was applied.) Pulse 198.  
 Resp. 69.  
 12.32. (After pressure was applied.) Pulse 220. Resp. 52.  
 Hemoglobin 85.  
 3.00. Dog drinking water. Pulse 180. Resp. 24.  
 March 14. 3.00 P. M. Pulse 128, regular. Dog quiet.  
 March 15. 1 P. M. Pulse 140, regular. Dog quiet.  
 March 24. Bandage taken off. Wound clean. Dog active  
 and feeling good.  
 April 12. Dog had been active and doing very well until two days  
 ago when she refused to eat, and on April 11, at 6 P. M. she died.  
*Autopsy.* Incision clean and perfectly united. There are a  
 few adhesions between omentum and abdominal wall along the  
 old wound. No free fluid and no blood in abdominal cavity.  
 Peritoneal surface smooth and apparently clear. Bladder  
 small. Uterine stumps free. No adhesions but tissues about  
 it are somewhat blood-stained. Intestines, spleen, liver, heart,  
 lungs, etc., appear normal.  
 Dog No. 21.—March 21. Black and tan short-haired bitch,  
 tan muzzle, white throat and four white feet. Weight 16 pounds.  
 10.30. Anesthetic started. Pulse 88, very irregular.  
 10.45. Pulse 160. Resp. 32. Hemoglobin 125.  
 11.20. The uterine vessels on both sides cut.  
 11.25. Pulse 162. Resp. 56.  
 11.27. Abdomen closed.  
 11.30. Light pressure bandage applied. Pulse 132–136. Resp.  
 48. Hemoglobin 110.  
 11.50. Pulse 126. Resp. 40.  
 11.55. Pulse 128. Resp. 30. labored.  
 12.00. Pulse 144, irregular.  
 12.05. Pulse 172, regular in force and rhythm. Resp. 20.  
 12.20. Pulse 136–156. Resp. 14.  
 12.23. Morph. sulph. gr.  $\frac{1}{2}$  by hypo.  
 12.30. Pulse 148. More regular and better quality. Resp.  
 12. Hemoglobin 110.  
 March 22. 5.00 P. M. Dog quiet. Pulse 132.  
 March 25. Bandage removed. Wound dressed again. In-  
 cision looks clean. Doing well. Dog feeling fairly well.  
 April 25. Dog has made an uninterrupted recovery. Is  
 now well nourished and in very good condition.  
 Dog No. 22.—March 24. Big long-haired black and white  
 bitch pup. Weight 50 pounds.  
 10.20. Anesthetic started.  
 10.30. Pulse 144. Resp. 100.  
 10.46. Incision made. Hemoglobin 115.  
 10.50. Hemoglobin 115.  
 11.06. The uterine vessels on both sides were cut and sutures

previously placed for closing abdominal walls were tied as soon as possible; rubber pressure bandage applied.

- 11.10. Hemoglobin 110.
- 11.15. Pulse 104. Resp. 32.
- 11.20. Pulse 200. Resp. 36.
- 11.27. Pulse 150-152. Resp. 48
- 11.35. Pulse 128-132. Resp. 24.
- 11.55. Pulse 132. Resp. 24.
- 12.05. Dog whining. Hemoglobin 100.
- 12.15. Pulse 200+. Resp. 20.
- 12.20. Morph. sulph. gr. 1 by hypo.
- March 25. Noon. Pressure bandage removed. Pulse 150 before removing pressure. Pulse 150 after removing pressure. Hemoglobin 100.
- March 26. Dog walking around.
- March 30. Dog active. Doing very well.
- April 15. Dressing removed. Hemoglobin 100.
- April 23. Hemoglobin 95.
- Dog No. 23.—April 15. Water spaniel bitch. Weight 25 pounds. Before operation pulse 160.
- 10.25. Incision made. Hemoglobin 108.
- 10.40. Left uterine vessels cut.
- 10.45. Pulse 172. Resp. 48.
- 10.47. Abdomen closed.
- 10.48. Hemoglobin 95.
- 10.50. Rubber pressure bandage applied.
- 10.55. Pulse 156. Resp. 58.
- 10.56. Hemoglobin 90.
- 11.15. Pulse 114. Resp. 40. Hemoglobin 85. (?)
- 11.25. Dog vomiting and whining. Pulse 180. Resp. 28.
- 11.30. Morph. sulph.  $\frac{1}{2}$  gr. hypo. Dog whining.
- 11.35. Pulse 156. Resp. 28.
- 11.45. Dog perfectly quiet. Pulse 140. Resp. 28.
- 12.15. Dog perfectly quiet. Pulse 140. Resp. 20. Hemoglobin 90.
- 12.30. Dog perfectly quiet. Pulse 154. Resp. 16.
- 2.10. Pulse 148. Resp. 18.
- 2.45. Pulse 148. Resp. 24. Hemoglobin 100. (?)
- 2.55. Dog perfectly quiet.
- 3.30. Dog perfectly quiet. Hemoglobin 90.
- 3.40. Dog moving head some. Pulse 140. Resp. 14.
- 5.00. Dog whining. Pulse 138. Resp. 12. Hemoglobin 90.
- Legs swollen, edematous, blue and cold.
- 5.10. Pressure bandage removed.
- 5.15. Morph. sulph. gr.  $\frac{1}{2}$  by hypo.
- 5.30. Pulse 140. Resp. 20. Hemoglobin 90+. Legs warm, swelling and edema have disappeared. Dog walks, but drags left leg.
- April 16. Dog walks about but seems sluggish.
- April 17. About the same as yesterday, eating and bowels moving.



- April 19. Dog still prefers to be quiet. Bandages removed.  
 April 25. Dog feeling better.
- Dog No. 24.—April 20. Brown short-haired bitch, toes white-tipped. Weight 13 pounds. Pulse before starting anesthetic 164. (Pulse taken through entire experiment, at heart apex with stethoscope.)
- 10.40. Anesthetic started.  
 10.52. Incision made.  
 10.59. The uterine vessels on both sides cut. Pulse 140.  
 Resp. 30. Hemoglobin 125.  
 11.00. Pulse 154. Resp. 80.  
 11.01. Closure finished.  
 11.02. Hemoglobin 125.  
 11.04. Abdomen compressed with hands, then two-pound weight applied until 11.00.  
 11.11. Twelve-pound weight applied to abdomen. Pulse 154.  
 Resp. 36.  
 11.12. Dog vomited. Hemoglobin 115.  
 11.20. Pulse good volume and quality. Pulse 118. Resp. 24.  
 11.25. Pulse good volume and quality. Hemoglobin 115.  
 11.30. Pulse good volume and quality. Pulse 116. Resp. 24.  
 11.31. Twelve-pound weight removed from abdomen.  
 11.35. Abdomen reopened. Pedicles drawn up. Clot torn off of cut end of right uterine vessels in drawing up the stump, leaving a pulsating hemorrhage. A firm clot remained over cut end of left uterine vessels. This was removed and the uterine dropped back into abdomen.  
 11.42. Reclosure of abdomen started. Pulse 116. Resp. 28.  
 11.47. Pulse 124. Resp. 24.  
 11.52. Hemoglobin 107.  
 11.55. Twelve-pound weight again applied to abdomen. Pulse 132. Resp. 16.  
 11.57. Pulse better volume and quality. Pulse 114. Resp. 16.  
 12.05. Pulse 128. Resp. 20. Hemoglobin 105.  
 12.09. Twelve-pound weight removed.  
 12.10. Pulse 138. Resp. 16.  
 12.15. Morph. sulph. gr.  $\frac{1}{4}$  by hypo.
- April 21. Dog walking around.  
 April 23. Dressings removed.  
 April 25. Doing very well.
- Dog No. 25.—April 21. Black and white long-haired bitch pup. Weight 12 pounds. (Pulse throughout entire experiment taken at heart apex with stethoscope.)
- 11.05. Anesthetic started.  
 11.20. Pulse 200+. Resp. 120. Hemoglobin 98.  
 11.25. Hemoglobin 98.  
 11.30. Incision made.  
 11.33. The uterine vessels on both sides cut.  
 11.35. Pulse 132. Resp. 96. Hemoglobin 97.  
 11.36. Abdomen closed and four-pound weight applied.

- 11.40. Pulse 120. Resp. 62.  
 11.42. Hemoglobin 88.  
 11.50. Seven and one-half pounds added. Total  $7\frac{1}{2}$  pounds.  
 Pulse 120. Resp. 62.  
 11.55. Pulse 100. Resp. 80. Hemoglobin 88.  
 12.00. Dog struggling some. Pulse 120. Resp. 80.  
 12.10. Pulse 120. Resp. 92. Hemoglobin 88.  
 12.16. Weight removed from abdomen and morph. sulph. gr.  $\frac{1}{2}$   
 given by hypo.  
 12.20. Pulse 120. Resp. 80.  
 12.35. Pulse 86. Resp. 140. (?)  
 2.30. Dog quiet. Pulse 88. Resp. 14.  
 April 22. Dog walking around.  
 April 25. Dog doing very well.  
 Dog No. 26.—April 22. Brown long-haired skye terrier bitch  
 pup. Weight  $13\frac{1}{2}$  pounds. Before starting operation pulse  
 160.  
 10.20. Anesthetic started. Pulse taken with stethoscope at  
 heart apex.  
 10.40. Pulse 218. Resp. 80. Hemoglobin 100.  
 10.50. Pulse 196. Resp. 112.  
 10.57. Morph. sulph. gr.  $\frac{1}{4}$  hypo.  
 11.00. Incision made.  
 11.05. Pulse 160. Resp. 100. Hemoglobin 100.  
 11.09. Distended bladder tapped.  
 11.15. The uterine vessels on both sides cut. Pulse 152.  
 Resp. 108.  
 11.18. Abdomen closed.  
 11.20. Pulse 140. Resp. 112. Hemoglobin 100.  
 11.21. Three and three-fourths-pound weight placed on abdo-  
 men.  
 11.22. Resp. 86.  
 11.27. Hemoglobin 95.  
 11.30. Pulse 120. Resp. 80, jerky.  
 11.35. Pulse 120. Resp. 86. Hemoglobin 95.  
 11.39. Four and three-fourths pounds added (total  $8\frac{1}{4}$  pounds  
 on abdomen).  
 11.42. Weight on abdomen increased to  $10\frac{1}{4}$  pounds.  
 11.45. Hemoglobin 95.  
 11.50. Pulse 100. Resp. 76. Hemoglobin 95.  
 11.51. All weights removed.  
 11.56. Pulse 120. Resp. 80. Hemoglobin 95.  
 12.00. Pulse 120. Good quality. Resp. 68.  
 12.08. Ten and one-fourth-pound weight again applied to  
 abdomen. Pulse good.  
 12.16. Pulse 132. Resp. 60.  
 12.21. Pulse 120. Resp. 44.  
 12.34. Morph. sulph. gr.  $\frac{1}{4}$  by hypo. Pulse 120. Resp. 44.  
 All weights removed.  
 April 23. Dog walking around. Condition good.  
 April 25. Condition good.



Dog No. 27.—April 24. This is the dog used as Dog No. 9. Weight 21 pounds. (Pulse taken with stethoscope at heart apex.)

- 10.25. Anesthetic started.
- 10.30. Pulse 140. Resp. 48.
- 10.40. Hemoglobin 100. (?)
- 10.45. Abdominal incision.
- 10.49. Top of uterus and lower portion of both oviducts excised.
- 10.50. Pulse 132. Resp. 56. Hemoglobin 110.
- 10.52. Abdominal closure finished and 5 pound weight applied.
- Pulse 120. Resp. 52.
- 10.57. Pulse 148. Resp. 44. Hemoglobin 109.
- 11.03. Pulse 176. Resp. 50. Hemoglobin 103.
- 11.10. Pulse 176. Resp. 48. Hemoglobin 103.
- 11.20. Morph. sulph. gr.  $\frac{1}{4}$  by hypo.
- 11.25. Four-pound weight added. (total 9 pounds). Pulse 180. Resp. 48.
- 11.35. Pulse 160. Resp. 36. Hemoglobin 98.
- 11.40. Pulse 160. Resp. 40. Hemoglobin 103.
- 11.45. Morph. sulph. gr.  $\frac{1}{4}$  hypo. Pulse 160. Resp. 36.
- 11.50. Pulse 176. Resp. 32.
- 12.00. Pulse 192. Resp. 32.
- 12.10. Pulse 192. Resp. 36.
- 12.15. All weights removed. Pulse 168. Resp. 36. Pulse irregular.
- 12.20. Pulse 160. Resp. 36.
- 12.30. Pulse 156. Resp. 36.
- 6.00. Dog lies quietly looking around.
- April 25. Dog walks around barking.

*Résumé.*—I wish to call attention to one or two striking experiments in this series.

Dog No. 19. Weight of dog, 8 pounds. The pulse immediately after both uterine arteries and veins had been cut and before a tight abdominal bandage had been applied, was 200, and the respirations were 48. Forty-five minutes later the pulse was 96 and the respirations were 24. Four hours and ten minutes after the cutting of the uterine vessels, the pulse was 108 and the respirations were 12.

In dog No. 21, the hemoglobin, which before the cutting of the vessels was 125, fell to 110 in 10 minutes. The bandage was then applied to the abdomen and the pulse from 162 and the respirations from 56 came down to 126 and 40 respectively in 20 minutes. Fifty minutes later the pulse varied between 156 and 136, and the respirations between 14 and 20, the hemoglobin still remaining at 110. In two similar experiments a rubber tourni-

quet was applied after cutting the vessels, and the results were somewhat similar.

In dogs Nos. 17, 18, 20, still more striking results in the pulse, respiration and hemoglobin were obtained by applying weights to the lower abdomen and thus bringing the anterior in more direct apposition with the posterior abdominal wall.

Thus in dog No. 17, which weighed 13 pounds, 12 minutes after cutting the uterine vessels the pulse was 154, the respirations were 36, and the hemoglobin had fallen 10 points. A 12-pound weight was applied to the abdomen and in 8 minutes the pulse had fallen to 118, and the respirations to 24, but the hemoglobin remained stationary. After 10 minutes the pulse was 116 and the respirations were 24. We now opened the abdomen and exposed the vessels; they were surrounded by a firm clot. The clot was removed and the pedicles were dropped back into the abdomen. The pulse and respirations rose again, and the hemoglobin fell to 107-8 points lower than it was before the fresh hemorrhage was started up. The weight was applied again to the abdomen and in 2 minutes the pulse had fallen from 132 to 114. Twelve minutes later the weight was removed again, and immediately the pulse rose to 148.

One other striking experiment in a dog that weighed 12 pounds in this group showed that in 5 minutes after putting a 7½-pound weight on the abdomen, the pulse had fallen from 120 to 100, and the hemoglobin from 98 to 88. This and other experiments with pressure, particularly when it is applied so that the anterior and posterior abdominal walls are brought more closely together, would suggest the application of pressure over the lower abdomen in cases of hemorrhage from a ruptured ectopic pregnancy. This might possibly be carried out by the use of shot or sand bags of known weight, as much weight being employed as the patient could comfortably stand. As our experiments showed, by using the weight in the way just described the results were more striking than when the abdomen was simply bandaged.

*Series No. 6.—Division of Uterine Vessels with Dog in the Perpendicular Position; Observations upon Pulse, Respiration and Hemoglobin.*

Dog. No. 28.—April 27. Same dog as used April 15 as dog No. 16.

Weight 24 pounds. Pulse before starting anesthetic 148.  
10.20. Anesthetic started.  
10.32. Pulse 148. Resp. 68. Hemoglobin 75.  
10.35. Hemoglobin 75.



10.38. Incision made. On opening peritoneal cavity no fluid present. A few adhesions between the intestines; posterior portion of the bladder adherent to the uterus. At this point a markedly organized blood-clot. The left uterine vessels thoroughly thrombosed.

10.52. The uterine vessels on both sides cut.

10.54. Ether anesthesia stopped. Morph. sulph. gr.  $\frac{1}{2}$  hypo. given and foot of table elevated  $2\frac{1}{2}$  feet.

10.56. Foot of table raised to perpendicular position.

11.00. Pulse 200. Resp. 28. Hemoglobin 65.

11.06. Pulse 180. Resp. 28. Hemoglobin 65.

11.12. Hemoglobin 62.

11.16. Pulse 140. Resp. 24. Hemoglobin 61.

11.18. Hemoglobin 61.

11.25. Pulse 160. Resp. 28. Hemoglobin 62.

11.36. Pulse 160. Resp. 28.

11.45. On reopening the peritoneal cavity a well-marked clot seen near bladder and incised uterine vessels. No bleeding at this point. On pulling the tissue and clot forward and separating them the oozing began from the left uterine vessels. The pelvic cavity was free from blood. On making pressure on the upper abdomen bloody fluid came out of incision which had been prolonged up toward head for  $2\frac{1}{2}$  to 3 inches. Clot removed from left vessels. Right vessels not disturbed. Three minutes after removing clot from left uterine vessels hemoglobin 55 per cent.

12.30. Table lowered to horizontal position. Pulse 200. Resp. 44.

12.32. Hemoglobin 54.

6.00. P. M. Dog drinking water.

April 28. Dog found dead this morning. On opening the abdomen the intestines are found surrounded by clotted blood. Blood-clots found above and below the liver and throughout the cavity. No new formed adhesions found. Both uterine vessels cut ends covered with blood-clots. Intestines, liver, spleen, heart, lungs, etc., appear normal. Bladder small and walls rather firm.

Dog. No. 29.—April 28. Same dog as that used for No. 13.

Weight  $23\frac{1}{2}$  pounds. Before starting anesthetic pulse 72.

11.40. Pulse 200. Resp. 44.

11.50. Morph. sulph. gr.  $\frac{1}{2}$  by hypo. Ether discontinued.

11.52. Pulse 200+. Resp. 24. Hemoglobin 100.

11.54. Incision made with table in perpendicular position; head down. Bladder found adherent to broad ligament near site of formerly incised vessel. Peritoneum, oviducts and body of uterus pale. Thrombosis in both uterine arteries well organized. Dog whining.

11.58. Both uterine vessels cut. Dog whining less than before vessels were cut.

12.00. Dog vomited. Straining and whining.

12.07. Morph. sulph. gr.  $\frac{1}{4}$  by hypo. Hemoglobin 97.

12.10. Morph. sulph. gr.  $\frac{1}{4}$  by hypo.

12.10. Blood-clot at seat of incision glazed over and vessel pulsates through partially clotted blood. Dog struggling markedly forcing blood and omentum out through the incision.

12.15. Ether given in mask and morph. sulph. gr.  $\frac{1}{4}$  hypo.

12.30. Closure.

12.50. Morph. sulph. gr.  $\frac{1}{4}$  by hypo. Pulse 168. Resp. 20. Hemoglobin 92.

1.30. Pulse irregular, Pulse 132. Resp. 16.

5.00. Dog awake, looking around.

April 29. Dog active.

May 2. Dressing removed. Wound doing well. Dog active and playful.

*Résumé.*—In the first dog the pulse had fallen from 200 to 180 ten minutes after the dog had been placed in the upright position, but the hemoglobin remained stationary. After twenty minutes the pulse had fallen to 140 and the hemoglobin had also dropped 4 points. In twenty minutes more the pulse had risen to 160, but the hemoglobin remained practically stationary. The abdominal cavity was reopened and a well-defined clot was seen covering the incised tissues; the vessel had ceased to bleed.

In the second dog the vessels were cut with the dog in the perpendicular position, and the bleeding vessel was observed through a strong magnifying glass in order to compare the time of clotting with the hemoglobin readings. The hemoglobin had fallen 3 points seven minutes after incision of the vessels. After 3 minutes more the incised tissues had begun to take on a glazed appearance, and the hemoglobin remained stationary (ten minutes after the uterine vessels had been cut). Three minutes later the dog began to struggle and to force the abdominal contents through the incision, and the hemoglobin taken 40 minutes later showed a fall of 5 points more. One hour and twenty minutes later the pulse was 132, the respirations were 16 (the hemoglobin was not taken). In this experiment we would have to consider the influence that the air would have in helping to cause the clotting of the blood, and as a consequence the slight drop in the hemoglobin index.

#### CONCLUSIONS.

From these experiments which now number 31 we feel justified more and more in believing that the intra-abdominal hemorrhage, such as is met with in women suffering from collapse after the rupture of an ectopic gestation, is not sufficient in itself to cause a fatal termination in these cases. Death is caused mainly



by shock which may be increased by various procedures. The hemorrhage *per se* is rarely, if ever, the sole cause of death.

One experiment goes to show that the superadded shock belonging to immediate operation is likely to be very dangerous.

It will doubtless be maintained by some that our experimental work has shown nothing more than that the dog can withstand a greater loss of blood than a woman—a recognized fact. And yet it seems fair to assume, as will be seen on consulting our protocols, that in many of our experiments, we made the tests sufficiently severe to more than equalize the factor of resistance to the loss of blood in the dog as compared with that of the human being under fairly similar conditions. In other words, taking into consideration this difference in resistance, by cutting both uterine arteries and veins and in some instances both ovarian arteries and veins as well, we subjected our dogs to a risk of bleeding to death as great as or greater than that incurred by the average woman suffering from a ruptured tubal pregnancy.

Our experiments further show that the clotting probably occurs within 15 to 20 minutes after the vessels have been incised, and that the time of clotting can be known by observing the hemoglobin index. The subcutaneous injection of normal salt solution in all probability does not cause a renewal of the hemorrhage. But manipulation of the tissues by disturbing the clot causes the bleeding to start up again, and may thus be mistaken for a continuing hemorrhage.

Our experiments also show that by the use of bandages, but more particularly by the application of more or less weight to the lower abdomen, the pulse is rendered slower and of better quality, and that the hemoglobin is kept up.

It gives me great pleasure to acknowledge the valuable assistance given me in the carrying out of these experiments by my former assistant Dr. M. B. Bonta, and by my present assistants Drs. Frank C. Ainley and Fred W. Hall.

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