Rupture of the Cæsarean Section Scar in Subsequent Pregnancy or Labour.[1]

By Eardley Holland, M.D., F.R.C.P. (Lond.), F.R.C.S. (Eng.).

My interest in this subject has been excited by the following series of events in the obstetrical department of the London Hospital. In November last I operated on a patient almost moribund from the effects of rupture of the scar of a Cæsarean section performed in 1915; in February of this year I saw in the postmortem room a patient dead from abdominal sepsis consequent on rupture of the scar of a Cæsarean section I had myself performed in 1916, and in the years 1915 and 1916 three other of our Cæsarean section patients got rupture of their scars. The occurrence of five of these treacherous accidents in five years has made a very great impression on the minds of myself and my colleagues.

On inquiry into the subject I was impressed with the fact that we possessed very little information about rupture of the scar, either as to its causes, or, far more important, as to the frequency with which it occurred. At the outset I was struck by the wide divergence of opinion amongst the few with whom I talked or corresponded. On the one hand, I was told that rupture of the scar was more or less of a myth; on the other hand, I learned that certain outstanding surgeons, the Camerons, of Glasgow, for example, were so afraid of ruptured scars that their invariable custom was to sterilize their patients at the first operation. Further inquiry proved that rupture of the scar was no myth, but was a real menace; I heard of recent cases in London and elsewhere; about a hundred cases had already been reported in the obstetrical literature of Europe and America. Obviously the subject required investigation. It seemed, above all, imperative to find out what was the actual frequency, the real risk, of rupture. Quite apart from the importance of this information to obstetric surgeons, patients themselves might wish to know what sort of obstetric future they were likely to have after submitting themselves to Cæsarean section. It seemed all the more important to get exact information in view of the increasing frequency with which the operation is being per-

formed; the scope of Cæsarean section has been widely extended of recent years, and its modern indications form an ever-growing list. There is another point: many patients who nowadays have had Cæsarean section have nothing to prevent them, in the event of a future pregnancy, from delivering themselves by the natural passages—a very different thing from the days when pelvic contraction was almost the only indication, when a repeated operation was the only way of future delivery, and when scars were seldom strained by labour.

If, on inquiry, the risk of scar rupture was revealed to be a negligible one, then we could, with clear consciences, go on advising and performing the operation according to its extended indications; but if the risk turned out to be an appreciable one, then we should be forced to seek safety either by limiting the indications or by contriving an operative technique which would give us a more dependable scar.

Impressed with the importance of these considerations, I determined to set about the subject and to arouse the interest and invite the co-operation of as many other obstetric surgeons as I could.

I have divided my paper into three sections:—

(I) An account of five new cases.
(II) An analysis of the literature, a general discussion on the ætiology and anatomy of ruptured scars, and an abstract of the cases hitherto reported.
(III) The results of a follow-up inquiry into the subsequent obstetric history of a large number of Cæsarean section patients, operated on between 1912 and 1918 inclusive.

(I) An Account of Five New Cases.

The details of the five new cases from the London Hospital are as follows:—

Case I.—Reg. No. 1914/41137. Cæsarean section on April 17, 1914, by Dr. Russell Andrews. Primigravida, aged 29; lumbar kyphosis, with extreme contraction of the pelvic outlet. Entered hospital early in labour at term; uterus opened by usual anterior median incision; sutured with two layers of chromic catgut, a deep buried one including the whole thickness of the muscle and missing the endometrium, and a continuous peritoneal suture. Placental site not noted. Living child, weight $6\frac{3}{4}$ lb. Recovery good; the temperature did not rise above 99.4° F. during the first four days, and afterwards was not above normal.

Readmitted on August 13, 1915, with rupture of the scar. No intervening pregnancy. Last menstrual period, November 11, 1914. Pain began on August 13, 1915, at 2.30 a.m., when she got out of bed to attend to her child, who was screaming; it was a continuous cramping pain which doubled her up and made her vomit and feel faint; it was stated that she

fainted several times. She was admitted at 8 a.m.; anæmic, pulse 120 and of poor volume, temperature 98° F. She was in continuous abdominal pain, the uterus was very tender and hard and the abdominal muscles rigid; the fœtal heart could not be heard; no external hæmorrhage. A diagnosis of concealed accidental hæmorrhage was made. There were no labour pains. Laparotomy by the late Dr. Drummond Maxwell. An ovoid rupture, 1½ in. long, was seen in the upper part of the uterine scar, the rest of which was faintly visible as a linear peritoneal thickening. Placental tissue protruded through the rupture, and blood was oozing from it. There were about 2 pints of blood in the peritoneal cavity. The uterus, with the ovum *in situ,* was removed by subtotal hysterectomy, and the patient made a good recovery.

The specimen is, unfortunately, not available for descriptive purposes.

Case II.—Reg. No. 1914/42248. July 26, 1914. Primigravida, aged 19; admitted with eclampsia, in the thirty-eighth week of pregnancy. Before admission had already had five convulsions; between 5 a.m. and 11.30 a.m. had convulsions every half hour; treated with morphia, venesection and intravenous saline infusion. After temporary improvement, the convulsions increased in severity and frequency. At 2.30 p.m. Cæsarean section was performed by Mr. Gordon Luker. Labour had already started. The uterus was opened by the usual anterior median incision. Recently dead fœtus, of 7½ lb. weight, delivered. Incision sutured with two layers of chromic catgut, deep and superficial. Convalescence was febrile; the temperature rose daily to 102° F. for the first four days, for the next five it did not exceed 100° F., on the tenth and eleventh it rose to 103° F.; on the twelfth it fell to 99° F., and remained between 99° F. and normal until the patient was discharged, well, on August 16, 1914. The abdominal wound healed by primary union.

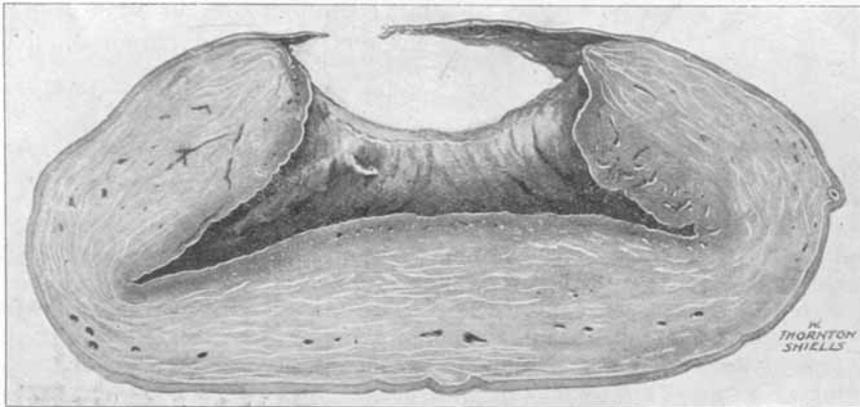FIG. 1 (Case II).

Drawing of section through upper third of uterus. Note: (1) Broad rounded edges of ununited muscle; (2) the decidua covers these edges and reaches almost to the peritoneum; (3) the narrow band of tissue between peritoneum and decidua on the right side, through which rupture has occurred; (4) the overhanging flap of wide thin scar area, consisting of little else than peritoneum.

Readmitted on November 19, 1915, in a state of collapse in the eighth month of her second pregnancy. Laparotomy by Dr. Drummond Maxwell : the dead fœtus and much blood lay in the peritoneal cavity. There was a rupture through the scar of the former Cæsarean section; the placenta lay almost completely outside the uterus, but still attached to one side of the rent. The uterus was removed by subtotal hysterectomy, but the patient died shortly afterwards.
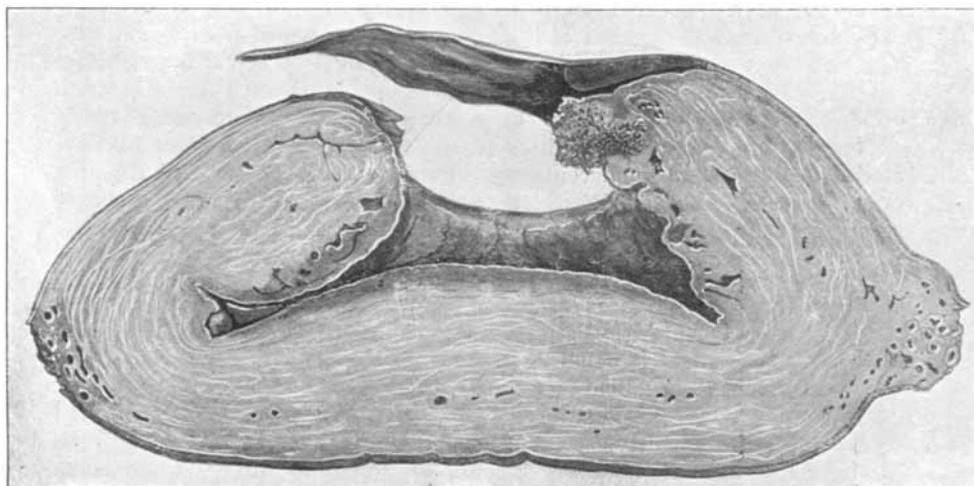

Fig. 2 (Case II).

Drawing through middle of uterus. Note, in addition to points in fig. 1 : (1) Insertion of a piece of placenta into left edge of ununited-muscle edge; (2) subperitoneal hæmatoma ; (3) the broad thin scar has torn through at one edge and not along its middle.

Description of the Uterus.— A uterus removed by amputation through the cervix, with a long, widely-gaping rupture through its anterior wall. Outside measurements of uterus : Length, 14.5 cm. ; greatest width, 14 cm. Uterine cavity : length, 13 cm. Measurements of rupture : Length, 10.5 cm. ; width at upper end, 7 cm. ; at lower end, 5 cm. Thickness of uterine wall at edges of rupture, 2 cm. near the upper end, decreasing to 1.5 cm. near lower end. Continuous with the lower angle of the rupture is a linear thinned area in the uterine wall, 2.5 cm. long. This is the unruptured part of the scar and is only 0.5 cm. thick. The edges of the uterine wall at the site of rupture are for the most part rounded and smooth. At first sight the impression obtained is that the whole thickness of the uterine wall had been torn through, but closer inspection shows that the decidual lining of the uterine cavity is continued up over these rounded edges, and reaches in most places very close to the torn peritoneum (see fig. 1) ; at the upper and lower ends of the ruptured area, decidua and peritoneum almost meet. The irregularly torn peritoneal layer overhangs very liberally the thick, decidua-covered edges (fig. 2) ; in places the peritoneum is thickened by an underlying thin fibrous tissue layer. In the middle two-thirds, on both sides, is a well-defined subperitoneal hæmatoma, extending laterally and

stripping the peritoneum for some distance from the underlying uterine wall. Firmly adherent to the middle third of the whole thickness of the left edge of the ruptured area is a piece of placenta, covered by loosened peritoneum and a subperitoneal hæmatoma (see fig. 2). On the opposite edge the decidual layer is absent, and is replaced by a roughened area covered with broken laminæ of clot; this evidently represents part of the placental site. There are the remains of many thick omental adhesions to the peritoneum over the ruptured area. These findings are to be interpreted as follows: (1) The real scar, through which the rupture occurred, is extremely thin, and consists of little more than stretched peritoneum with here and there a thin layer of fibrous tissue. In its original state, before rupture, no doubt this thin peritoneal scar was covered beneath with decidua. (2) The thick edges of the ruptured area are the ununited muscle wall of the uterus, covered with decidua, except where they enter into the placental site. (3) The placenta was inserted over the scar and into the thick ununited muscle edges. (4) Retroplacental hæmorrhage probably occurred beneath the stretched scar before rupture occurred; in fact, retroplacental hæmorrhage may have been the determining cause of rupture.

Case III.—Reg. No. 1914/40909. Cæsarean section on March 26, 1914, by Dr. Russell Andrews. Patient, aged 28, with flat rickety pelvis, and other skeletal changes, including bowing of the femora, tibiæ and ulnæ. Two former full term labours: (1) 1911, instrumental dead birth; (2) 1912, instrumental live birth. Last menstrual period, August 14, 1913. Admitted to the hospital in thirty-second week of pregnancy, on March 26, 1914, having been eighteen hours in labour; os uteri two-fifths dilated, membranes intact, transverse presentation. After external cephalic version the head was found too large to enter the pelvic brim. Cæsarean section performed; uterus opened by usual anterior median incision; sutured with two layers of chromic catgut, a deep buried one including the whole thickness of the muscle and missing the endometrium, and a continuous Lembert peritoneal suture. Placental site not noted. Child alive, weight 5¼ lb. The convalescence was febrile, the temperature rising daily for thirteen days after operation to 100° or 101° F.

Readmitted, early in her fourth labour, on March 16, 1916, calculated to be thirty-two weeks pregnant. Labour pains began at 2.30 p.m., and were of moderate strength. At 6 p.m. spontaneous rupture of the uterus occurred, accompanied by the usual signs of collapse, pronounced anæmia, cessation of labour pains, and distinctive feeling of the fœtus beneath the abdominal wall. Immediate laparotomy; the dead fœtus, placenta and much blood were in the peritoneal cavity. The scar was ruptured in its entire length; uterus removed by subtotal hysterectomy. Next day the patient got left hemiplegia, but ultimately made a good recovery from the operation.

The specimen is not available for examination, and it is not known whether the placenta was implanted over the scar or not.

Case IV.—Reg. No. 1910/42939. A case of pronounced rickety flat pelvis, with stunted stature and other skeletal changes, including bowing of the femora and tibiæ. Preceding obstetrical history: (1) Instrumental labour at term, dead birth; (2) instrumental labour at term, child lived a few hours; (3) instrumental labour at term, dead birth. In her fourth labour

at term the patient was admitted under the care of the late Dr. Drummond Maxwell on October 11, 1914, and was delivered by Cæsarean section. The usual anterior median incision was made in the uterus, and it was sutured with two layers, deep and superficial, of chromic catgut. Child alive, weight 6½ lb. Convalescence febrile; the temperature rose to 102.8° F. on the second day, and varied between 100° and 103° F. until the seventh day, after which it gradually fell. Placental site not recorded.

Readmitted in her fifth labour, at term, in 1916. Head was engaged in pelvic brim; forceps applied, and a healthy child of 7 lb. delivered. Puerperium febrile; temperature gradually rose to 103° F. on the fourth day, fell by lysis, and reached normal on the ninth day.

Readmitted in her sixth pregnancy, with rupture of the uterus, on August 8, 1919. She had last menstruated on December 1, 1918, and was in regular attendance at the ante-natal department. At 12 o'clock, midday, whilst sitting in a chair, she suddenly got intense abdominal pain, which made her feel very faint. The pain persisted, and as she appeared obviously very ill, her friends summoned assistance at 3 p.m. When the midwifery assistant arrived he found her sitting propped up in a chair and in the last stages of collapse. She was immediately transported to the hospital in an ambulance. On arrival, she was profoundly anæmic, and collapsed; abdomen distended and extremely tender all over; fœtus felt with remarkable distinctness, and what was surmised to be the empty uterus was felt reaching up to the umbilicus. Immediate operation by Mr. Eardley Holland, under stovaine spinal anæsthesia. The dead fœtus, together with a large quantity of blood and many recent clots, was found free in the peritoneal cavity. The placenta was almost completely separated and lying just outside a large gaping rent in the anterior wall of the uterus, a very small part of it being still attached near the left edge of the rupture. After removing the fœtus and placenta, attention was turned to the uterus, which was rigidly contracted and anæmic, and a long, widely-gaping rupture occupied almost the whole length of the anterior wall. The rupture looked like a clean tear, except at its upper and lower ends, where it had extended laterally to a slight extent. Its edges were thick and smooth, giving the false impression that the rupture had occurred through the entire thickness of the uterine wall. Projecting from the thick edge of one side was a ragged leaf of thickened peritoneum, about 1 cm. wide. This was in reality the stretched scar, and it had ruptured, not along its middle, but along its junction with the opposite thick edge. There had been a complete failure of muscular union, and the ununited muscle formed the two thick edges. The rupture was rapidly closed with a single layer of interrupted sutures of No. 3 silk, placed about ½ cm. apart, and including the whole thickness of the uterine wall except the endometrium. The patient made an excellent recovery; for the first week the evening temperature rose to 100° F., but there was no other trouble. She was last seen in excellent health on February 1, 1920; the management of a future pregnancy will be a problem (but refer to case abstract No. 87).

Case V.—Reg. No. 1917/40655. Cæsarean section on February 26, 1917, by Mr. Eardley Holland. Primigravida, aged 20; admitted with eclampsia, in the thirty-sixth week of pregnancy. Had three convulsions before admission, was comatose, and the urine, on boiling, was solid with albumin; cervix intact, no labour pains, fœtal heart heard. Cæsarean section under

stovaine spinal anæsthesia; uterus opened by anterior median incision, foetus dead, placenta posterior. Incision closed with No. 3 interrupted silk sutures, placed about ½ cm. apart, and including the whole thickness of the uterine wall except the endometrium; this layer was covered with a continuous peritoneal suture. Convalescence febrile; temperature ranged between 100° and 102.6° F. for first seven days, and lochia was offensive. The abdominal wound healed by primary union.
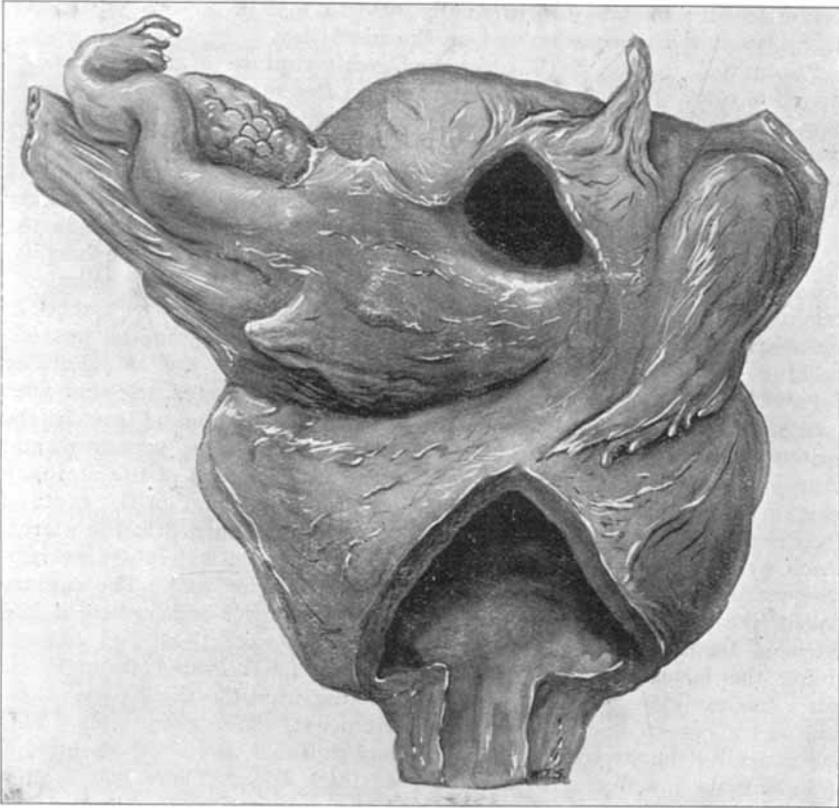
FIG. 3 (Case V).

Puerperal uterus, tubes, ovaries and bladder; bladder and urethra have been laid open. On anterior surface of uterus is a rupture through the lower two-thirds of a Cæsarean section scar. Left half of utero-vesical pouch obliterated by adhesions; right half of the pouch was the site of an abscess cavity, with fæcal contents, communicating both with the uterine cavity through the rupture, and with a perforation in an adherent coil of small intestine.

During her second pregnancy she was a regular attendant at the ante-natal department. Last period, May 28, 1919; urine never contained albumin, and health excellent. She was admitted again on January 17, 1920, with severe puerperal sepsis, following premature confinement. Only an imperfect history of her confinement and illness could be obtained.

Labour was completed in a few hours, on January 11, 1920; the placenta was retained, and was removed manually, with some difficulty, two hours after the birth of the child, which lived only a few hours. The following day she got abdominal pain and dyspnœa, and was sent into hospital. On admission into the septicæmia ward on January 17, 1920, she was extremely ill : temperature 104° F., pulse 120, abdomen rigid and tender, constant diarrhœa. She was considered to have puerperal septicæmia, but blood cultures taken on different occasions were sterile. The perineum was completely ruptured into the rectum. For a fortnight she held her ground, and even improved slightly in her general condition. Abdominal section was considered and rejected. In the light of what was found post-mortem, I am bound to admit that if the true condition of affairs had been suspected and her abdomen opened, her life might have been saved. The discharge from her uterus became more and more offensive, and was undoubtedly fæcal in character. She died on February 16, 1920.

A post-mortem examination was made, and I am indebted to Professor Turnbull for the following notes : General purulent peritonitis, with localized abscesses. Fibrous peritoneal adhesions at fundus of uterus, between bladder, uterus, and small and large intestines. Pus tracking up right and left sides of abdominal cavity. Localized subdiaphragmatic abscess in antero-superior surface of the right lobe of the liver, close to the falciform ligament. Perforation, 1 cm. in diameter, in wall of small intestine, 240 cm. below the duodeno-jejunal flexure. Dense fibrous peritoneal adhesions with pus-pockets between the lower coils of small intestine and uterus. Diphtheroid inflammation with slight scarring of vagina. Dilated cervix uteri admitting two fingers. Rounded perforation, 3 cm. by 2 cm., on anterior wall of fundus of uterus. Dirty green diphtheroid inflammation of endometrium. Dilatation with purulent content in left Fallopian tube. Small amount of pus in right Fallopian tube. No thrombi in uterine or ovarian veins. Small empyema between right middle and lower lobes and the diaphragm, the result of spread of infection from subdiaphragmatic abscess. The pelvic viscera were removed *en masse,* and show the following details (see fig. 3) : Uterine cavity, 7 cm. long, 4 cm. laterally, and 4 cm. antero-posteriorly. The rupture measures 3 cm. by 2 cm., with rounded smooth edges; the right edge is 1.5 cm. thick and the left 0.5 cm. The edge at the upper angle of the rupture is thin (0.5 cm.), where it is continued into the unruptured part of the scar. The unruptured part, which can be seen and felt as a thin furrow on the inner surface of the anterior wall, measures 1.8 cm. long; it is not visible on the outer surface, as it is covered by adhesions. The scar had, therefore, ruptured in its lower two-thirds. There are the remains of many old firm adhesions over the anterior surface and fundus of the uterus, one particularly broad and firm, one covering the unruptured part of the scar. The left half of the utero-vesical pouch of peritoneum is obliterated by dense adhesions between the bladder and the uterus; to the right of the midline it was occupied by an abscess cavity, with fæcal contents. This abscess communicated with the already-mentioned tear or perforation in the small intestine and with the uterine cavity, through the rupture. Thus, there had been a utero-intestinal fistula.

Whether the intestine was injured at the time the rupture occurred, or whether the perforation arose subsequently cannot be said for certain. I favour the former view.

A point of special interest in this case is whether the scar ruptured spontaneously during labour, or whether it was ruptured during the difficult manual removal of the placenta. In the light of other reported cases I am inclined to think it ruptured during labour, and that the rentention of the placenta, as well as the difficulty of its removal, was due to its partial escape into the peritoneal cavity.

(II) On the Ætiology and Pathology of Ruptured Scars, with Analysis of Reported Cases and Critical Review of the Literature.

I have found accounts of ninety-two cases, reported in sufficient detail to make them worth collective study, and have made a short abstract of the essential facts of each case.[1] These have been got direct from the original source, with the very few exceptions where the original accounts were not accessible and I had to rely on abstracts made by others. I have omitted a few cases to which I found references, but of which I could neither get at the original report nor find reliable abstracts. It is obvious, too, that many cases have never been published at all; speakers in discussions before Societies on the subject of ruptured scars often refer to such cases, personal or otherwise. Up to a point, references to cases were not hard to find, and I am indebted to other writers who have published collections of cases, especially to L. Singer (1909), Albert Wyss (1912), Palmer Findley (1916), and E. Schroeder (1916).

The classical operation dates from 1882, when Sänger and others published their improved suture methods. I need hardly state that I have not included cases of ruptured scar following the operation of pre-suture days: one half of the minority who survived this operation got a ruptured scar in the unfortunate event of a future pregnancy. The case in my list, Koblank's, occurred in 1891, and more than two-thirds have been reported since 1910, coinciding with the period when the indications for Cæsarean section began to be extended.

In each case abstract the following essential points are noted: Age, parity. At Cæsarean section: Indication, uterine incision, placental site, suture material, recovery afebrile or otherwise. Number of Cæsarean sertions, labours intervening between Cæsarean section and rupture. At rupture: Interval since Cæsarean section, period of pregnancy, in labour or not, placental site, peculiarities in symptoms or their onset, accidental factors, extent of rupture, treatment, result to mother and child. Unfortunately, all cases are not reported in full detail; but, amongst the sum of the cases the data are in sufficient number to indicate the

1. These abstracts are printed in full in the *Proc. Roy. Soc. Med.*, 1920, vol. xiv (Obstet. and Gyn. Sect.), pp.

chief factors favouring rupture of the scar. The case abstracts will be found at the end of the paper, numbered and with their references.[1] I have isolated the essential points of these ninety-two reported cases, and of my own five, in the following summary, so that the extent to which each one occurs can be conveniently noted, and its individual importance estimated.

Parity.

Rupture occurred in the second pregnancy	...	...	...	in 54 cases
„	„	third	„	...	...	...	„	19	„
„	„	fourth	„	...	...	...	„	10	„
„	„	fifth	„	...	...	...	„	6	„
„	„	sixth	„	...	...	...	„	3	„
„	„	eighth	„	...	...	...	„	1	„
Number of preceding pregnancies not mentioned ...			...	„	4	„

Indications for Cæsarean Section.

Contracted pelvis	...	...	...	...	...	...	in 64 cases
Eclampsia	...	...	...	...	...	...	„	12	„
" Nephritis "	...	...	...	...	...	...	„	1	„
Albuminuria of pregnancy	...	...	...	...	„	1	„
Dermoid cyst of ovary ...	...	...	...	...	„	2	„
Fibromyoma of uterus ...	...	...	...	...	„	1	„
Hæmatoma of vagina and vulva	...	...	...	„	1	„
Sacral tumour	...	...	...	...	...	„	1	„
Stricture of cervix	...	...	...	...	...	„	1	„
Vaginal varices ...	...	...	...	...	...	„	1	„
Shoulder presentation	...	...	...	...	„	1	„
Concealed accidental hæmorrhage	...	...	...	„	1	„
Indication not mentioned	...	...	...	...	„	10	„

The Cæsarean Section Incision.

Anterior median ...	...	...	...	...	...	...	in 54 cases
Posterior median ...	...	...	...	...	...	„	1	„
Transverse fundal	...	...	...	...	...	„	28	„
Anterior median and transverse fundal	...	...	...	„	1	„
Cervical	...	...	...	...	...	...	„	1	„
Site of incision not mentioned ...	...	...	...	„	12	„

Relation of Incision to Placental site at Cæsarean Section.

Incision through placental site	...	...	...	...	in 10 cases
Incision not through placental site ...	...	...	...	„	6	„
Placental site not mentioned ...	...	...	...	„	81	„

Suture Material.

Catgut	...	...	...	...	...	...	...	in 41 cases
Silk, often with continuous catgut for the peritoneum	...	„	12	„
Reindeer tendon ...	...	...	...	...	...	„	1	„
Suture material not mentioned	...	...	...	...	„	43	„

1. Refer to *Proc. Roy. Soc. Med.*, 1920, vol. xiv. (Obstet. and Gyn. Sect.).

K

Fever or Sepsis during recovery from Cæsarean Section.

Recovery febrile, or abdominal or uterine infection   ... in 51 cases
Recovery stated to be afebrile ...   .   „ 15   „
No details mentioned   ...   .   „ 31   „
Cases with afebrile recovery are   ...   Nos. 11, 12, 16, 17, 20, 22, 27, 41,
42, 43, 58, 81, 82, 84 and 93

Interval between Cæsarean Section and Rupture.

Less than one year   ...   .   in 2 cases
One year   ...   .   „ 12   „
Two years ...   .   „ 25   „
Three years   ...   .   „ 21   „
Four years   ...   .   „ 13   „
Five years ...   .   „   3   „
Six years ...   .   „   3   „
More than six years (including one of eleven and one of
twelve)   ...   .   „   4   „
Interval not stated   ...   .   „ 14   „

Number of Cæsarean Sections preceding Rupture.

One   ...   .   in 88 cases
Two   ...   .   „   6   „
Three   ...   .   „   2   „
Number not mentioned ...   .   „   1   „

Number of Labours intervening between Cæsarean Section and Rupture.

None   ...   .   in 85 cases
One   ...   .   „   8   „
Not stated ...   .   „   4   „
The numbers of the cases in which an intervening labour is reported
are as follows :   ...   .   Nos. 17, 19, 30, 40, 43, 59, 64, 96

Period of Pregnancy at which Rupture Occurred.

Term   ...   .   in 47 cases
Near term ..   .   .   „   6   „
8½ months   .   ...   „   1   „
8   „   ..   ..   „ 10   „
7½   „   ...   .   „   1   „
7   „   (Nos. 2, 22, 53, 65, 70, 88, 90)   ...   ...   „   8   „
4, and again at 7 months (No. 34)   ...   .   „   1   „
38 weeks   ...   .   „   3   „
37   „   ...   .   „   2   „
36   „   ...   .   „   4   „
32   „   (Nos. 77, 95) ...   .   „   2   „
" Early pregnancy " (No. 15) ...   .   „   1   „
Eleven months, post mature (No. 48)   ...   .   „   1   „
Period not stated ...   .   „ 10   „

*Whether Rupture occurred during Labour or during Pregnancy before
the onset of Labour.*

In labour ...   .   in 19 cases
In labour, early in first stage ...   .   „ 29   „
During pregnancy, before the onset of labour   ...   ..   „ 36   „
No details given ...   .   „ 13   „

Relation of Placenta to Scar at time of Rupture.

Placenta implanted over scar	in 34 cases
Placenta not implanted over scar	„ 17 „
Placental site not mentioned	„ 46 „

Accidental Factors likely to have been Exciting Cause of Rupture.

None mentioned	in 80 cases
Nos. 20 and 35, Hydramnios	„ 2 „
„ 3, Twins and hydramnios	„ 1 „
„ 26 and 43, Version	„ 2 „
„ 59 and 61, Induction and version	„ 2 „
„ 88, Accidental hæmorrhage	„ 1 „
„ 14, Accident	„ 1 „
„ 30, Difficult breech labour	„ 1 „
„ 48, Post mature fœtus	„ 1 „
„ 55, Fœtus excessively large	„ 1 „
„ 65, Placenta prævia, hydrostatic bag ... ... „	„ 1 „
„ 74, Pituitrin	„ 1 „
„ 84, Pituitrin and obstructed breech labour	„ 1 „
„ 97, Manual removal of placenta	„ 1 „
„ 19, Long labour, with contracted pelvis	„ 1 „

Extent of Rupture.

Rupture of entire or almost entire length of scar	in 67 cases
Rupture of small portion only of scar	„ 22 „
Extent not mentioned	„ 8 „

(Small perforation only in Nos. 19, 21, 24, 28, 33, 38, 41, 47, 49, 50, 56, 66, 70, 71, 78, 81, 82, 83, 84, 90, 93, 97)

Treatment of Rupture.

Hysterectomy, subtotal	in 56 cases
Vaginal hysterectomy	„ 2 „
Suture, sometimes with excision of edges	„ 26 „
Drainage	„ 2 „
Treatment not stated	„ 1 „
Death before operative treatment	„ 10 „

Result to Mother.

Lived	in 66 cases
Died	„ 28 „
Not mentioned	„ 3 „

Result to Child.

Dead	in 69 cases
Lived	„ 21 „
Not mentioned	„ 7 „

On the Anatomy of the Uterine Scar.

(A) *Perfectly Healed Scars.*—Perfect healing of the uterine incision may result in complete muscular regeneration, leaving no trace of scar tissue except on the peritoneal surface. Whitridge Williams has studied the cicatrix in ten uteri, removed by Cæsarean

hysterectomy, which had been subjected to Cæsarean section upon one or more previous occasions. In eight of his specimens (one of which had been subjected to two, and another to three previous Cæsarean sections) it was difficult to find the old cicatrix by examination with the naked eye; the only indication of its existence was the presence of slight vertical depressions upon the external and internal surfaces of the uterus. Microscopical examination revealed the entire absence of scar tissue in the uterine wall, and showed the muscle fibres extending across the site of the old incision as if it had never existed. It is interesting to note that the convalescence from the previous operations had been uncomplicated. In another specimen, deep furrows existed on the external and internal surfaces of the uterus, the two being separated by a band of tissue 3 mm. thick, in contrast to the adjacent uterine walls which measured 2.5 cm. in thickness. The external furrow was covered with peritoneum, and the internal was lined with typical decidua; the intervening tissue was normal muscle, showing no trace of scar tissue, and differing from the normal only by its thinness. The history of this patient was that the convalescence had been stormy. Jolly, in his case (abstract No. 50), describes perfect muscular regeneration in the unruptured part of the scar.

(B) *Thin Scars.*—Light is thrown on the causes and anatomy of ruptured scars by studying scars that are thin, for it is only thin scars that are likely to rupture. A thin scar becomes progressively stretched and thinned during pregnancy, owing to the increasing distension of the uterus. Thinning of the scar, as found at a repeated Cæsarean section, or in a uterus removed for some reason from a patient who has formerly had a Cæsarean section, is not at all uncommon, every obstetric surgeon of experience has encountered it. Harrar, at the New York Lying-in Hospital, found that in fifty instances of the repeated operation, in forty-two the old scar was either not found at all, or, if found, was solid; in four there was marked attenuation, in two there was partial rupture at the location of the old scar, and in two there was complete rupture. Van Leuwen collected all cases of repeated operation reported in literature down to 1903, and found thin scars reported in twenty out of 117 cases. These figures probably represent cases of extreme thinning only; a moderate degree of thinning, or extreme thinning of a small portion of the scar is, in my experience, much commoner than this, if looked for by palpating the whole length of the scar, after the uterus has been emptied, between a finger within and a finger without the uterus. By various writers these wide thin scar areas, as found at repeated operations, have been described as "thin as paper, only 1 to 2 mm. thick," and have sometimes been mistaken for the bulging amnion herniated through

the scar. Sometimes a subperitoneal hæmatoma has been observed, an indication of imminent rupture. There are, of course, varying degrees of thinning of the scar. Sometimes it is extreme, sometimes moderate : sometimes the entire length of the scar is affected, sometimes only a part. The only case I have found recorded in which the thin scar consisted of normal muscle is that of Whitridge Williams, to which I have already referred. In all others it was composed of scar tissue, often with a varying proportion of muscle fibres scattered through it. In my own second case the unruptured part of the scar consists almost entirely of scar tissue, but muscle fibres, singly or in groups, are scattered through it, and have even grown right across its whole width. In cases of extreme thinning the attenuated scar area consists merely of peritoneum in contact with decidua, with a few intervening strands of fibrous tissue. These attenuated peritoneo-decidual scars are just the scars liable to rupture during pregnancy or labour from a rise of intra-uterine pressure. The point of greatest importance about these scars is that the uterine muscle has completely failed to unite : the sutures employed to close the incision either slough out or cut out, and the muscle surfaces retract, and become widely separated. The peritoneum, on the contrary, holds firm. The retracted muscle surfaces later become smooth and rounded, and in course of time covered by a layer of endometrium, which, in a subsequent pregnancy, is converted into decidua. The endometrium grows also across the line of the scar beneath the peritoneum, and covers the inner surface of the gap. Further thinning of this peritoneo-decidual scar is the natural sequence of the distension of the uterus during pregnancy. The analogy between such a scar and a defective abdominal scar is irresistible; the one consists of peritoneum and decidua, and the other of peritoneum and skin; in both the muscle is wanting. In some cases even peritoneal union has been demonstrated to have failed in parts of the scar, and the gaps have been plugged by adherent omentum or bowel. Excellent histological studies of thin scars have been published by Couvelaire, Offermann, Spalding and others.

(C) *Ruptured Scars.*—Good anatomical and histological descriptions of the ruptured scar are given in the case abstracts, Nos. 2, 11, 16, 17, 20, 27, 31, 32, 33, 35, 43, 46, 50, 55, 56, 60, 72, 73, 80, 82 and 84. There is no doubt that when the scar has ruptured it has nearly always been one of the thin scars I have described in the foregoing section. The peritoneo-decidual scar has gradually been converted into a widely stretched area, during the progressive uterine distension. When this thin area ruptures it has usually been noticed that the line of rupture does not occur along its middle, but at the sides, near the thick part of the uterine wall. A

thick, or even a moderately thick scar, whether composed of fibrous or muscular tissue or both, does not rupture except under extreme provocation, such as obstructed labour. The appearance of a ruptured scar, after the uterine contents have escaped, and retraction has occurred, is deceptive, and has, in the earlier observed cases, led to wrong descriptions and tortuous explanations. The deceptive feature is the thickness of the edges of the ruptured area. These edges, as already pointed out, consist of the ununited muscle surface covered with decidua. After the uterus is emptied and retracted these muscle edges become extremely thick—equal in thickness indeed to the rest of the uterine wall. Furthermore, these thick edges, since chorion or placenta has been separated from off them, are either found oozing blood or covered with pieces of blood clot. In fact, their appearance is almost exactly as if the whole thickness of the uterine wall had been newly torn through, whereas in reality it is only the stretched deciduo-peritoneal area that has given way. The true state of affairs is illustrated in figs. 1 and 2, where the decidua can be followed from the uterine cavity over the ununited muscle edges almost up to the ruptured peritoneal coat. In my own fourth case, where I sutured the rupture, I believed I was suturing thick recently ruptured surfaces; it is only in the light of the experience from my second case, and of cases reported in the literature, that I now realize I sutured together the old ununited muscle surfaces.

It is interesting to note that for many years the true significance of the decidual covering to the muscle surfaces was missed; it was supposed that during pregnancy decidual cells grew up through the scar to the peritoneum, weakening the scar and making it liable to rupture (refer to case abstract No. 16).

Liability of Uterine Incision to yield shortly after Operation.

It is not often that Cæsarean section cases come to post-mortem, and it is even rarer for a case to be reopened for hæmorrhage or sepsis. In such cases it is surprising how often there has been observed a yielding of the incision from the loosening or cutting through of the sutures. Wyss has made a small collection of these. Scheffzek reports having seen two post-mortems after Cæsarean section, in which the catgut sutures had become completely unknotted. Boissard reports the case of a patient who died from sepsis on the fifth day; four of the interrupted catgut sutures had become untied and the incision gaped widely, there was intraperitoneal hæmorrhage and the uterine cavity was filled with blood clot. Cristalli reports a case in which, because of severe and persistent hæmorrhage following Cæsarean section, subtotal hysterectomy was performed; a gap was found in the line of uterine

incision, which had been sutured with silk. Le Page reports a somewhat similar case, in which the uterus had been sutured with catgut. One is led to believe that this accident may sometimes happen in cases that recover; they would not necessarily pass through a stormy convalescence, for such an accident, without sepsis or with only local sepsis, should not produce much disturbance. The partially or completely gaping scar would quickly be sealed or plugged by omentum. It is quite probable that the firm adhesion of omentum to the old scar, so commonly found in cases of repeated Cæsarean section or subsequent rupture, may represent the same protective plug.

Utero-abdominal Fistula.

This is not a great rarity, following infection of the uterine and abdominal wounds; it may persist for many months. The uterine scar, in such cases, is bound to be extremely defective and liable to rupture in the event of subsequent pregnancy. Amongst the case abstracts, utero-abdominal fistula will be found noted in Nos. 14, 32, 34, 45 and 51. Case No. 34 is peculiar: at the fourth month threatened abortion resulted in partial rupture of the scar and the formation of a utero-abdominal fistula through which a piece of intestine could be seen adherent to the scar; at the seventh month a more extensive rupture occurred, resulting in death of the patient in spite of operation.

If, accompanying the fistula, the uterine scar is completely adherent to the abdominal wall, subsequent rupture may be entirely extra-peritoneal. An interesting example of this is recorded by Noble (not placed amongst the list of ruptured scars). A utero-abdominal fistula persisted after the first Cæsarean section; another pregnancy soon followed and the liquor amnii escaped through the fistula in the thirty-third week. The second Cæsarean section was performed by enlarging the fistulous opening; the uterine scar was found completely adherent to the abdominal wall, and the operation was entirely an extraperitoneal one.

On the Site of the Uterine Incision and Subsequent Rupture.

On referring to the summary of reported cases it will be noted that, in the eighty-five cases where the site of incision was stated, the classical incision was employed fifty-five times, the tranverse fundal incision twenty-eight times, and the cervical incision only once. There is no doubt that the transverse fundal incision, introduced by Fritsch in 1897, is specially liable to rupture. Ekstein (abstract No. 50), reported the first case of ruptured fundal scar in 1904. The number of ruptures after the transverse fundal incision compared with the number after the classical operation is

relatively very high, considering how late it was introduced, and how relatively few must be the number of Cæsarean sections in which this incision was employed. Two points theoretically favour rupture of tranverse fundal scars; one is that most of the muscle bundles are cut at right angles, and the incision therefore tends to gape widely, favouring imperfect union; the other is that the fundus is the part of the uterus which is relatively most distended during pregnancy, and, in consequence, a fundal scar will be relatively more stretched than the scar of the classical operation. There have been comparatively few reports of the successful termination of pregnancy and labour after the transverse fundal incision. This incision is, in fact, to be avoided because of its liability to rupture.

The incision that at present holds the best record for immunity from rupture is the cervical (by this I mean the transperitoneal or extraperitoneal cervical operations, of which, as is well known, there are many varieties). All the same, before this incision is lauded because of its apparent immunity from rupture, it must be remembered that very few cervical Cæsarean sections have, up to now, been performed, compared to the thousands of classical and transverse fundal Cæsarean sections; it still has to stand the test of time.

The cervical incision was first employed by Frank in 1906. It was at once pointed out by the theorists that the cervical scar would be specially prone to rupture; it lay in that part of the uterus most subjected to stretching during labour, and, being placed nearer the contaminated area (*i.e.*, the vulvo-vaginal tract) would therefore be more liable to infection. These fears of rupture have not been fulfilled; only one case has been reported (abstract No. 72) and only a small number of thin cervical scars have been observed, in spite of the fact that many cases of subsequent pregnancy have occurred. There seem to be excellent reasons for the sound healing of cervical scars, and for their resistance to rupture. Rest is an essential to good union of divided muscles; a state of rest or immobility is impossible in the body of the puerperal uterus, where contractions and relaxations are constantly tending to disturb the apposed surfaces and draw the healing muscle fibres apart; all operators are aware of the great lateral tension on the sutures, and of the tendency of the incision to gape during a strong contraction. On the other hand, the cervical incision is situated in a quiet part of the uterus which does not undergo contractions and relaxations. In Frank's original operation he incised the cervix transversely; this has now been generally replaced by a longitudinal incision. Mechanically, the stretching and rupture of the transverse scar would seem more likely, because its line lies at right angles to the direction of the chief pull of the uterine muscle fibres; whereas the

longitudinal scar lies in the line of the pull, and its edges have scarcely any tendency to be drawn apart.

As regards the reported case of rupture of a cervical scar (abstract No. 72), it is only fair to state that at the Cæsarean section the cervical incision had to be prolonged for a short distance upwards into the body of the uterus in order to give more room for the fœtus, and it is quite possible that the rupture started in this part of the scar.

Some reports on thinning of the cervical scar are the following : Traugott reports a case where the first Cæsarean section was a Frank's cervical one, done for contracted pelvis. The next pregnancy was a placenta prævia, in the eighth month, with natural delivery ; the third time, at term, another cervical Cæsarean section was done. The cervical wall, in the region of the old incision, was thinned out to a membrane 1 mm. thick, and was on the point of rupturing. The first Cæsarean section was an infected one, and the recovery was septic. Sellheim (see under Traugott), out of five cases with later pregnancy, saw the same thinning in one of them. Bumm (see under Traugott, and Jolly) had done second operations in three cases; in two the scar was sound, in the third the scar was so stretched and thin that he thought at first it was distended bladder; in reality it was the scar bulged by the liquor amnii.

Reports of cases of cervical Cæsarean section with subsequent pregnancy, terminating either by repeated operation or natural delivery, are given by Hartmann, Lichtenstein, Litschkuss, Rohrbach and Scheffzek, amongst others. Hartmann reports twelve cases, three of which were delivered by the natural passages, and nine by repeated operation; in none was there rupture or thinning of the scar. Lichtenstein reports two cases of subsequent delivery after the extraperitoneal operation, one by repeated operation, and the other by the natural delivery of twins; no complications were noted. Rohrbach followed up thirty-eight cases of cervical Cæsarean section, and found three subsequent deliveries : one normal full time labour and two repeated operations. Scheffzek reports ten cases of pregnancy subsequent to extraperitoneal Cæsarean section : five with repeated operation, and five with delivery by the natural passages.

The above are only a few of the published lists of pregnancies subsequent to cervical Cæsarean section, but the numbers are all so small that it is hardly justifiable to draw conclusions. I believe I am right in stating that up to the present time no further case of rupture of the cervical scar has been reported. The operation is certainly gaining favour, especially in America; British and French obstetric surgeons are still shy of it. The low mortality reported by exponents of cervical Cæsarean section is

remarkable compared to that of the classical operation : For the transperitoneal operation up to 1914, Hofmeier reports forty-five cases, with one death ; Baisch reports nineteen cases, without a death ; Frank reports 130 cases with two deaths ; giving a total of 194 operations with three deaths.   Half of these were suspect or infected cases.   For the extraperitoneal operation, Küstner had 110 cases without a death, of which again half were suspect or infected.   The grand total comes to 304 cervical operations, with three deaths—a very remarkable figure, especially as a large number of the patients was infected.

Although the consideration of scars resulting from vaginal hysterotomy (so-called vaginal Cæsarean section) does not belong to the subject of rupture of the Cæsarean section scar proper, it is interesting to consider the possibility of their rupture in a subsequent pregnancy or labour, since in both vaginal hysterotomy and cervical Cæsarean section the incisions lie in much the same part of the uterus.   The behaviour of these scars in subsequent labour has been investigated by Olow ; he reports seventeen cases, mostly performed for eclampsia ; in none of them was thinning or rupture of the scar observed.   Engström reports a case of rupture of the lower uterine segment six years after vaginal hysterotomy for vesicular mole.   The case was one of obstructed labour from pelvic contraction, and the retraction ring reached almost to the umbilicus.   The site of rupture corresponded to the line of the scar ; but the case is hardly a fair one, as rupture would have probably occurred in any case, former operation or no.   An example of rupture of the scar of a deep cervical incision (made for placenta prævia) in a subsequent labour is reported by Labhardt.   I have not found any reference to vaginal hysterotomy scars beyond these few.

The Influence of Implantation of the Placenta over the Scar.

The relation of the placenta to the scar at the time of rupture was noted in fifty-one of the ninety-seven cases ; in thirty-four cases is was implanted over the scar, and in seventeen it was not. From this it may be assumed that the implantation of the placenta has at all events a share in predisposing the scar to rupture, but far too great importance has in the past been attached to this point. That the placenta cannot be the direct cause of rupture is obvious enough, for on the one hand, the placenta is very often not over the scar in cases of rupture, and on the other, in cases of repeated Cæsarean section it is often found over the scar without any harmful effect.   The idea that implantation of the placenta over the scar was the cause of rupture came very early into the field. It was known that rupture of the pregnant tube was caused by

the eroding action of the villi, and that in certain cases of placenta prævia the lower uterine segment was appreciably weakened and more liable to traumatic rupture. An analogy between these two and scar rupture was tempting; but there is no histological evidence to show that chorionic villi invade the scar tissue any more than they do normal uterine tissue. It has also been suggested that when at the original Cæsarean section the incision is over the placental site perfect healing is interfered with; there is no histological evidence for this. Amongst the ninety-seven cases of ruptured scar the relation of the incision to the placental site of the original Cæsarean section is only mentioned in sixteen cases, in ten of which the incision was over the placental site. Nothing can be inferred from these figures; it must be remembered that when the operator encounters the placenta in his incision he may state the fact in his records, but that he is much less likely to state the negative fact. A large number of uteri which bear Cæsarean section incisions, removed subsequently by hysterotomy, and where the full details of the Cæsarean section are known, has now been reported (refer to Whitridge Williams and Spalding amongst others). No fact has been forthcoming to show that the placenta has any influence on the healing of Cæsarean section incisions, or on the rupture of Cæsarean section scars by tissue invasion.

I believe the real reason why implantation of the placenta over a thin scar makes it liable to rupture is the occurrence of retro-placental hæmorrhage. The first step towards this is a gradual yielding and widening of the scar area; there follows a very gradual, and probably very slight, separation of the placenta over and adjacent to the scar area. The mechanism of this separation is comparable to the separation of a placenta prævia from the lower uterine segment when the cervix begins to dilate. Hæmorrhage between the scar area and the placenta will bring about a sudden rise of pressure sufficient to precipitate rupture. In my own Case II there was beneath the peritoneal scar area a well-defined subperitoneal hæmatoma, which had extended laterally, stripping the peritoneum off the uterine wall; I do not think this occurred entirely after the event. Attention is directed to case abstract No. 85, in which there was a well-defined blood clot on the maternal surface of the placenta, and there can hardly be any doubt that hæmorrhage between the scar area and the placenta was the direct cause of the rupture.

On the Effect of Sepsis on the Healing of the Uterine Wound.

Of all the causes of imperfectly healed scars, sepsis is by far the most important. Reference to the table shows that the presence

or absence of raised temperature or of sepsis during recovery from the Cæsarean section is mentioned in sixty-six cases; in as many as fifty-one cases either raised temperature, or definite uterine or abdominal sepsis is noted. In only fifteen of the sixty-six is an afebrile recovery noted. It is, of course, obvious that infection and suppuration of the uterine incision must, of necessity, be followed by imperfect healing. If the septic process be severe, the uterine tissues included between the sutures will undergo necrosis; the sutures will cut out, the muscular walls will retract, and the end result will be a scar which consists of little more than peritoneum with a protective layer of omental or other adhesions. Even if the sutures do not cut out, the wound will have to pass through a stage of granulation tissue, and will result in a broad fibrous scar. If silk be employed, the suppurative process will continue until the silk sutures have come away; cases have been recorded in which silk sutures were found in the uterine discharges. Of the two cases recorded by Wyss, in one silk stitch sinuses persisted for many months, and in the other, after a persistence of stitch sinuses, the linen thread sutures were removed from the interior of the uterus by curetting. If catgut be employed, its absorption will be hastened by sepsis. The point will be raised that in fifteen cases of rupture there was no evidence of sepsis in that the convalescence was afebrile. But infection of the uterine wound may occur without rise of temperature, or with only a very slight one; for example, few will deny that the presence of extensive adhesions to the scar at a subsequent operation is evidence of sepsis during the healing process, and there must be a good many operators who have found these adhesions when the temperature chart of the original Cæsarean section did not betray any indication of sepsis. For example, in 1913 I performed a second operation on a patient on whom the first Cæsarean section had been performed in 1902 by the late Mr. John Taylor, of Birmingham; I found extensive adhesions of the omentum to the abdominal wall and to the uterine incision, accompanied by such a number of enormously distended blood-vessels, that I had to eventrate the uterus and incise its posterior wall. After the uterus had been emptied, palpation of the old scar showed that it was extremely thin in places, and formed a series of deep pits on the inner surface of the uterus. I was fortunate enough to obtain complete notes and temperature charts of the first operation. The temperature had been charted every two hours during the first five days; on the second day the highest record was 99.6°F., on the third 99°F., on the fourth 98°F., and on the fifth 98.4°F. During the following days the only records above normal were 99.2°F. on the ninth day, 99.8°F. on the eleventh, and 99.6°F. on the fourteenth. The abdominal wound healed by

primary union, and the patient made an exceptionally smooth convalescence. Silk was employed to suture the uterus. Here there had clearly been infection of the uterine wound, and yet the temperature chart did not betray it. If the abstracts of cases with the afebrile recovery be referred to it will be noted that the ruptured scar was of the same thin peritoneo-decidual nature, in no way differing from other cases. The point is that although the temperature chart may be a smooth one, infection of the uterine wound may occur, sufficient to impair healing.

In connexion with infection of the uterine wound, I believe that the operation of Cæsarean section can never be guaranteed as a surgically clean one; for there is a large wound in a mucous cavity in direct communication with, and within a short distance of, a contaminated area (the vulvo-vaginal tract). I admit that pathogenic bacteria capable of infecting the tissues are seldom present in a normal vagina, unless vaginal examinations have been made. This is a point I will not enter into any further, as it would have to be very closely argued; but it is sufficiently well known that hæmolytic streptococci have frequently been found in the normal puerperium, not only in the vagina, but also in the apparently healthy uterus. I have been surprised by the large number of Cæsarean section cases in which the recovery was febrile; in the London Hospital and City of London Maternity Hospital series of eighty-four cases, recovery was afebrile in only thirty-eight, or 45 per cent. (trivial rise of temperature in first forty-eight hours of course not counted). I only make this as a general statement, and think it is a point which might advantageously be inquired into.

A study of the type of convalescence from the Cæsarean section is of the utmost importance in arriving at a decision as to the management of future pregnancies. If the convalescence has been febrile and there has been other evidence of sepsis, the scar is probably thin and there is risk of rupture. If, on the other hand, convalescence has been afebrile, the chance of rupture is a very small one, but it is quite plain that there is no absolute guarantee against rupture, since an appreciable number of cases of rupture have been reported even after an afebrile convalescence. On the other hand, it can be shown that patients whose convalescence has been accompanied by even considerable fever can successfully deliver themselves on a future occasion by the natural passages.

To sum up, it cannot be too strongly emphasized that infection of the uterine wound is, above all others, the essential cause of weak scars.

On Suture Material and Method of Suture.

In all the cases under review (except in case abstract No. 13) the entire thickness of the uterine wall was sutured either by

introducing buried layers, or by using deep sutures which passed through the whole thickness of the uterine wall except the endometrium. There is no need to dwell upon this point, as it may be taken for granted that all modern operators take good care to unite the whole thickness of the uterine wall.

Great controversy has raged over the question of the best suture material for closing the uterine incision. On looking at the table it will be noted that, out of the fifty-three cases in which the suture material used for the deep sutures is mentioned, catgut was employed in forty-one, and silk in twelve; in most of the cases in which silk was used there was also a superficial peritoneal suture, burying the knots of the deep layer. It would be false reasoning to conclude from these figures that rupture is more liable to occur after catgut than after silk. Before it is justifiable to come to such a conclusion it would be necessary to know the relative frequency with which silk and catgut were employed. In Great Britain, up to the year 1910, Dr. Amand Routh's book tells us (p. 23) that, of the eighty-one operators who sent him particulars, forty-one used silk for the deep sutures, twenty-seven catgut, eight silkworm gut, and four linen thread. Since the date of this inquiry, amongst those surgeons who have sent me particulars of their cases for the period under investigation (1912-18) the use of catgut is far more customary than that of silk (see p. 518). From reading modern textbooks and monographs by American and German authors it is apparent that catgut is almost universally used in those countries; in France, silk is still preferred. There seems to be no doubt that catgut has been in the past, and still is, far more commonly employed than silk. It is not justifiable therefore to conclude from the figures relating to the use of catgut and silk respectively, in cases of ruptured scar, that catgut is more blameworthy than silk.

The suture material can, of course, only be of importance during the process of healing, and so long as a slowly absorbable preparation of catgut, such as chromic, is used, capable of resisting absorption for at least three weeks, there can be no objection to its use so long as the wound is healing aseptically. A point that has been emphasized is that in the involuting uterus the intracellular enzyme activity is considerably raised, and that therefore a protein material, such as catgut, would be absorbed more quickly than in other tissues; this point is a sound one, and is sufficient reason for not employing plain catgut, which is quickly absorbable. If the uterine incision becomes infected, the process of healing is of course considerably delayed, and the absorption of catgut hastened; for this reason I think catgut has serious disadvantages. In the case of an infected wound, the muscular edges of which are constantly tending to be drawn apart by the retractile power of the muscle, it

is important that the edges should be kept in apposition for as long as possible. Here catgut fails, and a less absorbable material is far preferable. Since it is, in my opinion, impossible to guarantee aseptic healing of the uterine incision, I believe that catgut should be avoided.

Considering now the two types of non-absorbable suture, we have to consider silk or linen thread, and silkworm gut. Theoretically, silkworm gut is by far the preferable of the two; it is well known that if infection occurs silk encourages the process of suppuration, which goes on almost indefinitely, and seldom ceases before the sutures have come away naturally or have been removed. Silk, in an infected wound, is an irritant, and an inveterate harbourer of bacteria. On the other hand, silkworm gut is an absolutely inert material in the presence of bacteria, and the presence of silkworm gut sutures has little or no influence in prolonging the suppurating process. My own opinion is strongly in favour of the use of silkworm gut for the deep uterine sutures, firstly because it is a non-absorbable material and will hold the sides of the uterine incision in place for an indefinite period of time, unless, of course, they cut out owing to an extensive necrosis of the tissues; secondly, because it is an inert material in the presence of bacteria. It is interesting to note that there has been reported no case of ruptured scar in which silkworm gut has been employed. It would be wrong, of course, from this to jump to a too obvious conclusion; the fact may well be explained because silkworm gut is relatively very seldom employed in Cæsarean sections.

Another point I consider of great importance in suturing is to wait for complete retraction before inserting the sutures : if the wound is sutured before retraction is complete, and the muscular walls are thin, the result is bound to be a scar thinner than the rest of the uterine wall; for the sutures fail to include layers of muscle fibres which during complete retraction would have slid inwards and become rearranged, adding to the thickness of the sides of the incision.

Accidental Factors in Causation of Rupture.

Any circumstance in pregnancy or labour which is likely to strain the scar to an exceptional degree may precipitate rupture in a case in which, under ordinary circumstances, the scar, though a weak one, might have remained intact. Such circumstances in pregnancy are the over-distension of the uterus by hydramnios, excessive size of the fœtus, or twins, a large retroplacental hæmorrhage, or the introduction of a hydrostatic bag; in labour, prolonged or obstructed labour, internal version or the use of pituitrin. In case abstract No. 14 the patient fell out of bed and got symp-

toms suggestive of rupture. It will be noted that such accidental factors are recorded in only seventeen of the ninety-seven cases. A study of these cases points the moral that patients who bear Cæsarean section scars should not be allowed long labours and that the employment of version, bags, or pituitrin and such-like drugs, is to be avoided.

Some Clinical Points.

Parity, interval between the Cæsarean section and rupture, number of Cæsarean sections preceding rupture, treatment, and result to mother and child, require no further comment here. The bare facts are sufficient, and will be found in the summary of cases. Other points deserve closer consideration.

Labours intervening between Cæsarean Section and Rupture.— In eight cases one delivery by the natural passages occurred between the two events. Why did the uterus stand the stress of one pregnancy and labour, only to yield to it in the next? We naturally turn to inquire whether any additional stress had been put on the scar beyond that of the normal state; whether anything occurred likely to have raised the intra-uterine pressure or to have increased the difficulties of labour? In four cases (see abstracts) we find unusual circumstances; in No. 19, the labour lasted twenty hours and the pelvis was contracted; in No. 30 the placenta was implanted over the scar; in No. 43 delivery was by internal version, and in No. 59 labour was induced by a hydrostatic bag for toxæmia of pregnancy. In the other four there was no abnormality of pregnancy or labour; it is unwise, therefore, to indulge in any false sense of security merely because a patient has already delivered herself by the natural passages.

Period of Pregnancy at which Rupture occurred.—In seventy out of the eighty-seven cases in which the period is stated, the scar ruptured at full term or within a month of it. In Case 15 (full details in the abstract) either the scar had ruptured at a very early period of pregnancy, or, what is much more likely, the original Cæsarean section incision had always remained open from imperfect healing, and was sealed by adhesions only; the ovum had developed partly in the uterus and partly in the abdominal cavity. The fœtus lay in an intraperitoneal gestation sac—a case of secondary abdominal pregnancy. In Case 34, a partial rupture occurred in the fourth month, which was completed at the seventh. Of the cases where rupture occurred in the seventh month (see summary), in only two was there any explanation for such early rupture; in No. 65, a bag was inserted for placenta prævia, and in No. 70 the placenta was implanted over the scar. Circumstances which should favour early rupture are implantation of the placenta

over the scar and retroplacental hæmorrhage, hydramnios, and operative manipulation; also excessive thinness of the scar, especially where there are gaps in the line of the scar merely closed by omental adhesions. In No. 48 the fœtus was post-mature and very large, and rupture was postponed until the eleventh month.

Moment of Rupture: during Pregnancy or during Labour.— It will be observed from the summary that in the eighty-four cases in which this point is stated, rupture occurred during labour in forty-eight and before the onset of labour in thirty-six. Of the former, rupture occurred early in the first stage in twenty-nine. This aspect of the subject is plain enough; a scar is much more strained during uterine contractions than during the quiescent period of pregnancy, and if labour be allowed to continue for a long time, especially if obstructed, the scar is subjected to an unwarrantable strain. A point worth bearing in mind is that for many patients who go into labour subsequently to a Cæsarean section, the labour is for all intents and purposes a primiparous one. At all events, a patient who has had labours previous to the operation is less likely to strain her scar and get a rupture than a patient whose operation was done when she was a primigravida. Other circumstances which obviously favour rupture during pregnancy and before the onset of labour pains are overdistension of the uterus and implantation of the placenta over the scar with retroplacental hæmorrhage; only a few examples of such will be found amongst the thirty-six reported cases, and it must be assumed that thin scars often yield under the influence of the normal intrauterine pressure. A sinister feature of rupture of Cæsarean section scars is that the accident may occur during pregnancy, and from the seventh month onwards. This makes it difficult for us, however forewarned by our knowledge of the risk run by the patient, to protect her completely from the consequences; we cannot very well keep her under close observation in a hospital or nursing home from the seventh month onwards, ready to operate at the first sign or symptom.

Cases with Absence of, or with very slight, Symptoms.—All are familiar with the usual signs of rupture of the uterus: sudden pain, collapse, signs of intraperitoneal bleeding, cessation of labour pains and the distinctive feeling of the fœtus and retracted uterus. The point about these cases of ruptured scar is that the signs and symptoms are often extremely slight and are not seldom absent altogether. The explanation is not far to seek; instead of the whole thickness of the uterine wall being torn through, only a membranous and avascular scar has yielded; instead of sudden rupture being determined by powerful and prolonged uterine action in an exhausted patient, the rupture often occurs quietly and

L

gradually during pregnancy or the early stage of labour. The membranous scar yields at one point, a small bag of membrane bulges through, and the patient goes into labour, as it were, through a gradually yielding scar until the ovum is born into the peritoneal cavity. The severity of the symptoms is naturally dependent on the position of the placenta. If the placenta is implanted over the scar hæmorrhage is likely to be very severe; if the placenta is well away from the scar, it separates and is expelled into the peritoneal cavity with very little more hæmorrhage than occurs after a normal third stage of labour. In cases in which the rupture is partial and the ovum is still in the uterus, acute symptoms are obviously not to be expected. In some cases a partial rupture, sometimes only a small perforation, has been quite unexpectedly discovered at a repeated Cæsarean section (see case abstracts Nos. 28, 33 and 56). If the placenta is over the scar,, even a small perforation may be accompanied by considerable intraperitoneal hæmorrhage, as in case abstract No. 93. Apart from the type of rupture (*i.e.*, whether complete or a mere perforation) the abstracts contain six cases where symptoms were absent (case abstracts Nos. 15, 24, 27, 40, 66 and 81) and fourteen in which they were slight (case abstracts Nos. 12, 14, 21, 22, 33, 35, 52, 56, 64, 79, 80, 83, 86 and 91). Three cases of complete rupture, accompanied by escape of the fœtus and placenta into the peritoneal cavity, with extremely slight and misleading symptoms may be quoted as examples. In Case No. 12 the absence of symptoms caused a mistake in diagnosis; there was no collapse, only a slight alteration in pulse tension and rate, and slight abdominal pain and tenderness. In Case No. 64 the only symptoms were a slight indefinite bearing-down pain and a feeling of weight in the lower abdomen, worse on standing. In Case No. 91 there was no intraperitoneal hæmorrhage or shock; there was diffuse abdominal pain for a few days, after which the patient was comparatively comfortable, walking about with little inconvenience.

On the Frequency of Rupture.

Upon this all-important point we possess, up to the present, no reliable information. A statement is often found that rupture of the scar follows Cæsarean section in 2 per cent. of cases. It has been of great interest to follow this tradition to its source; it was introduced by Couvelaire, quoting van Leuwen. I cannot get at van Leuwen's thesis (a Dutch one), and the summary he has published[1] is very confusing. To begin with, his method of estimating the percentage of ruptures was fallacious; he collected from literature all reports of cases of pregnancy following

---

1. *Annales de Gyn., et d'Obst.*, October, 1904.

Cæsarean section, including chiefly cases of repeated operation and ruptured scar. By comparing cases of rupture with cases of pregnancy that did not rupture, he calculated the percentage of rupture. Quite apart from the faulty method, the conclusions that have been drawn from his figures are inaccurate and confusing, as will be obvious to anyone who cares to read his published summary.

Harrar, reviewing the records of fifty repeated operations at the New York Lying-in Hospital, found two partial and two complete ruptures of the scar. Spalding states that, of forty patients who had Cæsarean section in his clinic or in his private practice, only one patient, to his knowledge, had had spontaneous labour later. This patient, after one spontaneous labour, got rupture of the scar in her next pregnancy (case abstract No. 64). Olshausen, in discussing Prüssmann's case (No. 16), said it was the only rupture out of at least 120 cases at his clinic. Jolly refers to his case (No. 50) as the third during the last thirty years at Olshausen's clinic. Asa B. Davis states that he had had only nine ruptured scars out of the 360 Cæsarean sections he had done (? personally). These figures, interesting as they may be, throw no light whatever on the frequency of ruptured Cæsarean section scars.

There is only one way of estimating this, by getting the subsequent obstetric history of a large number of Cæsarean section patients, and this forms the subject of Part III.

(III) THE RESULTS OF A FOLLOW-UP INQUIRY INTO THE SUBSEQUENT
HISTORY OF A SERIES OF CÆSAREAN SECTION PATIENTS
OPERATED ON BETWEEN 1912 AND 1918.

I wish first to draw attention to an elementary point which is often overlooked in referring to the frequency of rupture of the scar. The number of cases of ruptured scar compared to the total number of cases of Cæsarean section does not give the required information, for many Cæsarean section patients never have a subsequent pregnancy. It is necessary to know the number of cases of ruptured scar compared to the number of cases of subsequent pregnancy that advanced to, or near to, full term (i.e., delivered by natural passages or repeated Cæsarean section; abortions not reckoned). There is only one way of finding out the frequency of ruptured scar; it is to get the subsequent obstetric history of a large number of Cæsarean section patients, over a definite period of years. I was, of course, especially concerned about the five cases of rupture at the London Hospital, and was anxious to find out what proportion these cases bore to the number of our Cæsarean section patients who subsequently became pregnant. This meant a follow-up inquiry. The difficulty was to decide how far back to

go in selecting a year for the beginning of the period of inquiry. It was useless to go too far back, as there would be a small chance of getting hold of patients who had their operation at too remote a date, in a class that changes its abode so often. I decided on the period 1912 to 1918. The results of this inquiry would give the frequency of ruptures at the London Hospital, but it would not give a reliable figure for the percentage of ruptures in general, for the London Hospital cases were only a small sample selected from the mass of cases throughout the country. Further, it was a special sample, in that it contained, without a shadow of doubt, a high proportion of cases of ruptured scar. A much larger and more mixed sample was necessary. So, to begin with, I decided to add to the London Hospital cases the cases from the City of London Maternity Hospital, taken over the same period; in the latter hospital there had been no case of ruptured scar. (The operations were performed by myself and my past and present colleagues at these two hospitals, viz.: Drs. Russell Andrews, Comyns Berkeley, H. Wlliiamson, the late Drummond Maxwell, Abernethy Willett, John Barris, Gordon Luker and Gordon Ley.) These combined figures work out as follows :—

Total number of Cæsarean section patients (excluding fatal and sterilized cases, and cases of repeated Cæsarean section where the first operation was performed prior to 1912) 112
Number followed up   84
Number in whom no subsequent pregnancy occurred   49
Number who subsequently became pregnant 35
Results of pregnancies :—
  Delivery by natural passages   10
  Repeated Cæsarean section   ...   ..   ,..   15
  Abortion   5
  Pregnant now   4
  Rupture of scar   5

These figures are depressing in the extreme; they show that five pregnancies out of thirty (i.e., after deducting abortions and patients in the early months of pregnancy), or 16 per cent. resulted in rupture of the scar, and that there were half as many ruptures as deliveries by the natural passages. They further showed an unexpected degree of sterility following the operation.

Leaving now the main line of argument for a moment, I will refer to an objection which can be raised against these figures; it is that the follow-up failed in 25 per cent. of the patients, and that some of these patients may have become pregnant, and may have got ruptured scars, or have had spontaneous deliveries, or what not. My own conviction is that these patients either did not become pregnant or had early abortions. If they had been expecting

confinements they would almost certainly have sought the advice of their hospital, except in the few cases where they had left London. If all the patients had been successfully followed up the only result would have been the recording of a still higher percentage of sterility.

To return to the main argument, it was essential to take a much larger sample of cases than that taken from the London and City of London Maternity Hospitals if the figures were to be statistically reliable. As it seemed of such immense importance to get at the truth, I decided to try and get the results of Cæsarean sections done throughout the country during the same period. I, therefore, wrote to many obstetric surgeons in active hospital practice, asking them to collaborate with me in a collective investigation. This investigation has been a complete success, in that we are in possession of the subsequent obstetric history of 1,103 cases of Cæsarean section (including the London Hopital and City of London Maternity Hospital cases already referred to) performed between the years 1912 and 1918, inclusive.

Result of the Collective Investigation.

In Table I are displayed the number of cases and their sources, together with the number followed up, the number that subsequently became pregnant, and the mode of termination of the pregnancies. The suture material, as used in the total number of Cæsarean sections, is also shown. The table may be summarized as follows :—

Total number of Cæsarean section patients (excluding fatal and
    sterilized cases, and cases of repeated Cæsarean section where
    the first operation was performed prior to 1912) 1,605
Number followed up   ...   .,   ... 1,103
Number in whom no subsequent pregnancy occurred   616
Number who subsequently became pregnant 487
Results of pregnancies :-
    Delivery by natural passages   78
    Repeated Cæsarean section   ...   .,   ... 352
    Abortion   47
    Pregnant now   86
    Rupture of scar   18

(The discrepancy between the number of pregnancies and the number of patients who became pregnant is, of course, accounted for by the fact that some patients became pregnant more than once.)

A good many interesting points could be worked out from the lists of cases I have had sent me; for example, the sterility rate that follows Cæsarean section. But here I intend only to work out two, viz., the frequency of rupture and the suture material.

(The publication in full of the lists of cases will give anyone who so wishes the opportunity of working out other points, or for checking my own results.)[1]

Tre Frequency of Rupture.

Out of the 487 patients who became pregnant, eighteen (or 3.6 per cent.) got ruptured scars. This figure does not represent the true frequency of rupture; it is necessary to know the frequency of rupture amongst the pregnancies that went to, or near to, term and were therefore liable to ruptured scars.

TABLE 1.

	Total patients	Followed up	No subsequent pregnancy	Subsequent pregnancy	Delivered natural passages	Repeated Cæsarean section	Abortions	Pregnant now	Rupture	Sutured with		
										Catgut	Silk	Silkworm gut
St. Mary's Manchester	243	190	96	94	4	79	13	21	1	188	1	—
Queen Charlotte's Hospital	175	88	49	39	8	24	5	7	—	3	70	8
Glasgow Royal Maternity and Women's Hospital	143	82	40	42	5	31	5	4	1	36	31	—
Liverpool Maternity Hospital	142	83	30	53	8	38	2	12	3	82	—	—
Jessop Hospital	128	105	64	41	8	37	3	2	4	84	30	—
Leeds Maternity Hospital	93	63	35	28	2	30	2	—	1	63	—	—
London Hospital	65	52	29	23	5	12	2	2	5	25	22	5
St. Bartholomew's Hospital	59	22	10	12	5	11	—	1	—	—	—	25
Guy's Hospital	57	45	18	27	7	13	3	6	—	45	—	—
Middlesex Hospital	56	36	22	14	4	10	3	2	1	21	14	—
Mr. F. Jordan	50	43	29	14	—	7	—	8	—	43	—	—
City of London Maternity Hospital	47	32	20	12	5	3	3	2	—	1	27	4
Edinburgh Maternity Hospital	46	38	27	11	1	8	—	3	—	12	27	—
General Lying-in Hospital, York Road	46	28	20	8	—	7	—	2	—	3	15	7
St. Thomas's Hospital	44	27	15	12	4	7	1	2	1	17	10	—
Leeds General Infirmary	41	38	22	16	5	12	1	3	—	38	—	—
Rotunda Hospital	40	28	14	14	4	6	—	5	1	2	27	—
Mr. F. Edge	36	25	15	10	1	7	1	1	—	25	—	—
Dr. B. Whitehouse	30	20	13	7	—	3	3	2	—	20	—	—
St. George's Hospital	16	14	13	1	—	1	—	—	—	—	—	14
Mr. C. Martin	15	15	13	2	—	2	—	—	—	12	3	—
Westminster Hospital	11	11	9	2	—	1	—	1	—	—	11	—
Dr. B. Solomons	8	5	4	1	—	1	—	—	—	5	—	—
Mr. Darwall Smith (private)	7	7	7	—	—	—	—	—	—	—	—	7
Women's Hospital, Birmingham	7	6	2	4	2	2	—	—	—	6	—	—
Total ...	1,605	1,103	616	487	78	352	47	86	18	731	288	70

1. The complete table made up of the lists of cases is published in the *Proc. Roy. Soc. of Med.*, 1920, vol. xiv (Obstet. and Gyn. Sect.), pp.

Adding together the repeated Cæsarean sections, the deliveries by the natural passages and the ruptured scars, we find they come to 448. The true frequency of rupture is eighteen in 448, or 4 per cent. It is also interesting to note that the proportion of ruptured scars to successful deliveries by the natural passages is 18 to 74, or 1 to 4.3.

The Suture Material.

Out of 1,089 Cæsarean sections in which the suture material is noted (see Table I), in 731 catgut was used, in 288 silk, and in seventy silkworm gut. In a few cases combined deep sutures of catgut and silk or silkworm gut were used; these have not been reckoned. The frequency with which these suture materials were used in general works out at 67 per cent. catgut, 26 per cent. silk, and 6 per cent. silkworm gut (incidence of catgut to silk equals 1 in 2½).

In the cases of ruptured scar, catgut was used in fifteen cases, silk in two, and in one case there is no record of the suture material. In no case was silkworm gut used. The frequency with which the suture materials was used in cases of ruptured scar, works out at 88 per cent. catgut, 12 per cent. silk, 0 per cent. silkworm gut (incidence of catgut to silk equals 1 in 7). The number of silkworm gut cases is, of course, too small to draw conclusions from. It is thus apparent that the incidence of catgut to silk in cases of ruptured scar is nearly three times its incidence in Cæsarean section in general. From this it might be inferred that scars are nearly three times as liable to rupture after the use of catgut as after the use of silk.

But to this conclusion a reasonable objection may be raised; it may be urged that perhaps very few cases of pregnancy followed the use of silk compared to the number that followed catgut. For example, if only ten or twenty cases of advanced pregnancy, or labour, occurred amongst the silk cases, silk would come badly out of the ordeal, with two ruptures to its credit. This objection can quite easily be met and overcome. It is necessary to find out the proportion of ruptures to advanced pregnancies amongst the silk cases, and compare it to the proportion of ruptures to advanced pregnancies amongst the catgut cases. This information is set out in the following table :—

	Repeated Cæsarean section.		Delivery by Natural passages.		Rupture.		Total.
Catgut	237	...	49	...	15	...	301
Silk	72	...	19	...	2	...	93
Silkworm gut	15	...	6	...	0	...	21

This shows that fifteen ruptures occurred in 301 cases of advanced pregnancy (*i.e.*, repeated Cæsarean section, plus delivery by the natural passages plus rupture) after the use of catgut, a proportion of 1 in 20; and that two ruptures occurred in ninety-one cases after the use of silk, a proportion of 1 in 46.5. That is, about 2 per cent. of the silk cases, and 5 per cent. of the catgut cases were followed by rupture in subsequent pregnancy.

The liability to rupture after catgut is, therefore, nearly two and a half times the liability after silk.

Put in another way, if silk had been used instead of catgut in the above 301 catgut cases, and rupture had occurred in the same proportion as for the silk cases, there would have been only six ruptures instead of fifteen, and the total number of ruptures for all cases would have been reduced from seventeen to eight.

From the facts revealed by these figures, I have no hesitation in declaring catgut to be a dangerous suture material for Cæsarean section, and in asserting that henceforth it should be discarded.

In conclusion, I wish to tender my most sincere and heartfelt thanks to my fellow obstetric surgeons in the British Isles who have so generously responded to my call for a collective investigation. The collection of these lists has occasioned an immense amount of careful work to those who have undertaken the task. It is the utmost gratification to me, as I am sure it is to them, that our work has met with success, and has revealed so many outstanding facts about a subject which is of such great importance to us all.

CONCLUSIONS.

(1) The frequency of rupture of the Cæsarean section scar in subsequent pregnancy or labour (abortions excluded) is 4 per cent.

(2) The cause of ruptured scar is imperfect healing, leading to a thin scar in which muscular union has failed, and which consists of little more than peritoneum and decidua with a varying amount of intervening fibrous tissue.

(3) All thin scars stretch during pregnancy; rupture of a thin scar may be determined solely by the intra-uterine tension of normal pregnancy, or by the uterine contractions of normal labour; or it may be favoured by various accidental factors, of which the chief is insertion of the placenta over the scar, with partial separation of the placenta and retroplacental hæmorrhage.

(4) Other accidental factors are over-distension of the uterus, prolonged or obstructed labour, operative interference, such as internal version, the insertion of hydrostatic bags, and the administration of such drugs as pituitrin.

(5) In the reported cases rupture occurred almost as often during pregnancy as during labour (in proportion of three to four); and many cases have been reported as early as the seventh month of pregnancy.

(6) The chief cause of imperfect healing is infection of the uterine wound; other causes are imperfect methods of suture and the employment of unsuitable suture material.

(7) As regards the suture material, catgut should not be used, for the liability to rupture after catgut is two and a half times the liability after silk. For theoretical reasons silkworm gut is the most suitable material.

(8) As regards the incision, the scar of the transverse fundal incision is especially liable to rupture. Only one case has so far been reported of rupture of the scar of the cervical incision.

REFERENCES TO LITERATURE OTHER THAN FOR THE NINETY-TWO
ABSTRACTED CASES.

Baisch. *See* under Hofmeier.
Beck. *Amer. Journ. Obst.*, 1916, lxxiv, p. 134.
Boissard. *Bull. de la Soc. d'Obstétrique de Paris*, 1910, xiii, p. 2
Braun. *Zentralbl. f. Gyn.*, 1895, No. 4.
Couvelaire. *Ann. de Gynécol.*, 1906 and 1909, 2nd sér.
Cristalli. *Archivio di ost. e gin.*, 1906, No. 12.
Davis, A. B. *Amer. Journ. Obst.*, 1918, lxxvii, p. 136.
Findlay, Palmer. *Amer. Journ. Obst.*, September, 1916.
Frank. *See* under Hofmeier.
Fritsch. *Zeitschr. f. Gyn.*, 1897.
Green. " Case Histories in Diseases of Women," 1915, p. 249.
Harrar. *Amer. Journ. Obst.*, 1912, lxv, 808.
Hartmann. *Gyn. Rundschau*, 1909, No. 20, and 1913, No. 10. *Zentralbl. f. Gyn.*, 1910, No. 28.
Hofmeier. *Münch. med. Wochenschr.*, 1916, xliii, 1; and *Berl. klin. Wochenschr.*, 1905, xlii, p. 835.
Jolly. *Arch. f. Gyn.*, 1912, xcvii, p. 229.
Kehrer. *Arch. f. Gyn.*, 1882, p. 206.
Kustner. *See* under Hofmeier.
Labhardt. *Zeitsch. f. Geb. u. Gyn.*, Bd. liii.
Leopold. *Arch. f. Gyn.*, 1884, p. 432.
Le Page. *Zentralbl. f. Gyn.*, 1907.
van Leuwen. *Ann. de Gyn., et d'Obst.*, October, 1904, p. 577.
Lichtenstein. *Zentralbl. f. Gyn.*, 1910, No. 26.
Litschkuss. *Monatsschr. f. Geb. u. Gyn.*, Bd. xxxvi, H. 6.
Löhlein. *Verhandl. d. Deutsch. Ges. f. Gyn.*, 1905.
McPherson. *Amer. Journ. Obst.*, 1911, lxiii, 3.
Marioton. *Archiv. mens. d'Obst. et de Gyn.*, 1912, l, p. 276.
Mauclaire and Burnier. *Archiv. Gyn. de Chir.*, Paris, 1908, iii, p. 149.
Noble. *Journ. Amer. Med. Assoc.*, 1891.

Offermann. *Zeitschr. f. Geb. u. Gyn.*, 1916, xliv, 173

Olow. *Zentralbl. f. Gyn.*, 1910, No. 31.

Rohrbach. *Zeitschr. f. Geb. u. Gyn.*, 1914, p. 530.

Routh, Amand " Cæsarean Section in Great Britain and Ireland," Sherratt and Hughes, London and Manchester.

Sänger. *Arch. f. Gyn.*, 1885, p. 226.

Schroeder. *Monatsschr. f. Geb. u. Gyn.*, 1916, xliv, p. 191.

Schauta. *Zentralbl. f. Gyn.*, 1895, p. 110.

Scheffzek. *Zeitsch. f. Geb. u. Gyn.*, lxvii, p. 752.

Sinclair. *Journ. Obst. and Gyn. of Brit. Emp.*, 1907, xii, p. 335.

Spalding. *Journ. Amer. Med. Assoc.*, 1917, 1847.

Singer. " Les Cicatrices Cesariennes Abdominales Classiques," Paris, 1909.

Traugott *Monatsschr. f. Geb. u. Gyn.*, 1911.

Wallace. " On Repeated Cæsarean Section," *Journ. Obst. and Gyn. of Brit. Emp.*, 1902, ii, p. 555.

Williams, J T. *Bull. Johns Hopkins Hosp.*, 1917, xxviii. 335.

Wyss *Beitr. z. Geb u. Gyn.*, 1912, xvii. 337