



CAESAREAN SECTION SCARS

by

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A THESIS

submitted to the

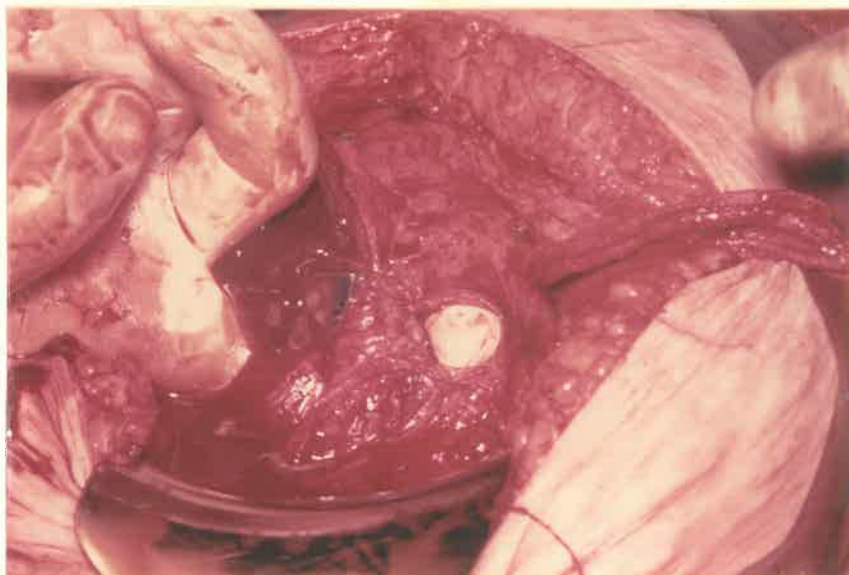
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MASTER OF SURGERY

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FRONTISPIECE



Uterine scar defect

Case M.V. - Q.V.M.H. 11664

Editorial comment in British Medical Journal,
9th July, 1960 on

"Report on Confidential Enquiries into Maternal
Deaths in England and Wales. 1955 - 57."

H.M.S.O. London 1960.

"Rupture of the uterus killed more
women (33) than did anaesthesia (31).
There is a tendency to regard this
accident as a thing of the past and
it is salutary to see a special section
of the report devoted to it. For
every fatal case of ruptured uterus
there must be many non-fatal ones."

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INTRODUCTION

INTRODUCTION

During the last decade there has evolved an almost negligible maternal loss from caesarean section delivery in competent hands. With the emphasis taken off maternal mortality, one would have thought it would have shifted to maternal morbidity or, more precisely, to uterine morbidity. There has, in fact, been very little emphasis placed on the uterine scar, as judged by the attention it has been given in the literature. Its safety has been judged by crude and inaccurate deductions such as the patient's convalescence after the operation, or the scar's ability to withstand a further pregnancy and labour. There is need of a more accurate and reliable method of estimating scar safety.

Not only has the detection of uterine morbidity been neglected, but its prevention has enjoyed too little attention. Present day textbooks avoid the problems of uterine closure almost completely, while few, if any, real contributions have been made elsewhere.

These studies to be presented have concerned themselves with two main aspects. Firstly, the development of a hystero-graphic method for

detecting uterine scar defects after the caesarean section operation, and secondly, a critical long term assessment of repair techniques in the human uterus using this method.

At the same time, an experimental study was conducted to obtain histological evidence of uterine healing using different closure techniques in the double horned uteri of animals after caesarean section delivery. The results of the animal experiments will show a definite relationship between the inclusion of the decidual lining during the closure of the uterine horn and subsequent deformity of healing, as judged histologically.

The human study, based on hystero-graphic examinations of more than 200 uteri six months or more after caesarean section, will show parallel results. The neater the closure of the uterus, particularly as regards the exclusion of the decidua and the use of interrupted sutures, the less the scar deformity that will be seen by hystero-graphy.

Since this study was begun in 1956, many authors have published confirmatory evidence of the reliability of the hystero-graphic technique used in my work. However, none have proceeded to show that

the best results are directly related to the neatness of closure of the uterus at the time of the caesarean section.

REQUIREMENTS OF REGULATIONS 2 AND 5 OF THE
DEGREE OF MASTER OF SURGERY, UNIVERSITY OF
ADELAIDE

In accordance with clause 2 of the regulations of the Degree of Master of Surgery in the calendar (1963) of the University of Adelaide

- a). The Faculty of Medicine has already approved my qualifications as a candidate.
- b). The thesis presented contains original work relevant to the science and art of surgery.
- c). Four published papers are presented.

In accordance with clause 5

- a). I am indebted to the following for help in the preparation of this thesis
 - 1). Mr. Peter Kempster, of the department of histology, for the preparation of all the histological sections.
 - 2). Mr. William Nolan, of the photographic section of the department of medicine for all the photographs.
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- 4). Others who also assisted me ~~include Dr. Peter Verco, who~~ reported on every film, and his radiographer, Mr. C. W. Cook. Sister Ivy Stockings was responsible for the clerical details and the preparation of each patient. Dr. Victor Bockner took some of the early hysterograms used in this presentation. I am also grateful to Professor L. W. Cox for his reading of the manuscript and his encouragement.

The thesis does not contain any material presented for examination for any other degree or diploma in the University.

- b). The nature of the problem investigated is explained in the "Introduction".
c). and d). are adequately covered within the body of the thesis.

Signed

HISTORICAL REVIEW AND PRESENT DAY SITUATION

HISTORICAL REVIEW

The story of the caesarean section operation through the ages provides courage, drama and disappointment as a backdrop to the present day tranquillity. In the centuries long before the Renaissance, reports indicate that the Romans ordered abdominal delivery of children after the death of the mother. Very naturally man's endeavours were subsequently directed to the recovery of the mother as well, and so began the events which have provided such a fascinating story of the almost infinite variety of techniques used by our forefathers, and even those self-inflicted by distraught mothers.

The body of the uterus has been opened anteriorly and posteriorly (Cohnheim 1881), using longitudinal, transverse, and even oblique incisions, the lower segment has been opened both intra and extraperitoneally and even from the upper vagina using the groin approach of Ritgen (1825) and named by Baudelocque the "gastro-elytrotomy." The production of a utero-abdominal fistula was designed in the hope of preventing

fatal infection, and later the uterus was amputated and the cervix fixed in the abdominal wound by Porro in his first successful case (1876).

The greatest reduction in maternal loss was associated with the realisation that leakage from the uterus into the general peritoneal cavity was the great killer. The subtotal amputation of the uterus, with exteriorisation of the cervical stump to the abdominal wall by Porro was a great advance. It was from this moment onwards that the maternal mortality began to fall. Other forms of utero-abdominal fistulae designed to prevent intra-peritoneal leakage also demonstrated the truth of this principle. Later came subtotal amputation of the uterine body with closure of the cervical stump. Although all these methods prevented leakage and salvaged mothers, they, at the same time, prevented further childbearing. It was natural that they should have been followed by methods which not only salvaged the mother but also her childbearing function. These methods concerned the adequate closure of the uterine wound. In the first instance, therefore, closure of the uterus had as its objective the prevention of leakage, and thus the salvage of the mother. In the second

instance the achievement of adequate and safe healing was, and still is, aimed at the prevention of rupture of the uterus in subsequent pregnancies and labours.

Until this period, closure of the uterus was either neglected or imperfectly done. Many and varied were the suggestions for the direction of the uterine incision in order to prevent subsequent gaping of the wound. Lauerjat (1788) recommended a transverse uterine incision as near the fundus as possible. His two reasons were, firstly, that the lower two-thirds of the uterus would thus remain undamaged and so provide a cavity in which blood could collect without spilling into the abdominal cavity. Secondly, he thought it would heal better, since "contractions of the organ took place from above downwards." Killian (1875) suggested a diagonal uterine incision, thinking that the wound would be less liable to gape, as the contracted tissue would be divided through planes where the fibres varied in direction. As late as 1921 Jones proposed a grid-iron incision through the three layers of the uterine muscle of the fundus. He incised the external layer transversely, separating it from the middle layer, which was then incised,

together with the inner layer, in a longitudinal direction.

Kehrer (1882) and Sanger (1882) seem to have been the first to attempt a neat closure. Kehrer began using interrupted silk sutures in the uterine muscle and closed the peritoneum separately, as a free layer, also with interrupted silk. He used the lower segment approach. How very modern! To these men, it seems, should go the credit for the birth of the present day caesarean section.

The writings of Oslander (1821), in the first quarter of the 19th century, indicate that, in those days, more than two-thirds of the women subjected to caesarean section died, while in Paris between the years 1800 and 1850 forty women were subjected to caesarean section and not one survived. (Fehling 1925).

From this moment onwards all types of suture materials have been tried. The maternal mortality began to drop precipitously until, by 1900, many clinics were reporting it as low as 5 per cent.

On the afternoon of 6th May 1920 at the Royal Society of Medicine meeting, Munro Kerr said "..... The fact that we have given the subject of the uterine cicatrix the honour of a full dress

debate is an admission that we are not quite satisfied, that by the methods we ordinarily employ at the present time, we can secure a cicatrix which will stand the strain of a subsequent pregnancy and labour." Were he alive today to discuss the same subject he could equally well choose the same words.

It was during the morning of the same day that Eardley Holland presented his extensive survey of this subject and gave us the figure of 4 per cent as the subsequent rate of rupture of the classical scar. This figure, though out of its text today, is still quoted. In his large follow up of over one thousand operations between 1912 and 1918 he showed that cat gut repairs were involved in subsequent rupture with three times the frequency of silk. He therefore advised against the use of cat gut because aseptic healing could never be guaranteed, and it was thought that cat gut disintegration was speeded considerably in the presence of sepsis.

Munro Kerr on that occasion gave six well known reasons for scar weakness, although he did not mention endometriosis within the scar. No mention was made of this phenomenon. However, at a subsequent Royal Society of Medicine meeting (1924),

following a similar presentation by Munro Kerr, McIntyre presented histological studies in which he showed, in some instances, that "..... isolated portions of the mucous membranes had been caught between the two surfaces of the incision or possibly had migrated there." Eden, during discussion "... doubted whether it would ever be possible to get a perfect scar" and that "..... discussions in the future would range round technique."

McIntyre devoted much study to caesarean section scars, always with emphasis on the pathological mechanism of healing. Endometrial deposits were noted, but no suggestion was ever followed up with proof that they were the direct result of a mucosal inclusion suture. At clinical meetings of that time it was advised that the mucosa be excluded when repairing the uterus, while Munro Kerr even suggested suturing it separately. Since then many discussions have taken place, and numerous clinical papers written on this subject. Emphasis has continually been placed on the subsequent incidence of uterine rupture and this has been used as the yard stick of technique. Even with its many fallacies this is still so today. It appears that no specific technical studies have been made, with

the result that we lack scientific evidence in favour of, or against, a certain technique.

Many fewer are the histological presentations. Schwarz and Paddock (1925) reviewed what earlier work had been done on smooth muscle union and found there was general acceptance of the early formation of a fibrin layer which later formed a conjunctive scar. Gould (1906), in his monograph on intestinal anastomosis, quotes Murphy as showing that an exudate was first formed between the smooth muscle ends and later fibroblasts contracted to form an imperceptible scar between the muscle tissue. Whitridge Williams (1923), in his text book, proposed the opposite view, that the uterine muscle healed together by regeneration of muscle fibres directly and not by original scar tissue. It seems that he based this opinion on the fact that he was not able to see any scar tissue in well healed wounds. This is, of course, so, and is a point often noted in well healed fundal incisions, because the earlier deposition of connective tissue has become completely invaded by muscle cells.

Schwarz and Paddock (1925) then proceeded to confirm the view of the earlier workers and disproved Williams' view. These authors used guinea

pigs to demonstrate that healing took place in the first few days by a layer of connective tissue, which caused adherence of the muscle edges, and later this layer so contracted and merged in with the adjacent muscle fibres that it was difficult or even, in time, impossible to see. Schwarz and Paddock used pregnant guinea pigs and after emptying each horn they repaired them with "fine silk continuous suture using small needles." They did not mention the degree of sterility employed in their operations. The animals were examined from day one to as late as ten weeks. They found little or no reaction round the silk sutures!

Quite by chance they noticed the implantation of endometrial tissue in the line of the incision and said "..... the frequency and extent to which this takes place is undoubtedly due to the marked abundance of endometrial tissue in these uteri." They made no reference to any relationship between the endometrial deposits and the actual technique of repair.

Nothing further appeared until 13 years later, when Schwarz, Paddock and Bortnick (1938) referred to the earlier paper just mentioned. They reported further work using rabbits and they confirmed

their earlier view that smooth muscle regeneration took place so slowly and meagerly that it could not, by itself, bring about healing in so comparatively short a period of time. In these experiments they again used silk sutures and allowed healing from 3 days to 26 days. They made no mention of surgical sterility. As before, they showed one case of wound failure due to a fistula lined by endometrium, without suggesting a technical etiology for this.

Siegel (1952) produced the only other histological paper. He experimented with pregnant and non-pregnant dogs and closed the incisions with continuous 4/0 chromic cat gut, examining all 14 days post-operatively. He concluded that connective tissue formation following incisions into the pregnant uterus was abundant in the wound and larger in amount than in the non-pregnant uterus. He confirmed the findings of Schwarz and his co-workers.

In a later section it will be apparent that animal experiments in this study support the view that initial union is by connective tissue which becomes invaded by smooth muscle cells. The earlier the examination is made post-operatively the more apparent the scar tissue. The later the

examination, the less the scar tissue, until at 6 or 7 weeks after cat caesarean sections, using a neat technique, no scar tissue can be seen at all.

No other published experimental work on this particular aspect has been found.

PRESENT DAY SITUATION

The present day safety of this operative form of delivery has been achieved, *pari passu*, with surgery in general, by the advances in anti-septics, asepsis, anaesthesia, anticoagulants, antibiotics, and blood transfusion, together with advances in medicine generally which have brought a better understanding of the many disease states which may sometimes complicate pregnancy.

An analysis of a collection of 7762 operations published by Marshall and Cox (1949) showed a maternal loss from the lower segment operation of 6 per thousand. Many personal series show an even lower maternal loss, for example, D'Esopo (1949) reported 1064 consecutive operations with no deaths, while in 1951 Harris et al. reported 2070 cases with one death. In this same paper the authors reported an almost identical maternal mortality (0.5 per thousand) with that from their vaginal deliveries (0.8 per thousand). Their foetal mortality from the vaginal series between the years 1937-1950 was 3.13%, while from the caesarean section series over the same years it was 2.99%. Since then many more favourable reports have appeared.

With all these recent advances it should now be possible to consider any death from this operation as unavoidable. Those cases of avoidable deaths, which are associated with inexpert obstetric care, will be reduced in accordance with the rate of dissemination of knowledge and facilities.

The foetus has shared almost as well as its mother in all these advances. Traumatic deliveries through the pelvis with their many and varied sequelae may now be avoided. The experienced operator will never inflict injury on a foetus during an abdominal delivery. However, there still remains one, and possibly two, hazards which the product of an abdominal delivery has had substituted for the difficulties of the birth canal. Hyaline membrane disease is a considerable hazard peculiar to abdominal delivery (Martin and More 1955), while prematurity, strangely enough, heads the list of causes of neonatal deaths from elective caesarean section in some large centres.

Whether or not a baby born vaginally is better or worse off than one born abdominally, all other factors being equal, is still being debated. However, there does seem good evidence that premature babies between 1500 and 2500 Gms. have a better chance

of survival if born vaginally (Bryant 1956). Some instances of prematurity will be avoided when the ability to accurately estimate foetal age is readily available. Although the fatalities from hyaline membrane have been lessened in some centres by certain attentions to technical details (Pash 1954), it is not likely that the condition will disappear entirely until the intricacies of the pulmonary circulation and the physiology of respiration in the foetal and newborn period are unravelled.

The advantages of this present day Utopian state would not be complete if the surgeon and his team were overlooked. It is not so many years ago that a decision to perform a caesarean section was not only far more onerous than it is today, but, to the surgeon who had experienced them, it inevitably flashed back his memory to past fatalities. He and his team then realised the tension and responsibility associated with his decision. The younger trained obstetrician of today cannot readily appreciate the stress then involved, when he contemplates the tranquil attitude of his present surroundings.

There can be no argument with the rising caesarean section rate over the last two decades.

Nor should there be. On the contrary, a persisting low rate indicates either a selective group of deliveries or poor obstetric management. A modern and well trained obstetric unit would prefer a few extra caesarean sections with live, healthy babies, rather than a few less caesarean sections with the odd foetal loss or damaged baby.

This happy situation as it exists in this decade could well lead to complacency, were it not inimical to the preservation of a scientific outlook. The maternal mortality can be demonstrated to be approximately the same as for vaginal delivery and there has been a manifold improvement in foetal outlook; for example, all trauma can be eliminated, anoxia can be short-circuited and from the maternal haemorrhages alone, the foetal lot is bettered by 6 to 7 times.

What then is on the debit side? Intra-peritoneal morbidity following the laparotomy was possible and often followed the classical type of operation in the form of adhesions with their sequelae or peritonitis. Morbidity following the lower segment intra-peritoneal operation is much less likely, as evidenced by the ability to perform

repeated operations of this type on the same woman with no intra-peritoneal adhesions or obvious defects. Morbidity, in the form of bladder injuries, is more likely when an extra-peritoneal type of operation is routinely used, but the almost universal acceptance of the intra-peritoneal lower segment operation has eliminated this. Deaths and even morbidity from pulmonary embolism, other forms of thrombophlebitis, peritonitis, ileus and blood losses have almost been eliminated with expert care. The anaesthetic risk, in expert hands, is negligible. There alone remains the uterine wound. The dilemma concerning its safety is sufficiently emphasised by a brief review of the two opposing schools of clinical management.

THE REPEAT SECTION SCHOOL

The present day situation resolves itself into two very definite schools. There is the school which does not trust the uterine scar in subsequent late pregnancy and labour, and believes that once having had a caesarean section, all subsequent deliveries should be abdominal. This school is large and has the support of many great and respected names in obstetrics, Meredith (1955), Pedowitz and Schwartz (1957), McNally and Fitzpatrick (1956), Cosgrove (1952), Baldwin (1957), Bak and Hayden (1955), Harris and Nessim (1959), Lane and Reid (1953), to mention only a few. These adherents believe that with present day techniques and present day knowledge of the healing powers of the individual they are still unable to decide which uterine scar has healed firmly and which one has not, and as there appears to be no selection, they apply a blanket type of management to all cases and practise "Once a caesarean section, always a caesarean section". Pedowitz and Schwartz (1957) of the State University of New York, conducted a valuable prospective study of 403 women who had a total of 482

previous caesarean sections. Most had been of the lower transverse type. At subsequent caesarean section they had found 48 disruptions quite unexpectedly, in that none had presented with symptoms or signs of rupture. Forty were complete ruptures and 8 were incomplete. Ten per cent, therefore, had defective uterine wounds. All were of long duration in that the edges of the "windows" in the uterus were rolled over and showed no evidence of recent tearing (see frontispiece). They point out that unless one carefully searches the lower uterine segment for these windows, sometimes small and sometimes large, and often to be found laterally under the peritoneum, they will be left undiscovered. They further point out that from 1932 to 1952 in their hospital only 3 cases of rupture of a previous caesarean section scar were recorded, demonstrating the unreliable nature of recorded data.

This incidence of silent rupture, which these authors give as 10%, may surprise some, yet there are many other authors, Posner Santos and Posner (1959) and Meredith (1955) who have written papers on rupture of the uterus and who have pointed out quite clearly that their cases of rupture have

not included those cases in which "windows" or incomplete ruptures of the lower segment were incidentally discovered at subsequent elective caesarean section. Riva et al. (1957) delivered 85 women vaginally from a group of 123 women who had previously had caesarean sections (69%). They manually explored 27 cases after delivery, searching for defects of 1 cm. or more, and found an incidence of 13.8%. Baker (1955) reported 17% of 64 women had defective wounds. Louros et al. (1958) reported a rupture rate of 12.7%. Quite obviously, if the incidence of uterine rupture subsequent to caesarean section is to be judged by the number of acute ruptures requiring immediate laparotomy, then a completely false impression of the true situation is gained.

The adherents of this school have made exhaustive clinical studies regarding post-operative healing and pyrexia, the indications for the previous section, the techniques used, as far as these were available, parity, age, and many other factors, and all usually conclude that technique and healing power of the individual are the two most important factors in wound healing. As neither of these are capable of accurate measurement there exists no means

of predicting the behaviour of a uterine scar during the course of a subsequent pregnancy. The blanketing of management of these cases into elective repeat caesarean section late in pregnancy before labour begins is only a partial protection against rupture, for many cases have ruptured, and will continue to rupture, prior to the time of elective section.

The Repeat Caesarean Section school freely admits the possibility of uterine rupture late in pregnancy and before the date set for elective caesarean section, and often stresses that uterine rupture during pregnancy is more to be feared than labour itself (McNally and Fitzpatrick 1956). Posner et al. (1959) reported their earliest rupture at 22 weeks of pregnancy.

THE SELECTION SCHOOL

On the other hand there is this school, well attended by eminent British obstetricians, which may be called the Selectionist School. This school does not practise the dictum of "once a caesarean section, always a caesarean section", but sets out to select cases individually. Those cases in which there is evidence of disproportion are almost invariably resectioned, as well as any case which presents any "unfavourable" features. Other cases done originally for non-recurring indications, and which appear to have had a normal and non-morbid recovery, are frequently selected for vaginal delivery. Selection therefore depends primarily on an apyrexial post-operative period with a knowledge of a supposedly correct technique. This latter point is often satisfied by a knowledge of the surgeon's qualifications rather than his actual technique, and on this point details are so often lacking when records are examined. Most present day textbooks avoid any reference to the correct method of repair and even those that do attempt this, produce no supporting evidence for their technique.

The advocates of this school, with their various criteria for selection, find that the incidence of vaginal delivery following previous caesarean section varies from 30 to 60 per cent. Nattrass (1953) reviewed this question over a four year period in Melbourne, during which 105 women were selected for vaginal delivery from a group of 278 women previously submitted to caesarean section. Our own figures from Adelaide over a 5 year period, using selection, showed 83 vaginal deliveries from 216 women who presented with a history of previous caesarean section (Poidevin and Bockner 1958). Thus both these surveys are very similar and show approximately 38 per cent of vaginal deliveries after previous caesarean section. Two cases of rupture were reported in the Melbourne series and none in the Adelaide figures to the time of reporting, although in the next two years two cases of rupture from previous caesarean section were reported (Poidevin 1959 (1)).

The criteria used by those of the Selection School at present are scientifically unsound. Reliance upon the smoothness or otherwise of the previous post-operative course in relation to sound uterine healing is unjustified. McNally and Fitz-

patrick (1956) showed that infection of the abdominal wound does not always mean a defective uterine scar and that a defective uterine scar does not depend on a parietal infection. Further, the degree of deficiency of the scar does not seem to have a direct relationship to the severity of the infection. Pedowitz and Schwartz (1957) said ".... an afebrile post-operative course does not imply a good scar nor a morbid one a defective scar and the degree and severity of the morbidity have little influence on the integrity of the scar." My own investigations support these views and will be presented in a later section.

The other important criteria of previous detailed technique and the individual healing powers, at the time, are presently beyond scientific assessment.

The weakest defect of the Selection School is found in the fact that its members universally insist that any attempted vaginal delivery must be conducted adjacent to full facilities for an urgent caesarean section, should it be indicated. This is surely proof that doubt concerning the integrity of the scar is paramount. The only test of integrity this school uses is therefore the ability of that uterus to deliver without apparently rupturing.

Again, this test is unscientific, for there are many reports of one vaginal delivery subsequent to caesarean section, only to be followed in the next labour by acute rupture. What proof, therefore, of uterine integrity, is one vaginal delivery after a caesarean section? Is it not possible that a uterus with a small defect in the lower segment may perform in an apparently normal manner? The answer is yes. One recent example was case no. 5651 Q.V.M.H., who had one vaginal delivery after a caesarean section and suffered a ruptured uterus in the succeeding labour. (See Fig. 89).

UTERINE WOUND HEALING

UTERINE WOUND HEALING

From the earlier work of Williams (1917) already referred to, the concept was accepted that healing of caesarean section wounds was by regeneration of smooth muscle without the development of scar tissue. This opinion was based on the microscopic examination of ten uteri which had been removed by Porro's technique, and which had previously had classical sections. Eight of the ten had no visible scars and no connective tissue in the old wounds. One showed a failure of myometrial union, thus producing a furrow, and the other had ruptured. Subsequently, the histological studies of Schwarz et al. (1938) and Siegel (1952) showed conclusively that original healing of wounds in the uterus takes place by fibroblastic reaction producing a fibrous tissue union, which is invaded by muscle cells so that the healing then appears to be by direct muscle to muscle union. This concept has been confirmed by many workers and will be demonstrated in the present study.

Under favourable conditions, and with care, the neatest healing may be obtained which demonstrates histologically very little, if any, fibrous tissue. On this particular point Potter and Johnston

(1954) wrote a most thought provoking paper in which they reported their findings in over 5,000 caesarean sections from their own unit. Between 1941 and the reporting, they did 1,521 cases using, in most cases, a high vertical fundal incision; some few cases were of the low transverse type. The fundal incision was sutured in all cases with interrupted silk sutures placed 2 cms. apart, using a straight round needle and only taking up the superficial third of myometrium. The stitches entered and left the wound about 1 cm. from its edge and were only lightly tied. These authors claimed that physiological healing occurred by the elimination of foreign body reaction to cat gut, the elimination of tissue strangulation, and the elimination of haematoma formation within the wound. Furthermore, they provided proof in many of their cases by subsequently recovering uteri and submitting them to exact examination. Published sections showed full thickness union and, impressively enough, some fibrous tissue union in the outer third, but almost complete muscle to muscle union in the inner two thirds. Furthermore, in 500 repeat sections in their 1,521 cases no case of rupture was found.

Potter and Johnston are far from being alone in their view that the fundal incision can, and will, heal perfectly if correctly repaired. Lane and Reid (1953) stated their conviction that the classical incision is more likely to withstand the forces of labour than the lower segment scar. These authors stressed the important point that the reported incidences of uterine rupture do not, in many cases, report scar weakness or "windows" found unexpectedly at subsequent operations and they therefore place little credence in the difference between the reported ratio of rupture in the lower and upper segments.

Lane and Reid recognise the restricted usefulness of clinical criteria as an indication to future management. They practise repeat caesarean section in all cases and use a vertical incision in the lower segment. Bowman and Seidner (1958) reported a series of 98 classical caesarean sections with no maternal or foetal loss and a post-operative morbidity which compared favourably with the low cervical operations in other institutions.

There must be few obstetricians practising today who have not had first hand evidence of perfect healing from previous classical caesarean

sections. Many hysterectomy specimens have become available to demonstrate this. These same obstetricians could equally well recall uteri with long deep furrows indicating deficient healing from fundal incisions.

It has to be remembered that the conditions present during uterine healing are unique. No other organ in the body undergoes such a rapid change in character as the involuting uterus. Because of rapid involution the transverse scar in the lower segment begins its existence (at the time of repair) four inches in length and within 6 weeks it is 1 cm. in length. The pathological principles of healing are required to adapt themselves to this dynamic situation.

It has been, and still is, often stated that the involution process is one of the main causes of wound failure. This factor was commonly invoked in the days when classical caesarean sections were the rule. Post-operative contractions in the puerperal uterus may create unfavourable conditions for healing and it is comfortable to consider the lower segment as being freer of these disadvantages than the upper. Nevertheless, whatever may be one's views on this particular aspect, it is essential to

remember that these suggested disadvantages can be, and are, overcome because many uterine wounds do heal safely both in the upper and lower segments.

Therefore it would seem illogical to invoke the autolytic processes of involution or even the myometrial activity as being major causes of wound failure in some cases and not in others. They are constant factors, yet the majority of wounds heal well. Apart from this reasoning there is no scientific evidence to show that the involution processes or uterine contractions are capable of causing wound failure. What, then, are the etiological factors of poor healing? They must be sought either among technique, wound infection or constitutional factors.

The purpose of this study has been primarily to investigate the role of actual technique. Some observations were made concurrently on one constitutional aspect and also on artificially infected wounds.

An experimental study was therefore designed to test various techniques of repairing the uterus as judged by subsequent histological examination. The study was conducted under full

surgical asepsis on cats and rabbits who, because of the double horned organ, eliminated ~~any~~ constitutional factor in healing.

ANIMAL EXPERIMENTS
CONCERNING
UTERINE WOUND HEALING

EXPERIMENTAL OBSERVATIONS IN DOMESTIC CATS
AND CHINCHILLA RABBITS

Fifteen pregnant cats and four pregnant does were the subjects of abdominal deliveries at term in order to make histological studies of healing in the uterine horns. This study occupied nine months. The cats proved more satisfactory for these experiments than the rabbits, for two main reasons. Firstly, they were larger and had bigger uterine horns with better developed muscular and decidual layers, and secondly, they were generally easier to handle and convalesced with better manners than the rabbits. The latter tended to interfere with their abdominal wounds, while the cats rested peacefully and kept their wounds very clean. One of the four does died because it tore open its abdominal wound and was found dead on the third post-operative day. The animals that recovered (18 out of 19 operations) were kept in the animal house for periods up to ten weeks, during which time the second operation -- a hysterectomy -- was done for the recovery of each uterine horn for study of the scar. All the eighteen animals recovered uneventfully from their second operation.

The use of animals with double-horned uteri proved ideal for these experiments. Whatever technique was used to repair one horn could be compared with the technique used in the control horn, knowing that the conditions operating during the whole period of the convalescence were constant for both horns within that animal. This particular situation has been considered most important, as it certainly eliminated the possibility of constitutional factors affecting the healing, because they would be common to both horns.

All the operations were conducted in the Department of Human Physiology of the University of Adelaide on a standard type of operating table with an electrically warmed top. Post-operatively the animals were taken to the animal house in the same building and made comfortable in their own cages. As they convalesced the cats were fed a generous diet of meat and milk and the rabbits were given lucerne and compressed food pellets. They were all kept under observation in the animal house for the full time between the initial operation and the later hysterectomy.

OPERATIVE TECHNIQUE

When pregnancy was judged to be nearing full term each animal was anaesthetised with intravenous nembutal (Sagatal) using a fore-paw vein in the cats and an ear vein in the rabbits. The dosage was adjusted according to weight, with an average dose of 100 milligrams for cats and 60 milligrams for rabbits. Once anaesthetised, the anterior abdominal wall was closely shaved from the sternum to the symphysis pubis and laterally to the nipple line. All drapes and instruments were autoclaved and surgical scrubbing of the operator's hands was thoroughly conducted before each operation. Rubber gloves were not used. After cleaning the skin with hibitane, the drapes were correctly placed and a midline incision about $3\frac{1}{2}$ inches was made upwards from the symphysis. The left horn was usually delivered first through the incision and then opened, using an antimesenteric longitudinal incision of about three inches in length. (Fig. 1). The muscle coats were quite thin at term but quickly thickened to about two millimetres after emptying. Each foetus with its placenta was manually extracted. (Figs 2, 3). On the



Fig. 1.



Fig. 2.



Fig. 3.

average, each horn held two kits, but with the rabbits up to six foetuses were delivered from each horn. No attempt was made to salvage the offspring. The right horn was then delivered and emptied. After closure of each horn the abdominal wall was closed with two layers of sutures and the wound mostly left uncovered.

At the conclusion of each operation, which usually occupied 30 - 35 minutes, the animal was placed on its side and kept warm. The rate of post-operative recovery depended upon the total dose of anaesthesia and usually required a full 24 hours before the animal was fully mobile again.

SPECIAL POINTS OF TECHNIQUE

In this study it was desired particularly to investigate histological healing using a decidual inclusion suture, as compared with one excluding the decidua. After emptying these pregnant horns the decidua was quite easily recognised as a layer of tissue approximately 1 millimetre in thickness, so that it could be included or excluded at will from the suture. Because of the almost complete absence of bleeding from this longitudinal incision in the uterine horn a very exact closure technique was possible. For the sake of uniformity the left horn was always repaired with an all layer decidual inclusion suture (Fig. 4), and the right horn closed with a decidual exclusion suture (Fig. 5). A diagrammatic sketch illustrates the actual needle path. (Figs. 6, 7). The haemostatic requirements of the sutures being minimal, meant that the only tension necessary was that required for apposition. In all cases one layer of sutures only was used.

Further, it was intended to study healing when various suture materials were used. Fine sutures were the rule and ranged from plain cat gut, 2/0 or 4/0, through chromic gut of the same order,

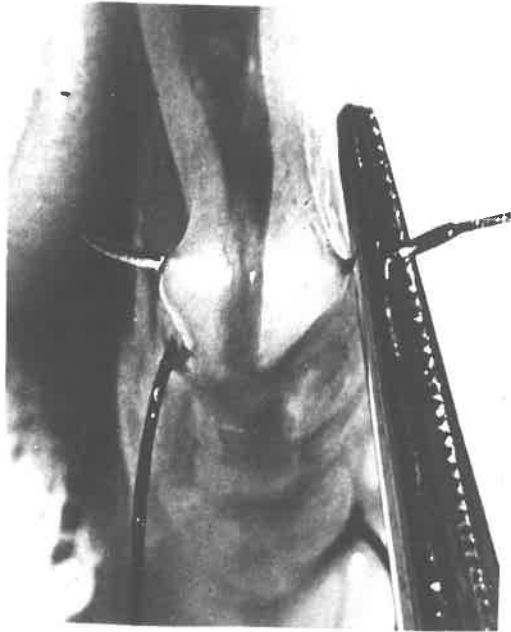
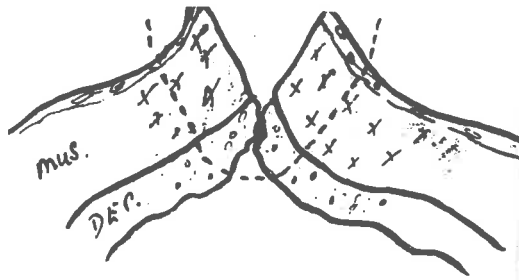


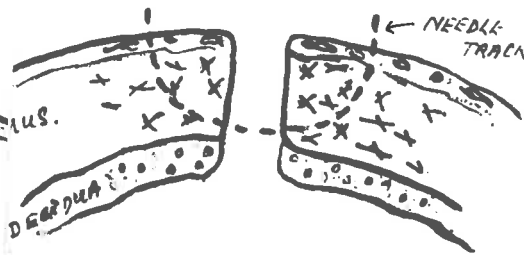
Fig. 4.



Fig. 5.



MUCOSAL INCLUSION
SUTURE



MUCOSAL EXCLUSION
SUTURE

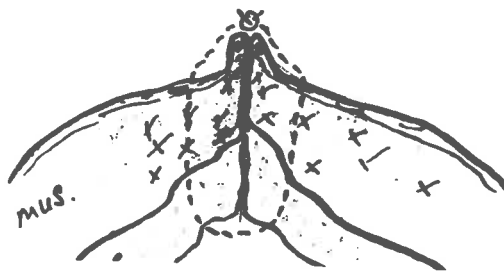


Fig. 6.

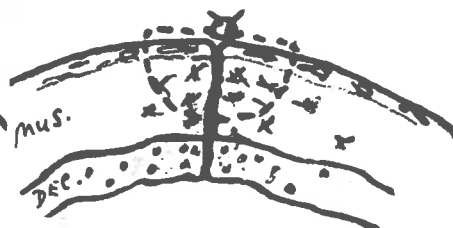


Fig. 7.

to linen thread and, in one case, fine tendon wire was used. In all cases, well known brands were used, with atraumatic needles, except with the linen thread.

In one cat the specific effects on healing of a localised abscess were able to be observed in one horn while uncomplicated healing occurred in the other, by the deliberate inclusion of a small gauze swab alongside one uterine wound.

Thirteen cats were held between 6 and 7 weeks before excision of the horns, and two were held 10 weeks. One of the four rabbits died in the early post-operative period and the other 3 were held between 3 and 5 weeks before the second operation.

EXPERIMENTAL FINDINGS

Macroscopic

When the abdominal cavities were reopened variable degrees of omental adhesions to the uterine scars were found. This was most pronounced in the one cat whose left horn was repaired with fine interrupted wire sutures. (Fig. 8). In another cat in which linen thread was used in one horn and chromic gut in the other, adhesions were excessive on the linen thread side. (Fig. 9).

The only other macroscopic interest was in the cat in whom a localised abscess was produced by leaving alongside one horn a piece of gauze. This created an inflammatory tumour over twice the size of the involuted horn. (Fig. 10).

Histological

Those horns which were examined in the early weeks after hysterotomy (3 weeks in Figs. 11 and 12) showed commencing union with much connective tissue. Fibroblasts and muscle cells could be seen invading this tissue in various stages of union until finally the scar tissue was replaced with

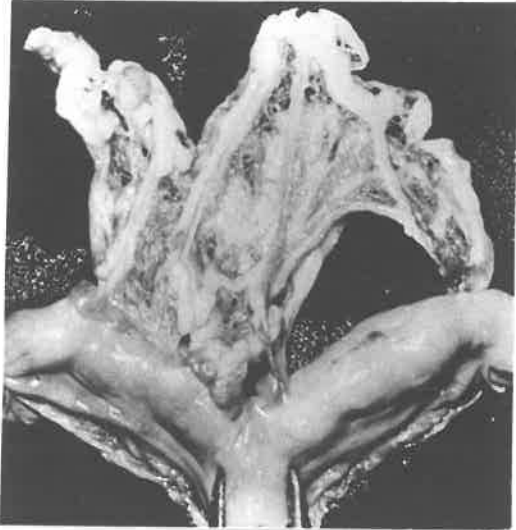


Fig. 8.



Fig. 9.



Fig. 10.

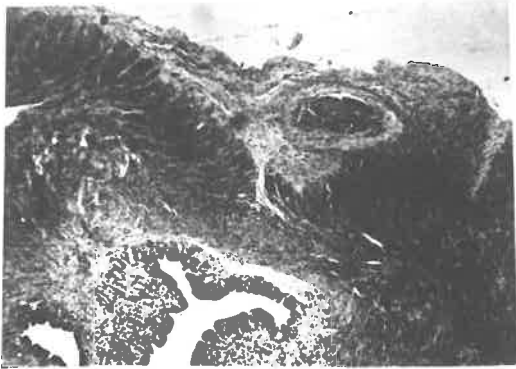


Fig. 11.

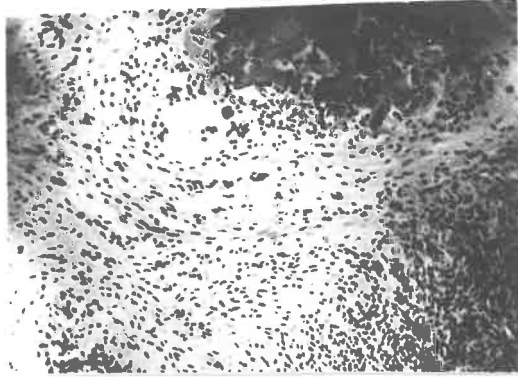


Fig. 12.



Fig. 13.

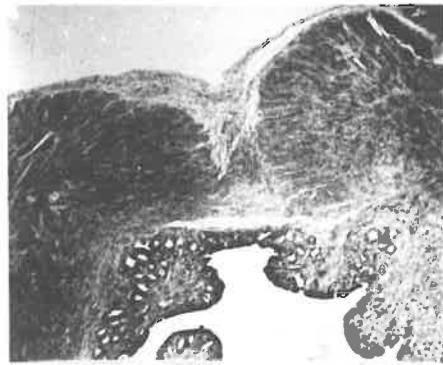


Fig. 14.

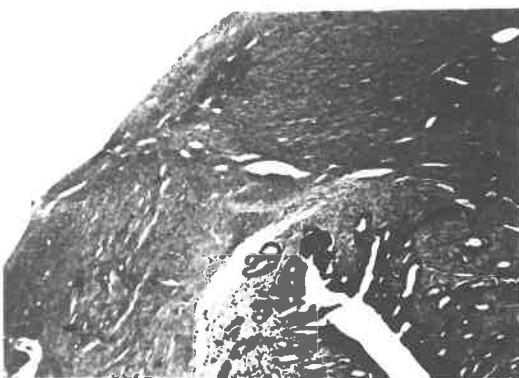


Fig. 15.

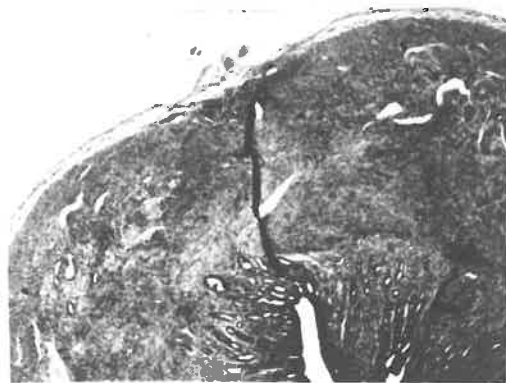


Fig. 16.

muscle. (Fig. 16). Examples of this healing process are shown in Figs. 11 to 16 inclusive. This evidence is in keeping with the findings of Schwarz, Paddock and Bortnick (1938) and Siegel (1952), whose work also showed an initial layer of connective tissue which later was replaced by muscle cell union. In the absence of infection this can therefore be regarded as the normal mechanism of uterine healing, provided the edges are neatly apposed without undue tension.

In the right horns of all the fifteen cats and the three rabbits, various degrees of good muscle to muscle union were found (Figs. 17 - 20). In the two horns in which linen thread was used there was an excess of connective tissue (Figs. 21, 22) and this can be interpreted as an irritant form of suture material; however, it did not appear to prevent muscle to muscle union, but distorted it.

The exclusion of the decidua from the suture allowed a final muscle to muscle union without any deformity. Therefore, from these 18 animals no healing deformities were noted, the edges had been neatly applied and were found to heal without any decidual inclusions. (Figs. 17 - 20).

In the other horn (the left), of thirteen



Fig. 17.



Fig. 18.

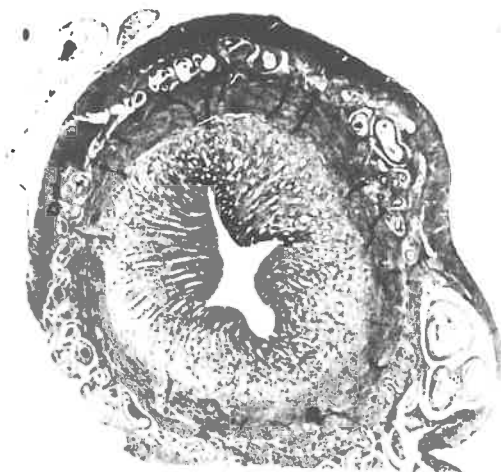


Fig. 19.



Fig. 20.

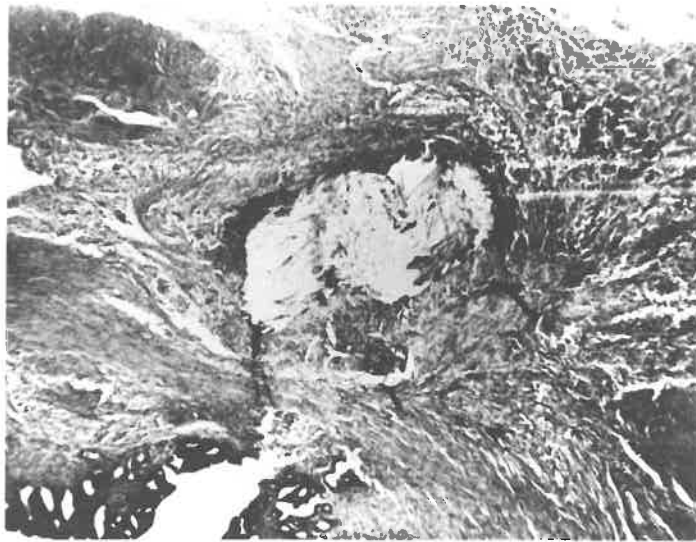


Fig. 21.

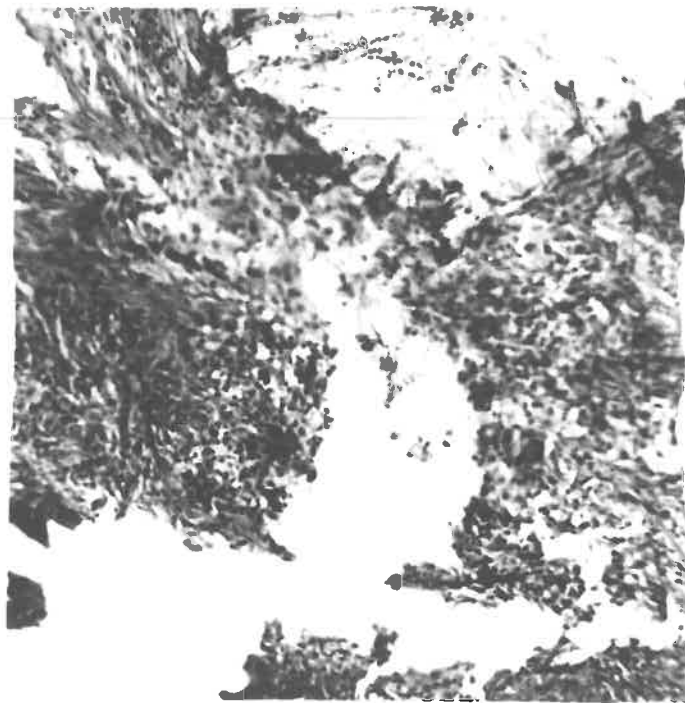


Fig. 22.

cats and one rabbit, that is, fourteen out of eighteen animals examined, the inclusion of the decidua produced deformities in healing. In some cases large islands of decidua were found amongst the myometrium. (Figs. 23, 24). In others there was quite obvious extension and interposition of the decidua in between the muscle edges (Figs. 25 - 31). These findings were irrespective of the suture materials, but were directly related to the decidual inclusion suture (Fig. 4).

This evidence of well marked and clearly demonstrated deformity of healing in fourteen out of eighteen animals examined, in which a decidual including suture technique was used, is most convincing. Particularly is this so when not one of the eighteen control horns, in which the decidua was excluded, showed any healing deformity.

A further histological finding of importance concerned the vascular layer of the myometrium. In those horns which were neatly apposed with a decidual excluding suture, the vascular layer could easily be demonstrated crossing the area of incision without any deformity (Figs. 19, 20). (Note adhesion to peritoneum indicating the area of incision). In the horns closed with an all layer

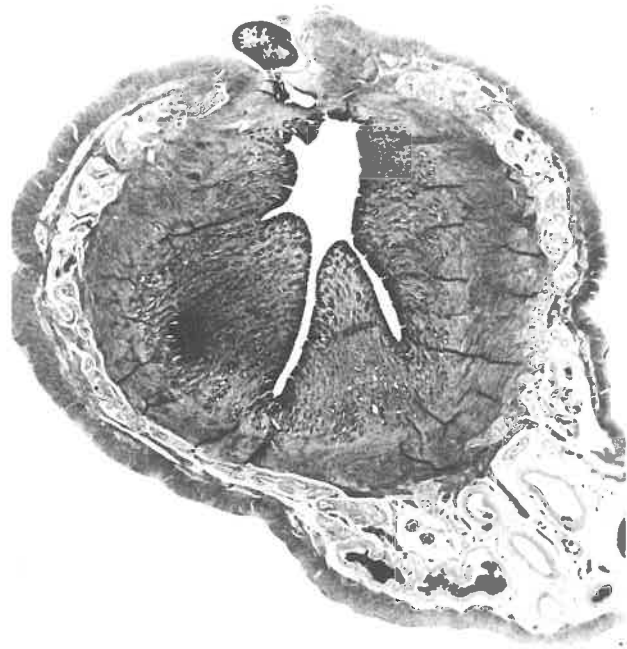


Fig. 23.



Fig. 24.
(Higher power)



Fig. 25.



Fig. 26.

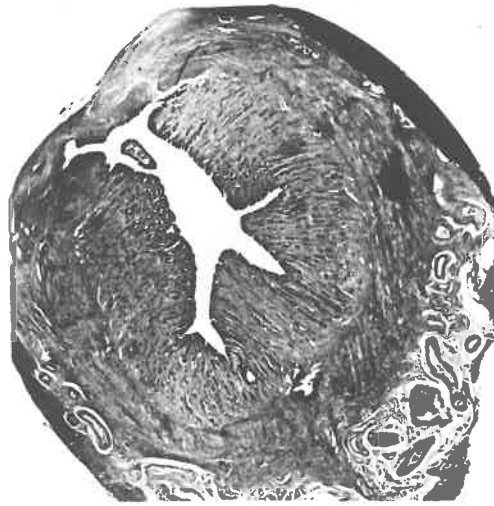


Fig. 27.

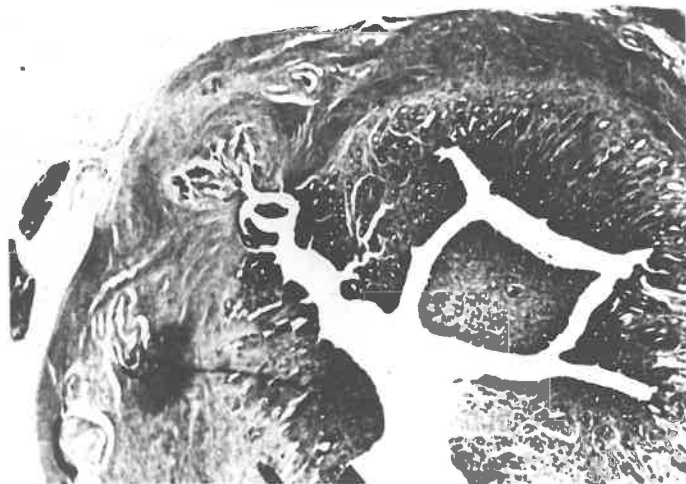


Fig. 28.



Fig. 29.



Fig. 30.



Fig. 31.

inclusion suture the main vascular layer stopped short of the uterine scar. (Fig. 23).

On the external surface of the left horn of one cat there was a macroscopically obvious endometriosis lesion (Fig. 32).

Thus it can be concluded that there is a definite relationship between the decidual inclusion suture technique and subsequent wound deformities.

McIntyre (1924), whose work has already been mentioned, and who suggested a migration hypothesis for endometrial deposits within the scar, devoted a great deal of time to the study of caesarean section scars in humans. He suggested that these deposits may be a cause of weakness within the scar, but much more interest was centred upon whether or not union was by muscle regeneration or scar tissue. No attempt appears to have been made to prove that these endometrial deposits directly resulted from an inclusion technique. The conclusions from this present study do prove this, and thus lend no support to any migration hypothesis.

UTERINE HEALING IN THE PRESENCE OF INFECTION

Cat G was selected for the production of an inflammatory mass alongside the wound in its right horn. After the uterine wounds in both horns had been closed in the routine manner of these experiments and replaced within the abdomen, a portion of a gauze swab was placed adjacent to the wound in the right horn. The abdominal wall was then closed as usual. The convalescence appeared normal, with no complication of abdominal wall healing, and the cat was clinically normal and healthy in every way when it was decided to reopen it seven weeks later.

There was a mass in the right side of the abdomen involving the right horn, about 4 cms. by 4 cms. Omental adhesions were firmly attached. The left horn was not involved in this and could be excised separately.

Histological examination of the right horn and its adjacent adherent mass showed a doubtfully healed myometrium with massive leucocytic and round-celled infiltration. There was abundant fibrous connective tissue, and one piece of chromic cat gut, broken up but unabsorbed (Fig. 33). A

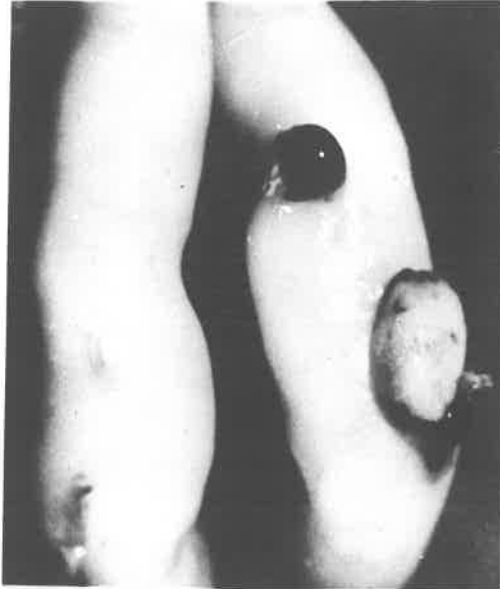


Fig. 32.



Fig. 33.



Fig. 34.
(Higher power)



Fig. 35.

higher powered view showed the endometrial lining and the adjacent inflammatory tissues. (Fig. 34).

The left horn of this same cat showed the usual type of healing when a decidual inclusion suture was used. An area of endometrial inclusion was present (Fig. 35). No evidence of infection was seen in this left uterine horn scar, and its healing could be considered satisfactory and in keeping with others in which the all inclusion suture technique was used.

This experimental method of producing an inflammatory reaction in association with the healing in one uterine horn, whilst the healing in the control horn is undisturbed, has been instructive. It has demonstrated, within the one animal, the specific effects of such an inflammatory process on uterine healing. There is no doubt, histologically, that the wound in the infected horn failed to heal adequately and, by inference, would be unsafe in a subsequent pregnancy. The method has also demonstrated that there can be serious inflammatory disturbances within the uterine wound without any complication of abdominal wound healing.

There is evidence that the reverse is equally true, from other rabbit experiments not

included in this study. The effects of massive post-operative doses of cortisone on actual uterine wound healing were being studied in two rabbits. It was found that abdominal wall healing was seriously impaired. The abdominal wound broke down completely in one rabbit ten days after operation; a massive protrusion of contents followed, and the animal died. The uterine wound was found to be healing quite normally (Fig. 36). The second rabbit did not suffer a burst abdomen, but on the 20th day it was reopened by simply splitting open the moist and infected abdominal wall, in which very little fibroblastic reaction could be demonstrated. The uterine wound appeared to be unaffected by the abdominal wound disturbances. (Fig. 37).

The evidence strongly suggests that it could be quite inaccurate to infer that uterine healing is necessarily affected in the presence of an infected abdominal wound, and vice versa.

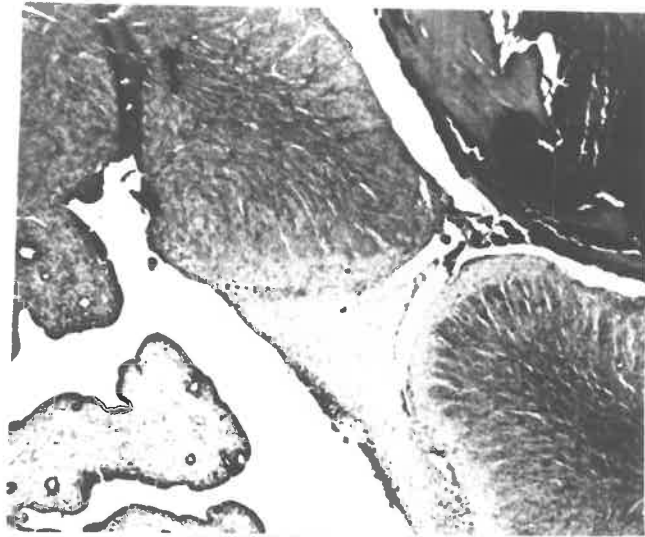


Fig. 36.

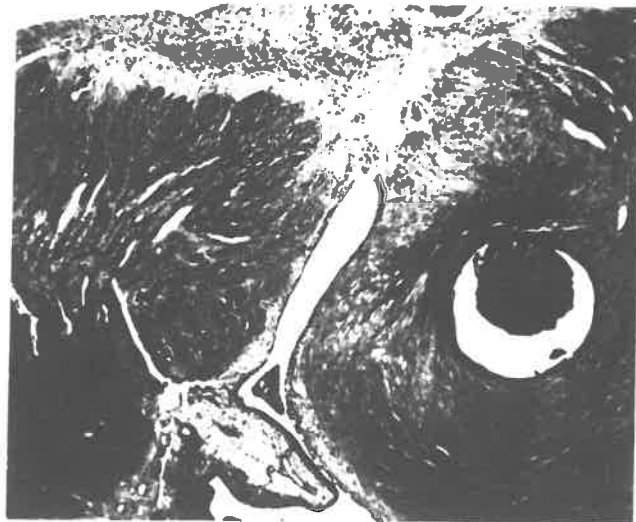


Fig. 37.

EXPERIMENTAL FINDINGS WITH VARIOUS SUTUREMATERIALS

During the course of these experiments an endeavour was made to evaluate the effects of various suture materials in relation to the uterine wound healing. Materials used were cat gut, either plain or chromic, linen thread, braided silk, and fine tendon wire. Atraumatic needles on 2/0 and 4/0 plain or chromic gut were used in thirteen animals, linen thread in three, braided silk in two, and fine tendon wire in one. The uterine repair techniques were kept standard, as already explained, so that variations in healing and local reactions to the various materials could be studied.

Cat gut: The wounds in these uterine horns were not able to be covered with peritoneum as in the human lower segment operation, so that various degrees of adhesions between omentum and the uterine horns were not unexpected. The use of cat gut, whether plain or chromic, was associated with the fewest adhesions.

The least histological tissue reaction was seen when chromic cat gut was used, except in the case of tendon wire. In many cases fine chromic gut

caused no obvious reaction, the chromic gut being very slow to absorb in most cases could often be seen intact 8 - 10 weeks after its use. (Figs. 38, 39). Plain cat gut was associated with more tissue reaction than chromic. (Fig. 40). It disintegrated earlier in most cases, so that it could not be found in many sections taken through horns where it was used. These differences could be demonstrated within the same cat. A continuous suture was used in each horn and, after 50 days, the 2/0 plain gut had been absorbed, while the 4/0 chromic was still intact.

Linen Thread: This was used in three animals and external adhesions were the rule. In some the tissue reaction was excessive, as judged by round celled infiltration and giant cells. The strands appeared to break up early. (Figs. 21, 22).

Silk: Braided silk was used in two animals. Adhesions were again the rule, and when a continuous suture was used a conglomerate mass of silk developed as the uterine horns involuted. The strands of silk seemed to disintegrate early, and the general structure was quickly lost, with much surround-

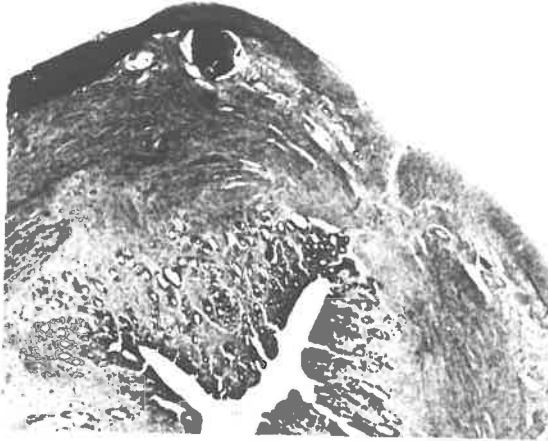


Fig. 38.



Fig. 39.



Fig. 40.



Fig. 41.

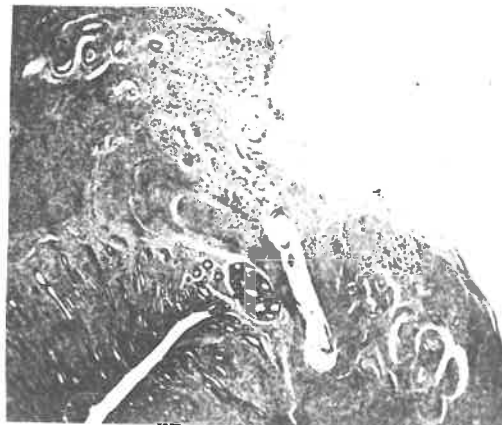


Fig. 42.

ing reaction. (Fig. 41).

Wire: These interrupted sutures had to be very carefully removed before section cutting was possible. Wire was used in one animal only. There was no tissue reaction seen around the site of the wire (Fig. 42). The external adhesions were excessive. A high power view of Fig. 42 shows absence of reaction (Fig. 43). whilst a high power view of the silk suture shows the giant celled reaction to a foreign body (Fig. 44).

From this aspect of the study it may therefore be concluded that fine chromic cat gut, used either as continuous or interrupted sutures, produced the least tissue reaction in the scar area and the minimal amount of external adhesions. Interrupted sutures gave the impression of allowing the involution to occur more evenly than when a continuous suture was used.



Fig. 43.

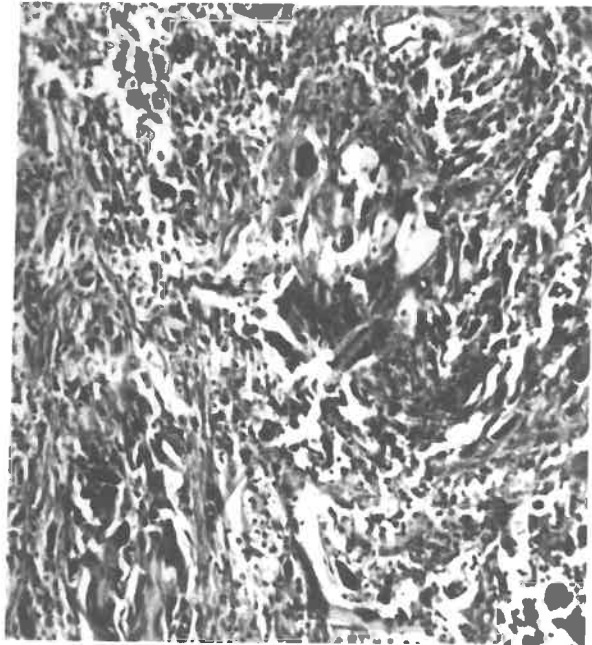


Fig. 44.

GENERAL CONCLUSIONS FROM EXPERIMENTAL WORK

The facts which have resulted from this series of caesarean sections in animals with double horned uteri can be enumerated thus:

1. A repair technique which completely excludes the decidua gives the neatest histological healing.
2. A repair technique which includes the decidua produces a deformed uterine scar with great consistency, namely in fourteen out of eighteen horns.
3. Fine chromic cat gut produced the neatest histological wounds of all materials used.
4. Chromic cat gut was associated with fewer and smaller omental adhesions than other suture materials.
5. The most massive adhesions were associated with the use of wire and linen thread.
6. A deliberately induced localised abscess adjacent to one uterine scar seriously interfered with the healing process.
7. The cat is a better animal for this type of uterine work than the rabbit.

SIGNIFICANCE OF ANIMAL FINDINGS

AND

THE HUMAN PROBLEM

SIGNIFICANCE OF THESE FINDINGS AND THE HUMANPROBLEM

Are we entitled to transfer this hypothesis, sustained in the cat and the rabbit, to the human uterus? In general terms, conclusions which concern chemical reactions or physiological processes in animal work have to be regarded with much caution before they can be applied to the human and, in some cases, may be completely misleading. However, it may be argued here that findings which concern myometrial healing in the cat could be quite relevant within the human myometrium because the basic physiology of healing is known to be common to both. Whether this point is conceded or not, the essence of this work emphasises the part played by technique alone, within the one animal.

Such an experiment is never likely to be conducted within the human myometrium in the one individual. To have the same set of controlled conditions one would have to postulate a double uterus, pregnant in both horns, and both to be delivered by caesarean section. Furthermore, the likelihood of recovering such a double uterus within

a reasonable time of delivery for complete histological study of the different closure technique used in each horn would not appear to be within the realms of possibility.

In the human, therefore, any studies of uterine healing must overlook such a control system within the one individual. The only two approaches that are available concern either histological examinations of caesarean section scars in uteri that have been the subject of hysterectomy some time after the caesarean section, or the development of some indirect method of making an examination of the scar area while the uterus is still in the pelvis. The first approach, that of waiting, perhaps up to half a life-time, for the recovery of a uterus, in order to submit it to histological scrutiny is too slow for our present requirements of knowledge. It is also too indefinite scientifically, because so many of these cases would disappear from follow-up, and even those who did not would have had to be conducted personally for accurate documentation of the precise technique used at the caesarean section. Nevertheless, as time goes by some such cases will and have appeared in my personal records. To date, I have nine of my own hysterectomy specimens from

women upon whom I had previously performed caesarean section deliveries, and these will be presented in some detail a little later. (Appendix B).

The second approach, namely the development of some indirect method by which the uterine healing may be measured in vivo, has been studied with much interest since 1956. A hystero-graphic method has been developed and used in more than two hundred human cases since that date. The method has been proved reliable and evidence will be presented to support this. (Appendix A). It is simple and occasions the woman little inconvenience. It produces a direct outline of the caesarean section scar area by the use of a contrast medium and X-rays. In this way it is possible to measure accurately any deformity, and to show failure of healing by the presence of a leakage of the contrast medium through the scar area. This hystero-graphic method has been used to test various uterine closure techniques. In particular, it has shown up a great difference between the closure technique used in the earlier years of this study and the modified technique of the later years. This clinical study will be presented following the description of the method.

HYSTEROGRAPHIC METHODS

HISTORY AND DESCRIPTION

DEVELOPMENT OF THE HYSTEROGRAPHIC METHOD

Baker (1955) was the first to publish any results of a hystero-graphic study after caesarean section. He manually examined the interior of the uterus of 64 patients who had vaginal deliveries following previous lower segment operations, and reported 53 as having a "sound scar". In 24 of his 64 patients he obtained hystero-grams about three months after the vaginal delivery. He was able to demonstrate a deformity in the lower anterior wall of the uterus in only 5 cases out of 24.

One's own experience of manual exploration of a previously sectioned uterus immediately following a vaginal delivery has been inconclusive. The soft and flabby state of this lower segment area at this time makes any firm conviction regarding the scar area very doubtful. It was therefore decided to concentrate on an X-ray technique which would accurately outline the scarred area in both the lateral and antero-posterior views, this examination not to be done before six months had elapsed since the caesarean section. By this time the healing was assumed to have been completed and the final shape of

the scar area determined.

DESCRIPTION OF HYSTEROGRAPHIC TECHNIQUE

All hystero-grams were done in the first half of the menstrual cycle. A vaginal examination was done following the taking of a short history. The patient was then placed in the left lateral position on the X-ray table and so positioned that the central ray would pass through the femoral heads. The thighs were flexed and a pillow placed between her knees. A bivalve vaginal speculum was next inserted, with the usual aseptic precautions and the anterior lip of the cervix gently grasped with a fine toothed tenaculum. A screw-in metal cannula with a wide cervical head of the Leech-Wilkinson type, previously filled with the contrast medium, was then used to procure a tight fit. Several different sized heads were always available and a suitable one chosen for each individual cervix. The contrast medium finally decided upon for this work was a viscous iodised oil (Lipiodol Lafay) and this has been used in all the cases in this study.

Having obtained a tight fit within the cervical canal, a 10 ml. syringe was then joined to the cannula, using an appropriate adaptor. Under direct vision 1.5 millilitres of Lipiodol was then

injected to confirm free flow and no leakage. A protective lead shield with a small slit in its lower edge was next dropped into place for the protection of the operator, the cannula and tenaculum projecting through the slit. A further 4 mls. were then slowly injected and, as the last millilitre was being injected, the exposure was made. It has always been considered an essential part of the technique to keep up a positive pressure within the uterus whilst the picture was taken. At this point the radiographer developed this film, and only after it was found to be satisfactory would the patient be placed in the dorsal position with her thighs flexed, the cannula and speculum having been carefully retained in position during the move.

With the protective screen repositioned, the radiographer rearranged the direction of the central beam, according to whether the uterus was in anteversion or retroversion. The bivalve speculum was next withdrawn almost to the introitus, and a further 2 mls. of Lipiodol injected, and a further film taken as the second millilitre was being forced into the uterus.

These two films were taken on all patients. The amount of contrast medium already mentioned was

found to be best. Too little failed to properly outline the uterus, too much caused excessive tube filling and peritoneal spill. No untoward reactions have been encountered in this series, and no morbidity has resulted from this examination.

The X-ray exposure details for the lateral position were KV90; MA200; time 1 second, anode film distance 44 inches; Bucky ratio 8 to 1; Target area 2 mm square; Du Pont Hi-speed thick screen, using Gold Seal film and phenisol developer. The area of radiation was restricted to 12" x 10" with the aid of a Videx Palmer light beam diaphragm, and total filtration of tube and diaphragm approximated the equivalent of 5 mm of aluminium. The antero-posterior position required $72\frac{1}{2}$ to $77\frac{1}{2}$ K.V., time 0.5 second, 200 M.A., 44 inches distance and 12" x 10" film with other details as for the lateral film.

CLINICAL STUDIES

EARLY STUDIES

LATER STUDIES

RESULTS

DISCUSSION

EARLY CLINICAL STUDIES

The work was done on patients of the ward service of the Queen Victoria Maternity Hospital, Adelaide. At the same time as the hystero-graphic investigations were begun on patients after caesarean section delivery, a control series was begun. For this control, primigravid women who had normal vaginal deliveries were asked to volunteer for X-ray examination. Thirteen such women were examined six months after the natural birth. During the first year's work, forty three women who had caesarean sections volunteered for the examination. All except four of this original group had the caesarean section operation done at the Queen Victoria Maternity Hospital, by various members of the staff.

The findings from this pilot study were most conclusive in the following respect. The hystero-graphs from the women in the control group all showed perfectly normal internal uterine outlines. A regular smooth contour extending from the tip of the canula up into the fundus of the uterus was demonstrated in all 13 cases. This was so, even if the uterus were in retroversion. Typical examples of this control group are shown in Figs. 45 and 46.



Fig. 45.

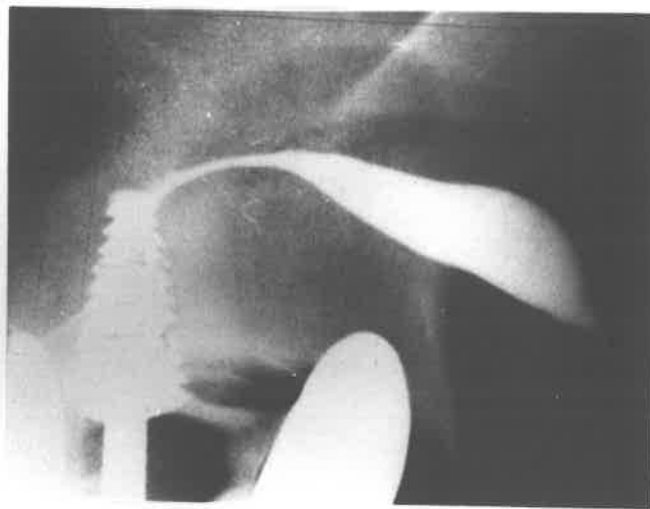


Fig. 46.

The hystero-grams from the 43 women who had previous caesarean sections all showed some deformities in the uterine outline. Those who had lower segment transverse incisions showed various degrees of deformity in the lower anterior uterine wall at the site of the incision. (Figs. 47, 48). One uterus, which had been subjected to a classical type of caesarean section, showed a massive deformity along the whole of the anterior wall of the body of the uterus (Fig. 49).

In order to prove that the deformities being demonstrated were, in fact, resulting from the caesarean section area, an attempt was made to localise the internal os in the following way. With the patient in the lateral position on the X-ray table a uterine sound was introduced into the cervical canal until the resistance of the internal os was felt. An exposure was then made. The sound was next removed and without disturbing the position of the patient, the cannula was screwed into the cervical canal, Lipiodol injected, and a further exposure made. These two developed films were then superimposed in exact anatomical register, giving the result shown in Figs. 50, 51. The area of deformity can be seen to be above the tip of the cannula. The level of the deformity varies quite

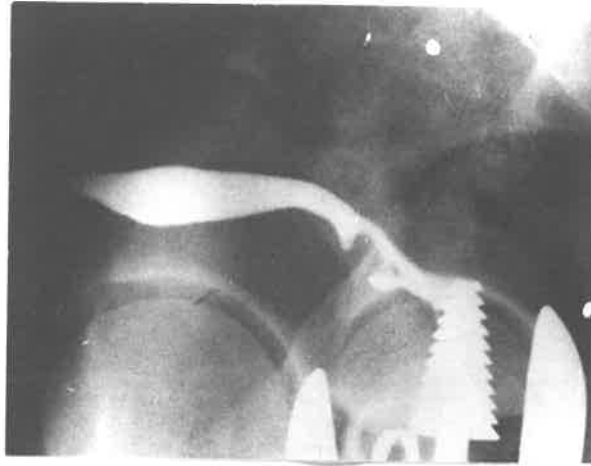


Fig. 47.

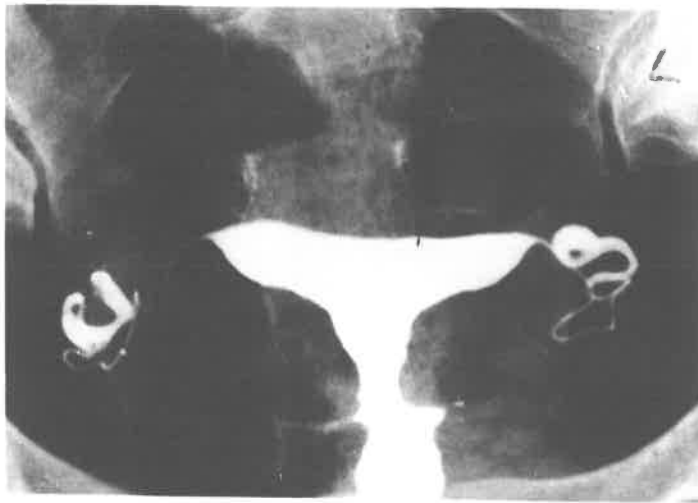


Fig. 48.



Fig. 49.

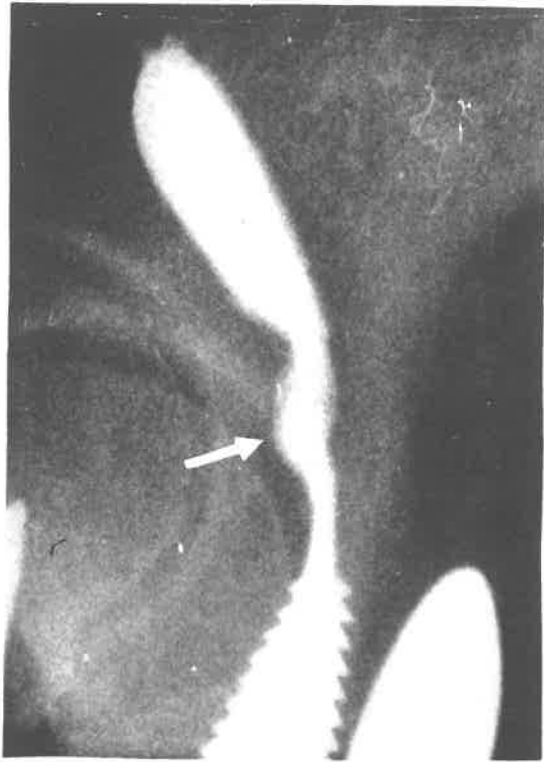


Fig. 50.

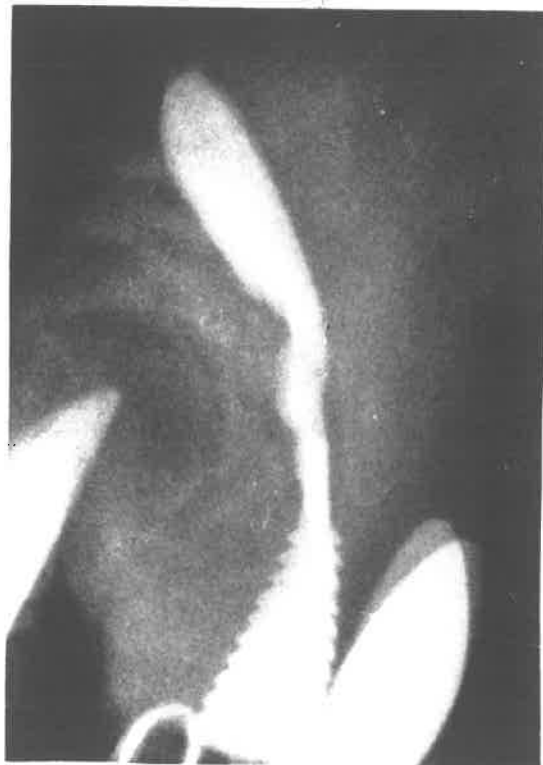


Fig. 51.

considerably because of the actual level of the incision in the uterus. In some cases, in obstructed labour, when the lower segment has been well stretched out, quite often the resultant deformity has been noted very low. In others, not in labour at the time of the section, the resultant scar deformity may be quite high. An actual specimen of a uterus subsequently removed shows a high position of the scar. (Fig. 52). Five cases were used for this particular experiment using the cannula to localise the internal os area.

From this original pilot study it was realised that many different types of deformity could result from the operation. In order to make some arbitrary levels the deformities were graded into small and large, depending on whether they were less than 5 mm in depth or over 6 mm. Five cases in this original study could not be safely interpreted, mainly for technical reasons, so that they were not included in the totals. Of the remaining 38 cases, twenty seven had small and eleven had large deformities. It should be noted particularly that all the 38 cases showed deformities.

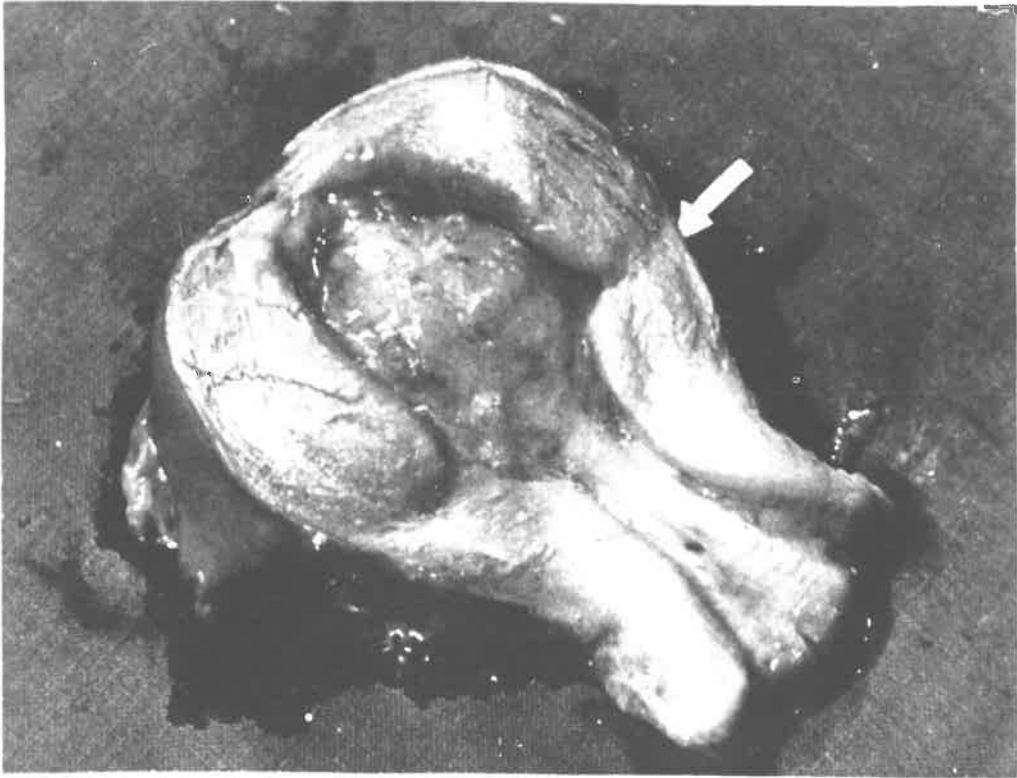


Fig. 52.

CONCLUSIONS

The conclusion from this pilot study showed:

1. Normal uterine outlines were demonstrated in all the control group of primigravid women who had had normal births.
2. Abnormal uterine outlines were demonstrated in all uteri which had been subjected to caesarean section.

Further, it was noted that there was no apparent detectable relationship between the uterine deformity and the many variables such as age, parity, indication for the section, post-operative pyrexia, abdominal wound healing, or operative technique.

The results of this study were published in 1958 (Poidevin and Bockner). Since that time several groups of workers have published confirmatory papers (Benzi et al. 1962, Lonnberg et al. 1962, Obolensky et al. 1963, Waniorek, 1963). The studies of Lonnberg, Obolensky and Waniorek confirm in exact detail the conclusions just enumerated. Le Page et al. (1959) studied 22 uteri by hystero-graphy and found 11 cases with minor deformities and 11 with more extensive ones. Varangot et al. (1959) found 10 deformities in 25 cases.

DISCUSSION

These findings (Poidevin and Bockner, 1958) were important because they made a considerable advance on those of Baker (1955). No previous study had been published on such a large series, all conducted six months or later after the caesarean section. The lateral view was emphasised and a reliable technique had been established.

However, many questions remained unanswered.

Namely:

1. Why was there always a deformity in the section scar area?
2. If this deformity was not related to age, parity, post-operative pyrexia and abdominal wound healing, could it possibly be related to the technique of closure of the uterus?
3. Is it possible to use such a technique for uterine closure that will produce a hystero-gram free of deformity?
4. Could the large deformities which were thought to represent a considerable leakage of contrast medium from the uterine cavity be demonstrated at subsequent caesarean section?

Two main requirements were obvious.

Firstly, a much larger series would need to be studied, with particular emphasis being placed on any relationship between the actual technique of closure of the uterus, as well as that between other factors, such as age and post-operative convalescence. Secondly, animal experiments to illustrate the part played by technique. No publications of any animal studies comparing various techniques of closure of the uterus could be found in the literature.

Since this pilot study in humans was completed a further 166 cases have been studied, thus making a total of 209 for detailed examination. Animal experiments have been done using pregnant cats and rabbits and have already been presented earlier in this thesis.

Therefore, the hypothesis must concern itself with the relationship between the technique of uterine closure and subsequent uterine deformity as measured by hystero-graphy. With the conclusive animal experiments in mind it was postulated that:

THE NEATER THE UTERINE REPAIR TECHNIQUE
IN THE HUMAN, THE LESS DEFORMITY THERE
SHOULD BE IN THE HYSTEROGRAM.

LATER CLINICAL STUDIES

Since 1958 a few minor modifications have been made in the X-ray technique. The actual film used has been changed and the exposure and developing times have been slightly adjusted. Otherwise the method used and the contrast medium have remained constant. The same radiographer has actually positioned every patient and taken every film. The same nursing sister has been in attendance at every examination. I, personally, have done over 100 of the injections and have supervised all the others, done by a succession of obstetric registrars.

Approximately the same rate of caesarean section delivery has operated in the ward service at the Queen Victoria Maternity Hospital over the study period. The caesarean sections have been done by many different members of the staff (22 different operators in all). In each case, however, the actual details of the closure technique have been recorded and full records of the post-operative course have been accurately kept. A few private patients, referred by their own practitioners for hystero-graphy, have been included in the larger group.

Although all women having caesarean sections were contacted six months later for hystero-graphic study, only about one in every three presented for examination. The large loss was due to several factors, either another pregnancy, the patient had moved interstate, or otherwise was lost, or, in some cases, just no response to the requests. There were very few refusals after an explanation had been given as to the purpose of the examination.

The findings of this larger series are mainly in keeping with those of the smaller pilot study as regards age, parity, post-partum pyrexia, and abdominal wound healing, in respect of the hystero-gram deformity. However, they differ in one main respect. A very close relationship between technique and the X-ray findings has been demonstrated. The more exact suturing methods used in the latter part of the study period have frequently produced hystero-grams with no deformities, and which are indistinguishable from those of women who have had only vaginal deliveries. The animal experiments, which were so conclusive as regards the importance of technique, have had some influence on the closure of the human uterus, particularly as regards neatness, exclusion of the decidua and the use of interrupted sutures.

From the available details in the records of the cases in the pilot study, it is apparent that the recognised method of uterine closure was to use a continuous suture, usually of No. 2 plain cat gut, and to quickly cobble the gaping wound edges together, using large bites through all layers, and to pull the suture quite firmly for haemostatic purposes. This was quick, and saved blood in some cases. The second layer, again, was usually a continuous plain cat gut suture in the more superficial layers of the myometrium which covered the first layer. The bladder peritoneum was then replaced. In some case records no details of closure were mentioned, and in the four cases who had their caesarean sections elsewhere, no details were available. However, knowing that most operators during the 1950's used this rapid all-inclusion technique and, from knowledge since gained, it is a reasonable assumption that all these early cases were closed in the way just outlined. It should be stressed that all cases in the pilot study showed some deformity.

In the second part of the study, when many operators were making every endeavour to repair the uterine edges with more finesse and with a greater emphasis on neatness, there began to appear much

better hysterograms. It will be apparent from a study of the results that the most perfect hysterograms were, in general, associated with a neat apposition, using interrupted chromic cat gut sutures and excluding the decidua from the suture. At times a very good result has been shown after a continuous suture was used, and also even in some cases where the decidua was reported as being included. However, those cases do not detract from the general findings, because the emphasis in the latter part of the study has been primarily on neatness and exactitude, rather than speed, irrespective of the actual details. An example of the decidual exclusion suture in the human uterus is shown being inserted in Figure 53.

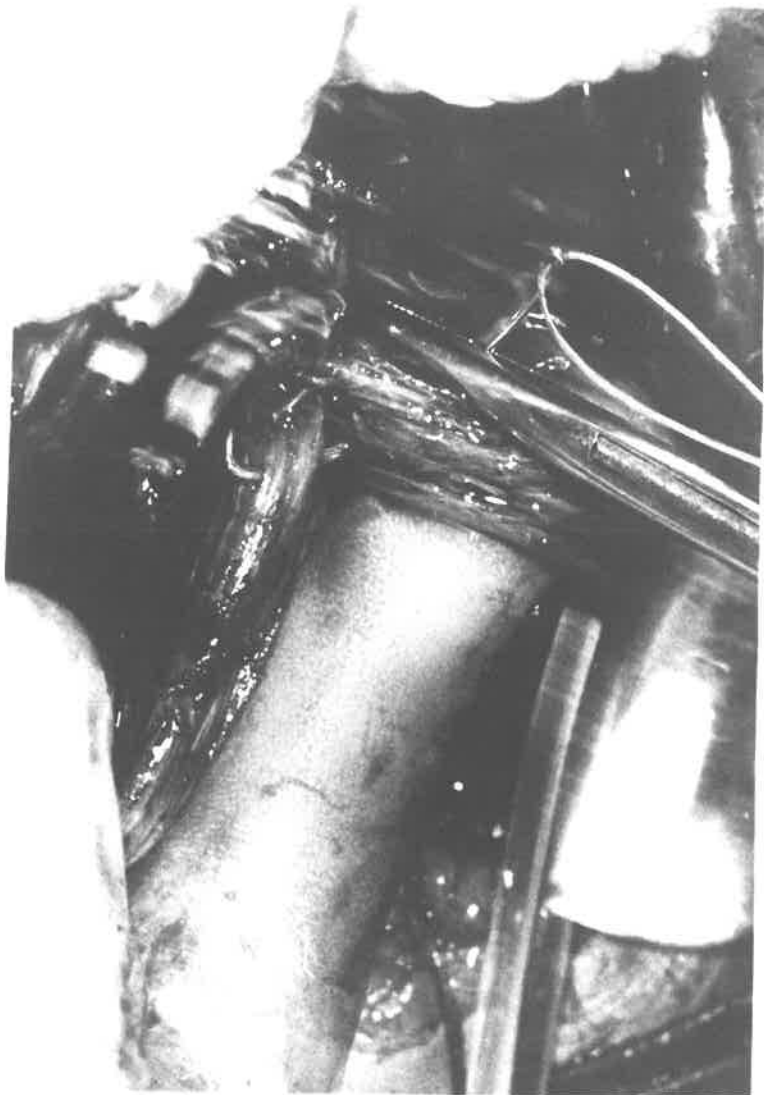


Fig. 53.

RESULTS

In order to assess the results in terms of relationship, a punch card was devised for recording the following information:

Hospital number

Surgeon (by code number)

Suture material

Continuous or interrupted stitch

Inclusion or exclusion of decidua

Post-partum pyrexia

Presence of a sinus

Grade of deformity: mild, moderate,
severe.

The grading of the deformity was altered from that used in the pilot study. It seemed more appropriate to include three grades, rather than two, and all the cases in the pilot study have been regraded for the purposes of this total study. Mild deformities have been recorded as those of 2 mm. depth or less (Figs. 54, 55, 56), moderate deformities from 3 mm. to 6 mm. (Figs. 57 - 62), and severe deformities, those of 6 mm. or more (Figs. 63, 64, 65). Perfect results have been recorded, when no deformity



Fig. 54.



Fig. 55.



Fig. 56.

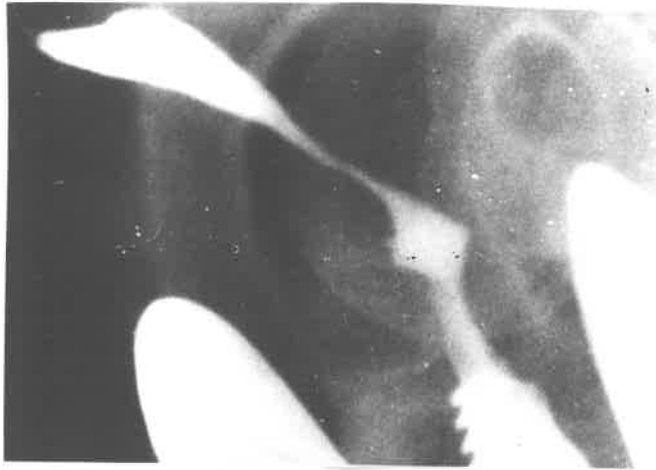


Fig. 57.

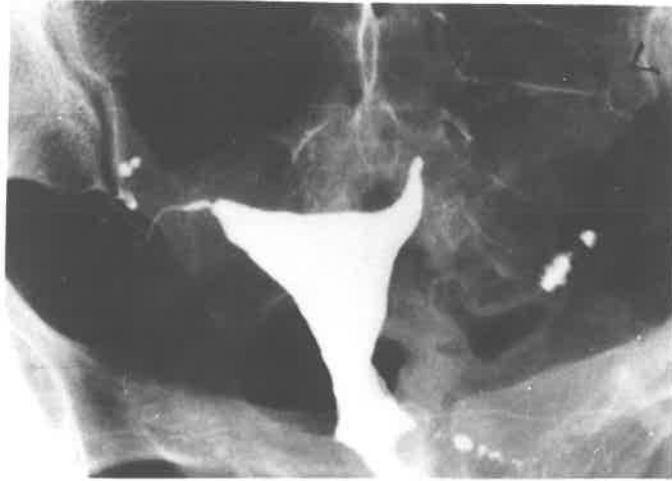


Fig. 58.

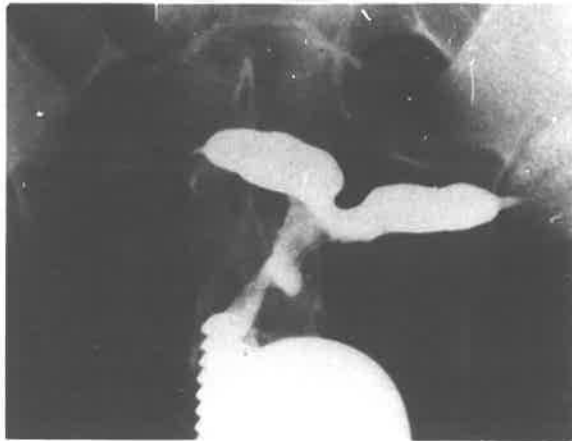


Fig. 59 .

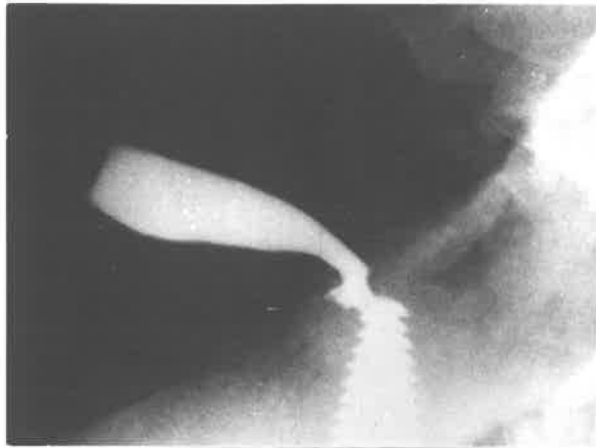


Fig. 60.

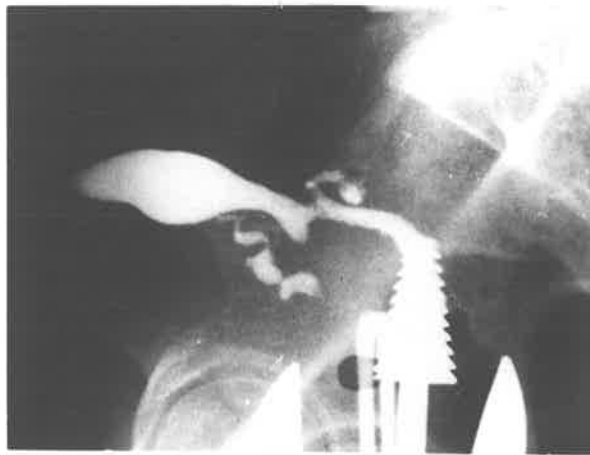


Fig. 61.



Fig. 62.



Fig. 63.

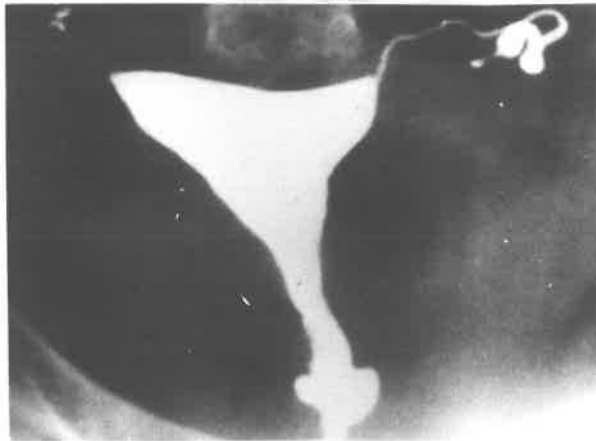


Fig. 64.



Fig. 65.

at all was apparent (Figs. 66, 67). The measurements were made on the actual X-ray films.

The presence of a sinus was recorded when it was apparent that contrast medium had escaped through a deficiency in the uterine scar and tracked away from the uterus. Examples of this are shown in Figs. 68 - 72.

Post-partum pyrexia has been recorded according to whether or not there was a temperature of 100.4° F. on two occasions within a 24-hour period during the convalescence, irrespective of etiology. It was found to be too inexact for this purpose to further subdivide the many causes of the post-partum fever.

When this information was punched out on the cards, the following relationships could be established:

Two cases from the 166 in the second portion of this study were unable to be classified for technical reasons and have thus been rejected.



Fig. 66.



Fig. 67.



Fig. 68.

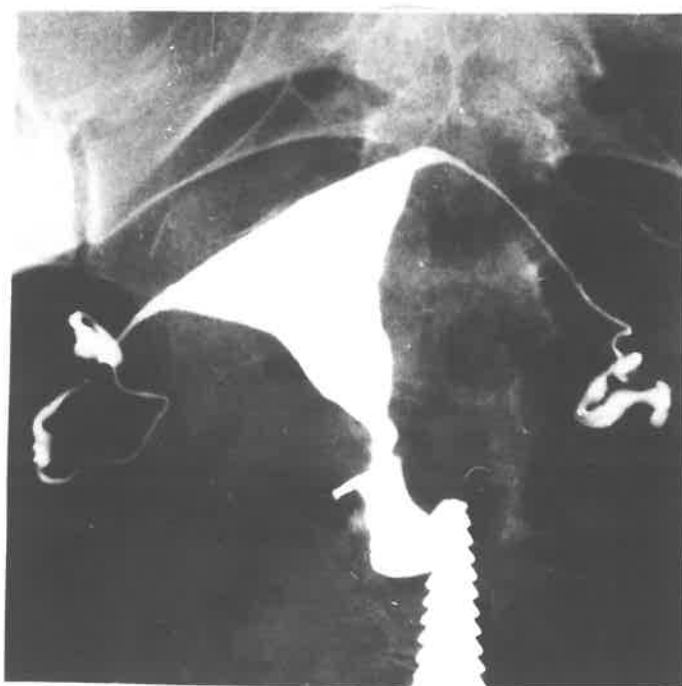


Fig. 69.

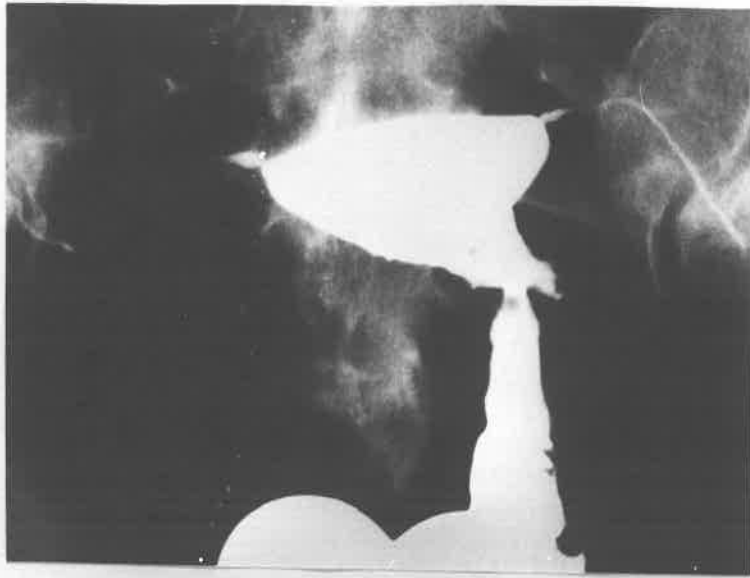


Fig. 70.



Fig. 71.

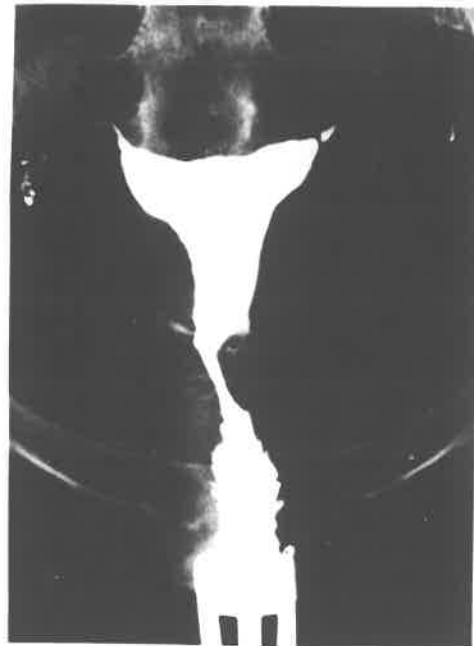


Fig. 72.

FINDINGS FROM TOTAL CLINICAL STUDY

Number of cases examined (excluding controls)

209

Cases rejected as unsuitable for classification

7

Total number for study

202

38 in pilot study

164 subsequently studied

TABLE 1. CLASSIFICATION OF HYSTEROGRAPHIC FINDINGS OF THE WHOLE GROUP.

Perfect	=	43
Mild deformity	=	60
Moderate deformity	=	85 (4 with sinuses)
Severe deformity	=	14 (8 with sinuses)

COMMENT:

The twelve cases with "sinuses" all exhibited a leakage of contrast medium giving an irregular track of the dye. Figs. 68 - 72 are examples. In several of these cases it has been possible to confirm the actual deficiency in the scar at a subsequent caesarean section. (See Appendix A).

As well as classifying the results into the four detailed grades shown in Table 1, they may also be grouped more simply into "good" or "bad". This gives a good working definition. Those cases classified as "perfect" and "mild deformity" can well be considered together as "good", and those classified as "moderate deformity" and "severe deformity" can be considered "bad". This will be done in each table to follow.

TABLE 2. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND DECIDUAL DESTINATION.

Decidual Inclusion Technique

Number of cases = 127

Perfect	--	2	} good = 27%
Mild	--	32	
Moderate	--	79	} bad = 73%
Severe	--	14	

Eleven cases of "sinuses" occurred in this "bad" group.

---o0o---

Decidual Exclusion Technique

Number of cases = 75

Perfect	--	41	} good = 92%
Mild	--	28	
Moderate	--	6	} bad = 8%
Severe	--	0	

One case of "sinus" occurred in this "bad" group.

COMMENT:

The figures indicate a close relationship between the best hystero-graphic findings and the decidual exclusion technique. The figures do not indicate, however, that the emphasis on the decidual exclusion technique affected the cases in the latter half of this study, and particularly following the ~~evidence from the animal experiments.~~ There is no doubt that simultaneously with the attempt to exclude the decidua there was automatically a greater emphasis on neatness generally. It is therefore impossible to attribute the outstandingly improved results to the decidual exclusion technique alone, but nevertheless, it cannot be denied that it has played a most important role.

It must be noted also that 43 cases have been reported as "perfect" in the total study, whereas in the early pilot study there were none. Thus, from the emphasis on neatness in the latter part of the study has resulted 43 perfect results from 164 operations, an incidence of 26%.

There were twelve cases found in the whole study which showed leakage of contrast medium, indicating a sinus track, and eleven of these occurred among the decidual inclusion group.

TABLE 3. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND THE USE OF CONTINUOUS OR INTERRUPTED SUTURES.

Cases closed with a continuous suture = 169

Perfect	--	23	}	good = 43%
Mild	--	49		
Moderate	--	83 (4 with sinus)	}	bad = 57%
Severe	--	14 (8 with sinus)		

Cases closed with an interrupted suture = 33

Perfect	--	20	}	good = 94%
Mild	--	11		
Moderate	--	2	}	bad = 6%
Severe	--	0		

COMMENT:

Many more cases were closed with a continuous suture than an interrupted, for several reasons. In the presence of bleeding sinuses it often appears more prudent to the operator to hurry along the closure for haemostatic reasons. Thus speed and haemostasis are important factors in this decision. Thirdly, I do not believe many operators have been as impressed as I have that neater healing can be expected in this rapidly involuting scar area when interrupted sutures are used. I, personally, believe the continuous

suture material must become considerably contracted within a few days during the normal process of involution, whereas interrupted sutures should produce less distortion during this shrinking process. Thus, most of the cases in which interrupted sutures have been used have been personal ones. The other reason for the greater number of continuous suture cases is that in the first half of the study all operators used a continuous all-inclusion suture for the first layer.

Although there are fewer cases, there are sufficient to make the finding significant that better results can be obtained with a neat, interrupted suture technique in the first closing layer. There is also good evidence that perfectly neat results can follow the use of a continuous suture technique, but not as often.

The twelve cases showing sinuses all occurred in the group repaired with a continuous suture. Twelve cases in 169 is an incidence of 1 in 14. Applying this same incidence to those repaired with interrupted sutures (33), there should have been two cases of sinuses, but none developed.

Lonnberg and his colleagues (1962) reported good scarring in 43.4% of cases when interrupted

sutures were used and 29.03% when a continuous suture was used for the first closure layer. Their study involved 54 cases, and Lipiodol was their preferred contrast medium.

TABLE 4. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND TYPE OF SUTURE MATERIAL.

Chromic cat gut = 155 cases

Perfect	--	41	}	good = 60%
Mild	--	52		
Moderate	--	55 (2 sinuses)	}	bad = 40%
Severe	--	7 (4 sinuses)		

Plain cat gut = 41 cases

Perfect	--	0	}	good = 15%
Mild	--	6		
Moderate	--	28 (2 sinuses)	}	bad = 85%
Severe	--	7 (4 sinuses)		

Other material = 6 cases

Perfect	--	2
Mild	--	2
Moderate	--	2
Severe	--	0

COMMENT:

The findings significantly favour chromic cat gut. It must be remembered that plain cat gut was used in the earlier part of this total study when other bad factors were also operating, so that the difference may not be as great as appears.

The incidence of sinus formation was greater when plain cat gut was used, namely 6 cases in 41, as against 6 in 155 with chromic gut.

The other materials, mainly linen, were used in too few cases to allow conclusions.

Greenhill (1962) stated: "I fully agree with Poidevin that wound failure after cesarean section is very common, that the decidua should not be included in the closing sutures and that fine chromic catgut is the best suture material. In former years, when infections after cesarean sections were fairly common, I urged the use of interrupted sutures in all cases."

TABLE 5. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND POST-PARTUM PYREXIA.

<u>Cases with Post-partum Pyrexia = 45</u>				
Perfect	--	9	}	good = 51%
Mild	--	14		
Moderate	--	20 (2 sinuses)	}	bad = 49%
Severe	--	2 (2 sinuses)		
<u>Cases with no Post-partum Pyrexia = 157</u>				
Perfect	--	34	}	good = 51%
Mild	--	46		
Moderate	--	65 (2 sinuses)	}	bad = 49%
Severe	--	12 (6 sinuses)		

COMMENT:

The incidence of post-partum pyrexia was noted to have been spread fairly evenly over the years of this study and represents 22% of all caesarean section cases. The causes have ranged from breast engorgement, upper respiratory tract infections, renal and genital tract infections and thrombophlebitis to abdominal wound infection and other rarer causes. From a close study of each case, no evidence has been found which could relate any of the abdominal wound infections with a higher incidence of hystero-graphic deformities.

The figures show an identical incidence of "good" and "bad" results in the two groups, so that the presence of puerperal pyrexia, from whatever cause, would appear to have no influence on uterine wound deformity.

There is, however, an incidence of sinus in the uterine scar of 1 in 11 in the pyrexial group and 1 in 20 in the apyrexial group.

TABLE 6. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND THE DECIDUAL EXCLUSION TECHNIQUE WITH INTERRUPTED OR CONTINUOUS SUTURES.

Decidual exclusion + interrupted sutures:

<u>Number of cases</u> = 30		
Perfect	-- 20 (66%)	} good 100%
Mild	-- 10	
Moderate		
Severe		

Decidual exclusion + continuous suture:

<u>Number of cases</u> = 45		
Perfect	-- 21	} good = 87%
Mild	-- 18	
Moderate	-- 6 (1 sinus)	} bad = 13%
Severe	-- 0	

COMMENT:

The 30 cases in which care was taken to exclude the decidua and in which interrupted sutures were used have produced 20 hystero-grams with perfectly normal outlines and 10 with minor wedging deformities. Although the numbers are not large, they indicate the most successful technique so far used. The use of continuous sutures produced excellent results also, but 1 sinus was found in this group.



TABLE 7. RELATIONSHIP BETWEEN HYSTEROGRAPHIC FINDINGS AND THE DECIDUAL INCLUSION TECHNIQUE WITH INTERRUPTED OR CONTINUOUS SUTURES.

Decidual inclusion + interrupted sutures:

Number of cases = 3

Perfect	--	0
Mild	--	1
Moderate	--	2
Severe	--	0

Decidual inclusion + continuous sutures:

Number of cases = 124

Perfect	--	2	good = 27%
Mild	--	31	
Moderate	--	77 (3 sinuses)	bad = 73%
Severe	--	14 (8 sinuses)	

COMMENT:

The decidual inclusion technique using a continuous suture produced the worst hysterographic results. This was the method used in the earlier part of the study when the older fashioned "cobbling in haste" technique was used in most cases. As has already been indicated, if the same desire for neatness had been evident in the earlier study even this technique of decidual inclusion and a continuous suture may not have appeared as bad as these figures indicate.

PROGRESSIVE HYSTEROGRAPHIC STUDY

There are three women who were subjects of the early pilot study and who later had another caesarean section and became part of the later study. They were each personal cases in which their first caesarean section was done using a decidual inclusion technique with continuous plain cat gut. Their next caesarean sections were repaired with a decidual exclusion technique using interrupted chromic cat gut sutures. The hystero-grams show the level of improvement. These three cases will be presented.

Case J.B., Q.V.M.H. 738, aged 28.

The first hystero-gram was taken in April 1956 following a caesarean section in February 1955, and showed a medium sized deformity in both lateral and antero-posterior views, Figs. 73, 74.

Caesarean section in February 1960 allowed excision of the old scar and as neat an apposition as possible using interrupted sutures, excluding the decidua. A hystero-gram taken in September 1960 showed a considerable improvement. Figs. 75, 76.



Fig. 73.



Fig. 74.

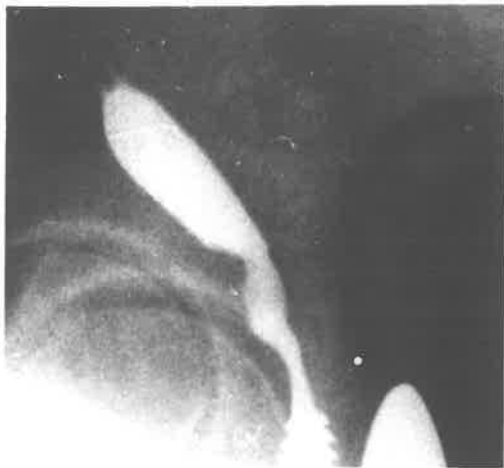


Fig. 75.

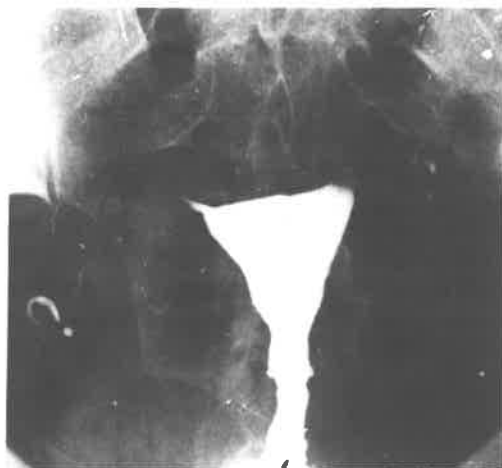


Fig. 76.

Case M.L., Q.V.M.H. A/425, aged 32.

The first hystero-gram taken in August 1958 followed a caesarean section in 1957. A sinus was associated with a marked deformity seen in both views. (Figs. 77, 78). A repeat section was done in December 1959 because of this major degree of deformity and a "window" was found in a very thin scar. Excision of portions of the old scar and as neat a repair as possible was done, excluding the decidua with interrupted sutures. A second hystero-gram in June 1960 showed a greatly improved anterior wall almost as perfect as those seen after vaginal delivery. The antero-posterior view was also excellent. Figs. 79, 80.

Case A.T., Q.V.M.H. 825, aged 38.

After her third caesarean section in March 1957, for a contracted pelvis, a hystero-gram was done in September 1958. The old scar had been easily seen at operation and the wound was repaired with No. 2 plain cat gut using an all layer inclusion technique. The hystero-gram showed a medium sized deformity, Fig. 81. In October 1959 a fourth caesarean section was done, the old scarred area, which was thin,



Fig. 77.

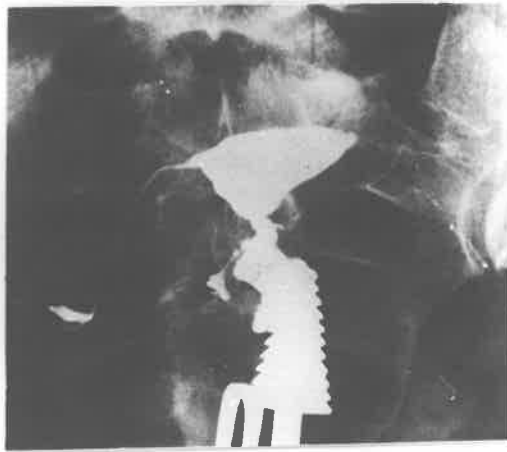


Fig. 78.



Fig. 79.

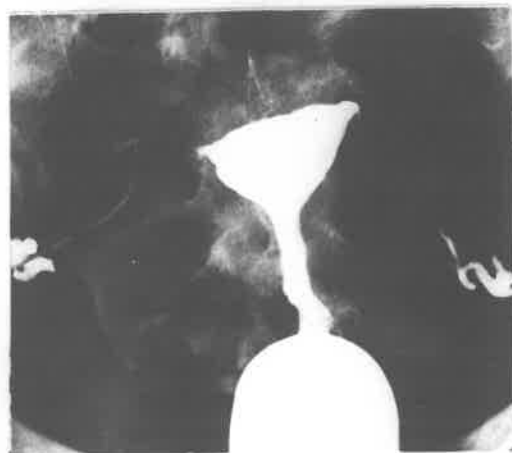


Fig. 80.



Fig. 81.



Fig. 82.

was excised, and the edges united using interrupted sutures and excluding the decidua as well as possible. In June 1960 the hysteroqram showed some improvement. (Fig. 82). This case does not demonstrate a great improvement, but then it is probably a little unfair to judge, in view of the multiple sections. However, there was some improvement demonstrated.

DISCUSSION OF CLINICAL STUDIES

From an analysis of this long clinical study there has developed support for the hypothesis. Sufficient evidence has been produced to prove a close relationship between technique of closure and subsequent hystero-graphic findings. The results presented in the tables show quite clearly that with greater attention to details of closure of the uterus, better results, as measured by hystero-graphy, can be produced. Three cases have been documented to show the progressive improvement which can be achieved in the same uterus with better techniques.

The hypothesis has therefore been sustained.

CONCLUSION

CONCLUSION

From this long term study of caesarean section scars, both in domestic animals and human beings, there emerge several positive findings.

In the original pilot study of hystero-grams, taken six months or more after caesarean section operations, all the 38 uteri showed some deformity, so that it was possible in every case to differentiate these hystero-grams from those in the control group of women who had vaginal deliveries. Although in some cases the deformities were quite small they were, nevertheless, present in all the section cases, none of them showing the perfect outline of the control vaginal delivery cases.

Following these original findings and while the study was being enlarged to include many more cases, some animal experiments were conducted to study the healing of the uterus in histological detail. From this work it was concluded that the best healing resulted from a careful suture technique using chromic cat gut and deliberately excluding the decidua from the suture. Excellent histological healing was demonstrated in all the animal operations in which this method was used. Not one case showing perfect

healing resulted from the opposite uterine horns in the same animals when a decidual inclusion technique was used.

The findings from this animal study put a greater emphasis on obtaining the neatest possible apposition of the uterine edges in the human and have undoubtedly influenced the results of the latter part of the human study. In the last 164 human cases studied there were 43 cases showing a perfect hysteroqram, that is, 26%.

The detailed tables presented of the human studies clearly demonstrate that the most perfect hysteroqrams resulted from a careful apposition of the uterine edges, using interrupted chromic cat gut sutures and excluding the decidua from the needle track. Almost as good results were obtained with a continuous suture, provided the decidua was excluded. The worst hysteroqrams resulted from the use of a rapid closure technique in a wound, through which there had been difficulty in delivering the baby, using a continuous plain cat gut suture through all layers.

The postulate that the hysteroqrammic findings are directly related to the degree of neatness of the closure technique has been sustained. Answers have also been provided for the questions posed after the

pilot study.

Firstly: There need not always be a deformity in the section scar area.

Secondly: The uterine deformity was not related to post-operative pyrexia or abdominal wound healing, but was related to the closure technique.

Thirdly: It is possible with present knowledge and techniques and favourable conditions to produce a hysterogram free of deformity in 66% of cases (Table 6).

Fourthly: It is possible to confirm the hysterographic findings of large deformities at subsequent caesarean section, if care is taken to search for them. (APPENDIX A)

This study of 202 cases compiled over several years, in which full details have been recorded at the time of the caesarean section, and who have all been subsequently X-rayed using a constant technique and in the same radiographic department, is unique. One of the latest authors (Waniorek, 1963) has published his conclusions (Appendix C) based on 85 examinations, and it will be

seen that they coincide closely with those presented in this thesis. However, he has not attempted to show a relationship between technique and final results.

Post-partum pyrexia following caesarean section has been shown unrelated to the hystero-graphic findings, and would thus appear to have little influence on uterine wound healing. However, there was a higher incidence of sinus tracks in the pyrexial group. There were 45 cases showing post-partum pyrexia and because of the multiple etiologies of the pyrexia, no firmer conclusions are possible.

The objective has been direct. The hystero-graphic examination with its exact findings has been used as the measure of efficiency of any technique. The hystero-graphic method has been proved reliable, not only in our hands, but by many authors throughout the world.

No attempt has been made to use uterine rupture in any way as a measure of any technique. This would virtually be impossible in human work. It may be argued then that all the emphasis on neatness, which has been the essence of this thesis, is unnecessary, for it has not been proved that

clinical rupture of the uterus is more common in the "bad" group of hystero-grams. As there have been only two cases of clinical uterine rupture from previous caesarean section in the Queen Victoria Maternity Hospital in the last ten years, it is most unlikely that any real figures will ever be available on this point. However, as regards "sub-clinical" rupture of the uterus, or, as I have frequently referred to it in the text, "sinus tracks" or "windows", there is abundant evidence that neatness and care lessens their incidence. Twelve such sinuses were seen in these 202 cases, an incidence of 6%, and eleven of these twelve were associated with a "cobbling" type of decidua-inclusion suture. The whole 12 were reported as being closed with a continuous suture. Even if this evidence were unconvincing, then the aesthetic satisfaction alone, of a neat hystero-graphic record, should be one's unchallenged objective.

The impact of these findings during the years of this study has led to the present policy of doing a repeat caesarean section in those cases showing moderate or severe deformities and all those with sinuses. Those cases whose hystero-grams show perfect and mild deformities are usually allowed

vaginal delivery unless there is some other
contrary factor.

Hystero-graphic examination is requested
as an established routine of all women who have
caesarean section at the Queen Victoria Maternity
Hospital. As explained earlier, only one third
actually have the examination. The study
continues.

APPENDICES

APPENDIX AACCURACY OF THE HYSTEROGRAPHIC METHOD

It was mentioned earlier that evidence would be presented to demonstrate the reliability of the hystero-graphic findings. Four cases will now be given in some detail as examples. In each case a major deformity was shown by X-ray and an opportunity was later presented to prove it.

CASE 1. M.V., Q.V.M.H., 11664, aged 31.

This woman had five uneventful pregnancies and labours, after which she had a Manchester-type repair operation. In August, 1956 she had a lower segment caesarean section for the delivery of her sixth child, the indication then being "... cervical rigidity subsequent to amputation of the cervix". The obstetrician at the time recorded "... great difficulty was experienced in suturing the left extremity of the uterine wound, which had extended laterally into the broad ligament." The abdominal wound did not heal well, and a pyrexia of 101° F. was recorded for the first two post-operative days.

Hystero-graphy in February 1957 showed a

sinus from the left end of the wound in the uterus. (Fig. 83). The woman became pregnant again in June 1958 and, on 18th March, 1959, an elective caesarean section was done because of the hystero-graphic findings. The peritoneum was opened transversely and, at the extreme left end of the old scar, a "window" was seen. After delivering the baby a photograph was taken to demonstrate this. (Fig. 84 and frontispiece). The edges of the hole were rolled and firm and showed no evidence of being recent. Biopsy proved this. The wound and the window were repaired and a bilateral partial salpingectomy performed.

This case illustrates the whole story, from the torn left end of the uterine wound at caesarean section and the difficulty of a proper repair, through the hystero-graphic findings, to the repeat caesarean section and photograph to prove the sinus or "window" in the original scar.

CASE 2. V.L., Q.V.M.H., A/7893, aged 23.

In 1958, when a primigravida, this woman had a lower segment caesarean section for a breech presentation. The baby weighed 8 pounds 15 ounces. The operation was performed in a teaching hospital by a specialist obstetrician before labour had begun,



Fig. 83.

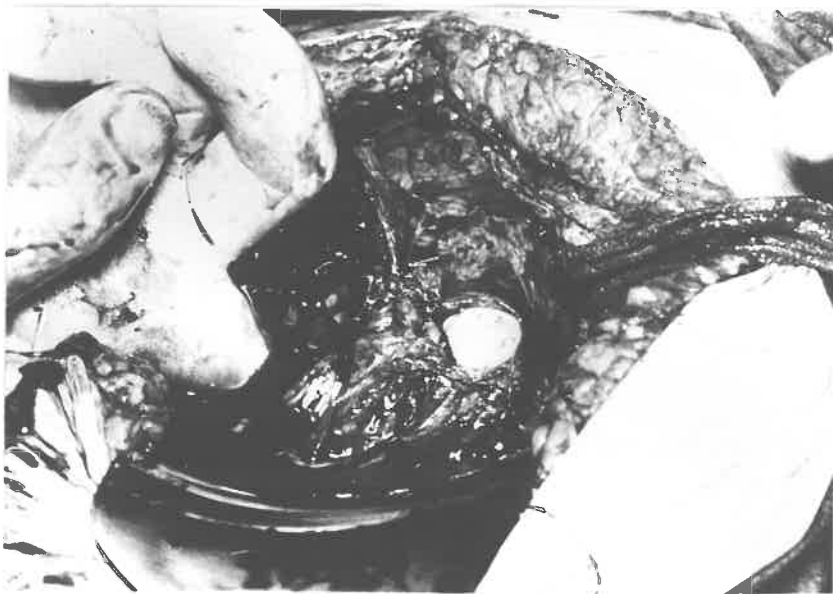


Fig. 84.

and with unruptured membranes. Conditions for good healing should therefore have been ideal. The operation was uneventful, with an equally normal and apyrexial convalescence. An all layer mucosal inclusion continuous suture was used. Routine hystero-graphy in 1959 showed a medium sized deformity with a sinus track leading from it at the right end of the scar. (Figs. 85, 86). During her second pregnancy, in 1960, she was under the care of another obstetrician, and she again had a persistent breech presentation. Her expected date of confinement was 5th November, 1960. An elective caesarean section was done on 6th November, early in the first stage of labour. When the peritoneum was reflected from the lower segment, a large deficiency was seen towards the right end of the old scar. This window measured 5 cms. x 3 cms., had rolled edges, and had membranes and one foetal buttock pressed hard up against it. There was no evidence of recent tearing. No camera could be found available at the time, so a sketch was made (Fig. 87). The hole was enlarged laterally in both directions, the baby delivered, and the wound edges excised and repaired with No. 1 chromic cat gut, excluding the decidua. The baby weighed 9 pounds

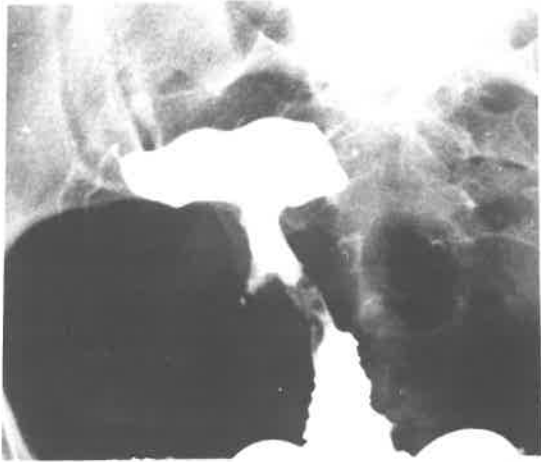
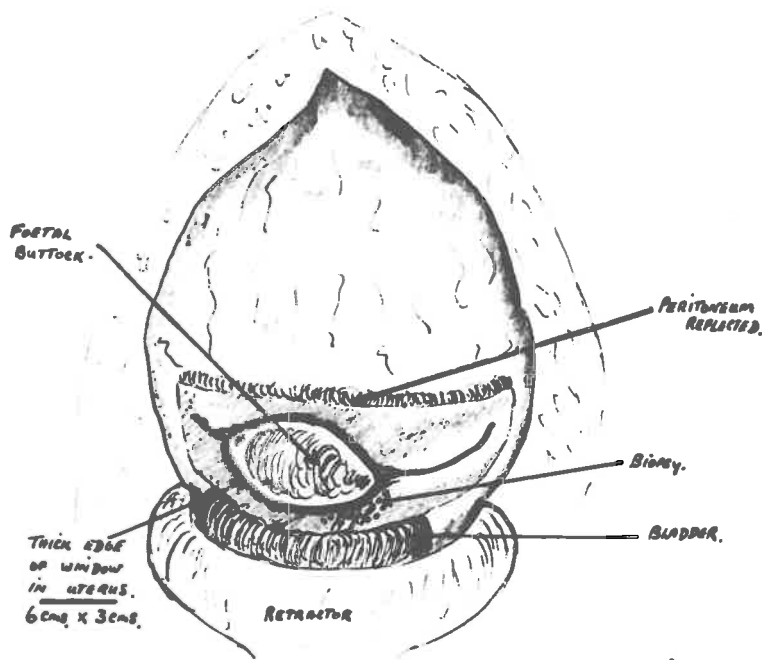


Fig. 85.



Fig. 86.



G.V.M.H. 177893. V. L. cut. 22.
 Cont. 2. . E.D.P. S.H. 60.

Fig. 87.

8 ounces. The patient has been lost to further follow up, so that no further hystero-graphy has been possible.

This is a further complete example of the hystero-graphic findings being confirmed at subsequent caesarean section. Because of the "ideal" conditions present at the first caesarean section, this woman may well have been allowed vaginal delivery, had there been a head presentation late in the second pregnancy, and if no hystero-graph had been taken, there would have been no knowledge of the sinus. Perhaps she would have passed quite uneventfully through such a vaginal delivery, for it is now known that such sinuses or "windows" may give no evidence of their presence during a vaginal delivery. The next case is such an example.

CASE 3. D.W., Q.V.M.H., 5651, aged 34.

In 1948 this woman had a vaginal delivery. In 1950 she was delivered by lower segment caesarean section for "failed forceps delivery", in a small South Australian country town. The consultant called in at that time explained that, during the delivery of the head, much difficulty had been experienced, with a considerable splitting of the

incision down through the anterior portion of the cervix. Repair had been difficult and the woman later developed an infection of the "pelvic tissues". A collection of pus discharged ten days post-operatively per vaginam.

In 1954 she had an apparently normal vaginal delivery of a male infant weighing 8 pounds $13\frac{1}{2}$ ounces in 21 hours. In 1956 a hystero-gram revealed a gross deformity of the lower uterine segment. Fig. 88. This was difficult to interpret at that time, but it was concluded that it was certainly not normal and any subsequent delivery should be by caesarean section.

In 1957 she became pregnant and was cared for by an obstetrician who was unaware of the hystero-graphic findings. After $10\frac{1}{2}$ hours of labour in March 1958 she developed intra-partum haemorrhage, a placenta praevia was suspected, and a caesarean section performed. The operation notes described visible blood and blood clot under the peritoneum of the lower uterine segment, and when this layer was opened the foetus was found protruding through a large rent in the anterior lower segment. The foetus was lost, as it was stillborn, and a hyster-ectomy was necessary. The specimen is shown in Fig. 89, and when it is compared with the hystero-grams,



Fig. 88.

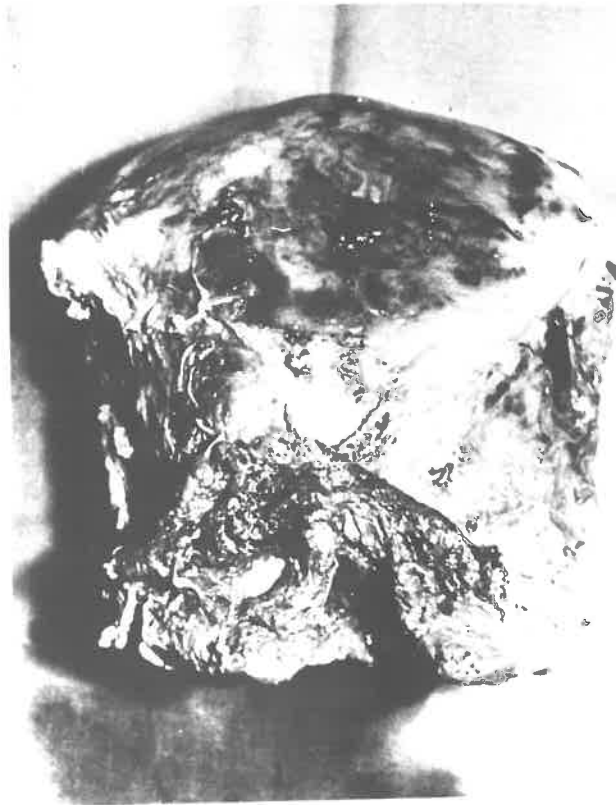


Fig. 89.

the latter can then be properly interpreted. This was a most unusual case with findings difficult to understand until the uterus ruptured. (Published by Bockner, 1960).

CASE 4. R.C., Q.E.H., 642, aged 30.

Her first six pregnancies had been uneventful and all deliveries had been vaginal. The seventh labour, in 1958, was complicated by a prolapsed cord, and a lower segment caesarean section was done, using a transverse incision. It was repaired with a continuous suture of No. 2 plain cat gut, including all layers. A second continuous suture covered the first layer. The abdominal wound became infected, and required resuture on the 8th day. Six months later a hysteroqram showed a large defect to the left with a filling deformity thought to be a granuloma. Figs. 90, 91. One month later a hysterectomy was done because of painful and heavy menstruation, and a strong request for sterilisation. When the intact specimen was examined it showed a sinus in the left end of the old scar area. Fig. 92. Lipiodol was next injected per os, and the oil was easily seen escaping through this sinus. An X-ray at this time proved this. Fig. 93. When the

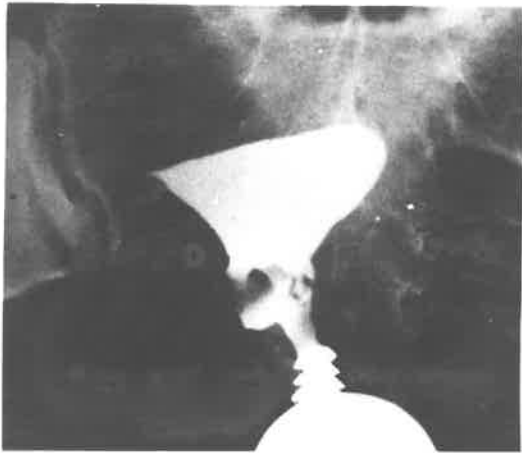


Fig. 90 (reversed).



Fig. 91.

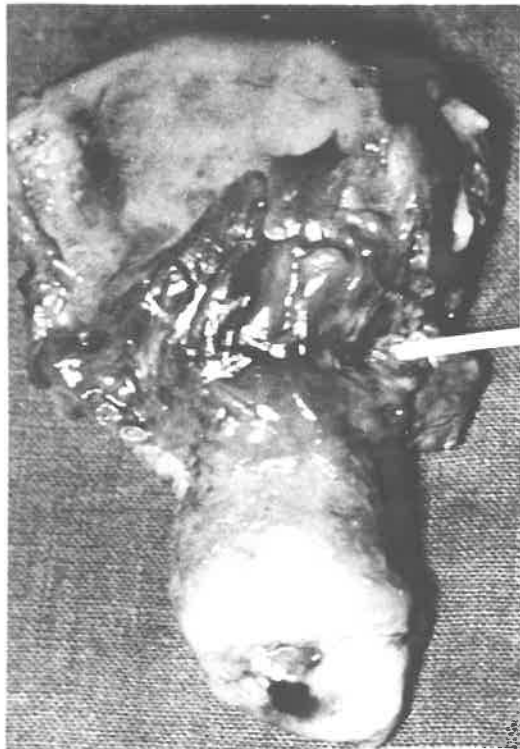


Fig. 92.



Fig. 93.



Fig. 94.

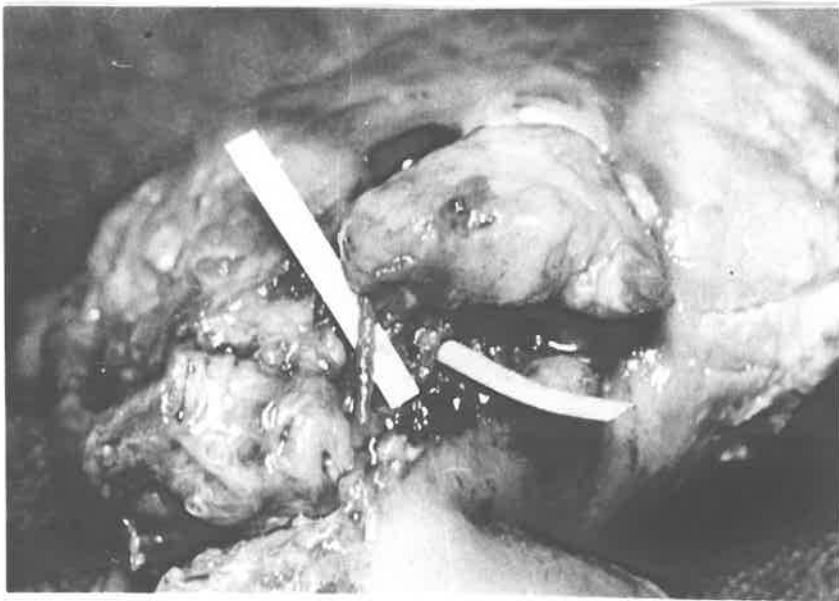


Fig. 95.

uterus was opened a granuloma was found in the caesarean section scar. Fig. 94. Much cat gut can be seen within the granuloma and the very weak and thin scar of the caesarean section is well demonstrated. A close up view of the wound shows the granuloma and undigested cat gut seven months after operation. Fig. 95.

Each of these four cases provides proof of the reliability of the hystero-graphic method used in this study. In the first two cases the X-ray findings were accepted and subsequent caesarean sections were done, with safe results. In the third case, had the X-ray findings been followed up by caesarean section, this woman would have had a live baby and, possibly, her uterus. The fourth case was most instructive, also, as regards the formation of a cat gut granuloma, seen seven months after the original section.

There have been some occasions when a repeat caesarean section has been indicated because of a moderate degree of hystero-graphic deformity and at operation no "window" has been found. In all such cases, however, one of two conditions has been noted. Either the scar was extremely thin and transparent to the uterine contents or, on later

inspection from within, a dimple could be found at the site of the hystero-graphic deformity. A recent case will demonstrate this latter condition.

CASE K.K., Q.V.M.H., B/5121, aged 23.

Gravida 2.

An elective caesarean section was done in 1961 because of a breech presentation and placenta praevia. The delivery of the baby was reported as difficult and the uterus was repaired with a continuous suture of chromic cat gut passing through all layers, including the decidua.

There was no post-partum pyrexia. Hystero-gram on 27th September, 1962 showed a tongue-like projection of contrast medium with a smooth outline round the whole of the projection.

Figs. 96, 97. Mrs. K.K. subsequently became pregnant and reported to the Queen Victoria Maternity Hospital on 20th December, 1963 for ante-natal care, her expected date being 27th March, 1964. At the caesarean section on 7th March the scar, although seen to be thin after reflecting the bladder peritoneum, was intact. After the foetus was delivered a very obvious dimple was seen from

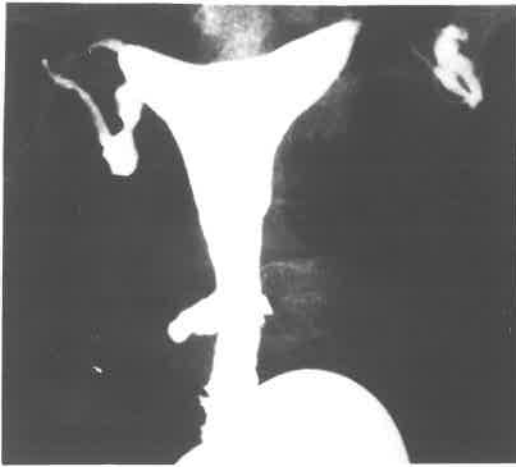


Fig. 96.



Fig. 97.

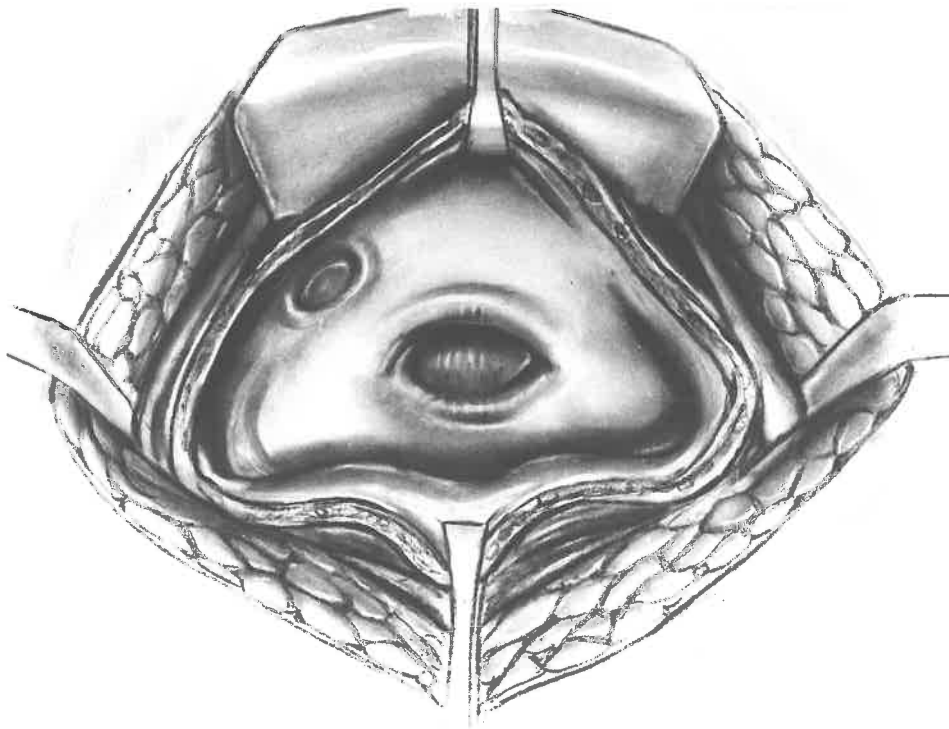


Fig. 98.

within at the left side of the wound area.

The sketch in Fig. 98 illustrates the finding.

In these cases when no actual deficiency was able to be demonstrated at subsequent caesarean section, one must conclude that the thin scar tissue was able to be ballooned out at the time of the hysteroqram by the Lipiodol injection under pressure. Therefore, although no actual leakage of contrast medium seems to occur from this type of scar, the significance of the finding is no less important, for it indicates a thin scar.

APPENDIX BHISTOLOGICAL EXAMINATION OF HUMAN UTERINE SCARS
FROM HYSTERECTOMY SPECIMENS

With the progress of time several such uteri have become available for study. To date I have nine personal cases. The caesarean sections were all of the lower segment type, using a transverse incision. My technique of closure in all these earlier cases was by the use of a continuous suture of No. 2 plain cat gut, including the decidua layer. A second layer of No. 1 plain cat gut was used to cover the first layer, following which the bladder peritoneum was replaced with a continuous No. 0 plain cat gut suture.

For various reasons these nine uteri have been removed by total hysterectomy and the scar areas have been examined in detail. Deposits of endometrium have been found in the depths of the scars in eight of the nine specimens. The scar of the ninth failed to demonstrate this. Illustrations of the phenomenon in the eight cases are shown in Figs. 99 - 107 inclusive. It will be remembered

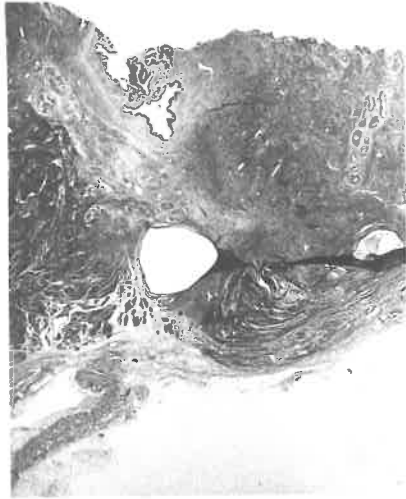


Fig. 99.

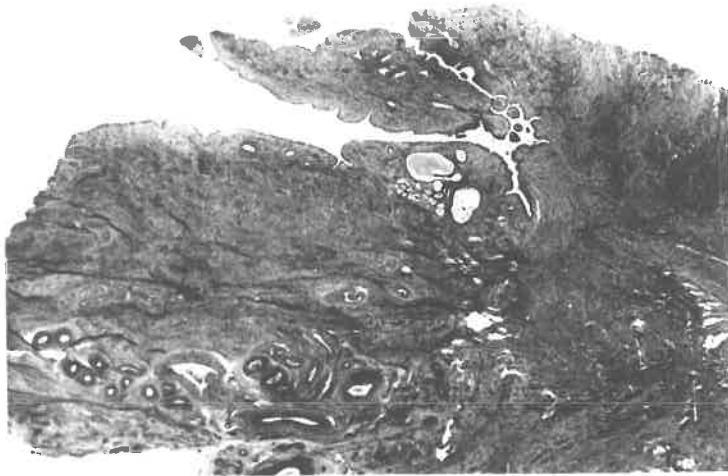


fig. 100.



Fig. 101.



Fig. 102.



Fig. 103.

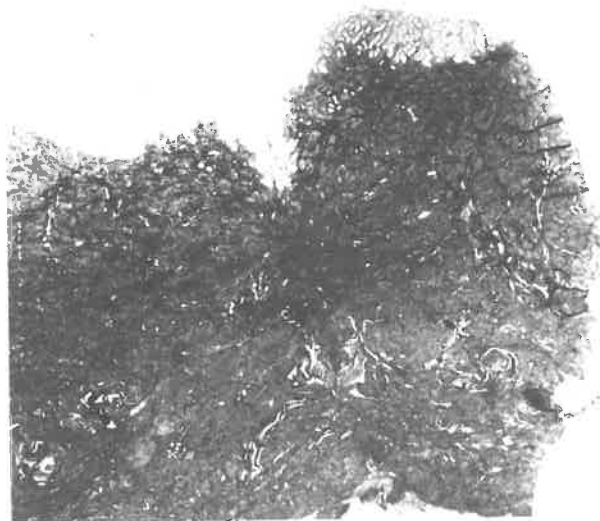


Fig. 104.

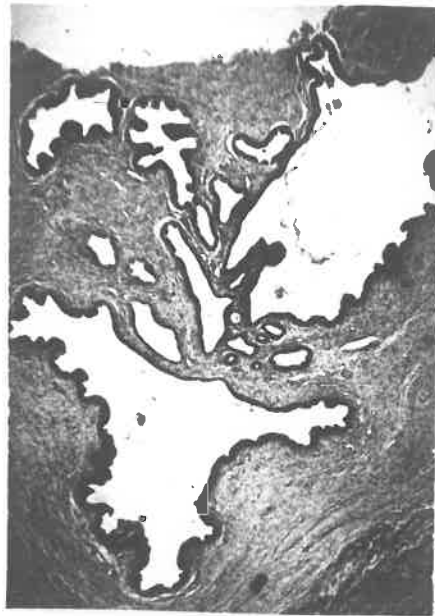


Fig. 105.

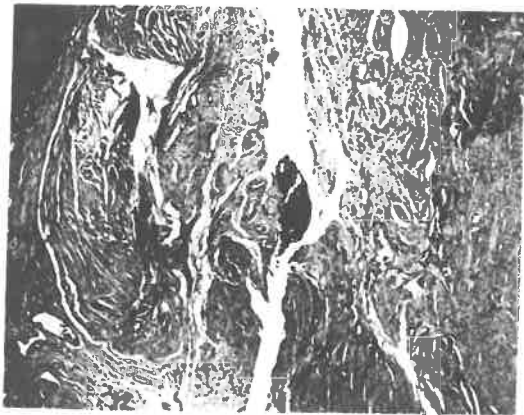


Fig. 106.

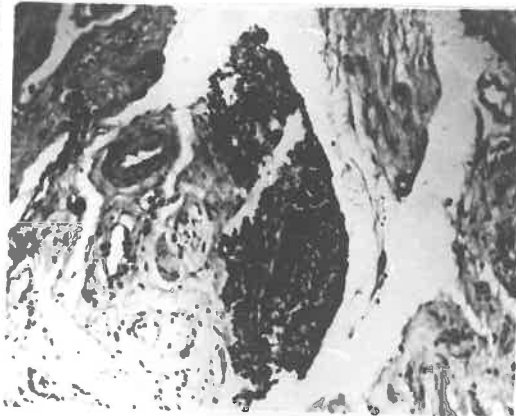


Fig. 107.
(Higher power)

that the experimental work in animals demonstrated the relationship between the decidual inclusion suture and the subsequent decidual deformities and defects within the scar. Thus, from eight out of nine human cases examined, and from fourteen out of eighteen animals examined, in all of whom the decidua had been included in the closing suture, endometrium was found in the scar.

The significance of this constant finding has still to be determined. It cannot yet be claimed that such a scar which includes endometrial glands or stroma is necessarily weakened as far as a subsequent pregnancy is concerned, though it is not unreasonable to pose such a question. It can be claimed that it is surgically untidy and that it is avoidable. Adenomyosis has already been observed more frequently in the uteri of women who have had caesarean sections (Weed, 1959).

APPENDIX CTHE CONCLUSIONS OF A. WANIOREK (1963)

(Annales de Radiologie 1963,
6, n° XI - XII)

1. Hystero-graphy enables us to assess the quality of a caesarean section scar on the basis of the depth and the surface of the deformations observed close to it.
2. A greater or lesser degree of deformation is present in the region of the scar in all cases.
3. The "minor" deformations indicate a normal cicatrization with the possibility of a subsequent vaginal delivery.
4. The "major" deformations with images of escape of the contrast medium constitute evidence that the cicatrization is defective. In such cases, a subsequent pregnancy will again have to end in caesarean section, vaginal delivery being too dangerous.
5. A defective cicatrization may be seen in

spite of favourable pre- and post-operative conditions. Special attention must be given to accurate suturing of the wound edges.

6. The major deformations are twice as frequent above the isthmus. It appears advisable, therefore, to incise the lower segment as low as possible.
7. The degree of the malformation has no correlation with the conditions of the operation: the indication of the caesarean section, the age, the parity, the dilatation at the moment of the operation, the duration of the labour and the moment of rupture of the membranes.
8. Nor is the degree of deformation correlated with the post-operative conditions; fever, appearance of the abdominal scar, quantity of blood transfused, antibiotics.
9. Women who exhibit "major" deformations must be kept under regular medical control when they become pregnant once more, and must be admitted to hospital 3 weeks prior to the delivery."

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CAESAREAN SECTION SCAR SAFETY

BY

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After a caesarean section, the question "Once or always?" still remains most pertinent, the answer to which verges on gambling. There is no clinical test for the estimation of scar safety in a subsequent pregnancy or labour short of the practical experience. Radiology is capable of providing guidance in some cases.

A recent specimen of a uterus previously subjected to a lower-segment caesarean section and later removed because of fibroids shows quite clearly the typical appearance of a healed transverse incision in the lower segment (Fig. 1). On opening all uteri which have previously been subjected to lower-segment caesarean section a larger or smaller depressed scar will always be seen. That this scar is at the site of the previous



FIG. 1.—Arrow points to the typically seen scar of a previous lower-segment caesarean section.

caesarean section can be confirmed by inspecting Fig. 2. A hystero-gram prior to opening this particular uterus shows a sound in the external scar and the typical internal depression at the same level (Fig. 3). Histopathological evidence (Fig. 4) adds further confirmation in that this thinned area, with both an external and an internal depression, consists entirely of fibrous tissue.

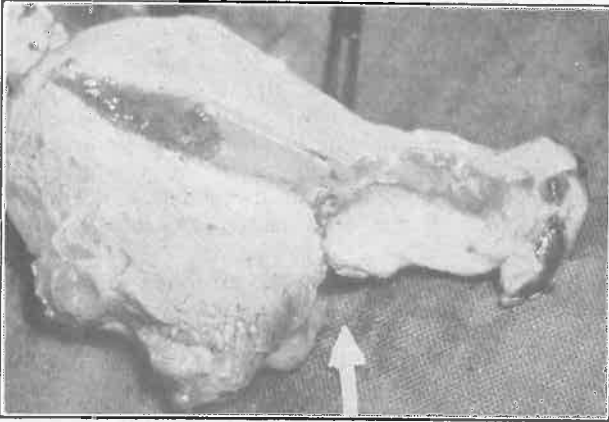


FIG. 2.—Arrow points to the external scar of a previous lower-segment caesarean section shown at the same level as the internal scar.

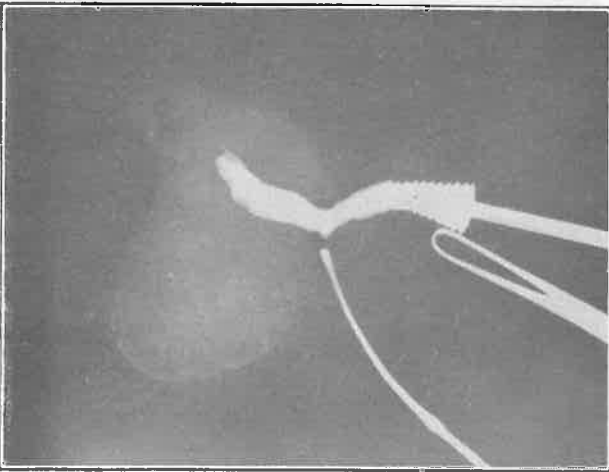


FIG. 3.—Hystero-gram of same uterus, as in Fig. 2, before opening. The sound is in the external scar, and the internal scar is shown by a typical wedge-type deformity.

Now this finding, far from being unusual, is present after all lower-segment caesarean sections. Poidevin and Bockner (1958) previously reported the results of a hystero-graphic study of uteri after caesarean sections and compared the findings between 13 control subjects

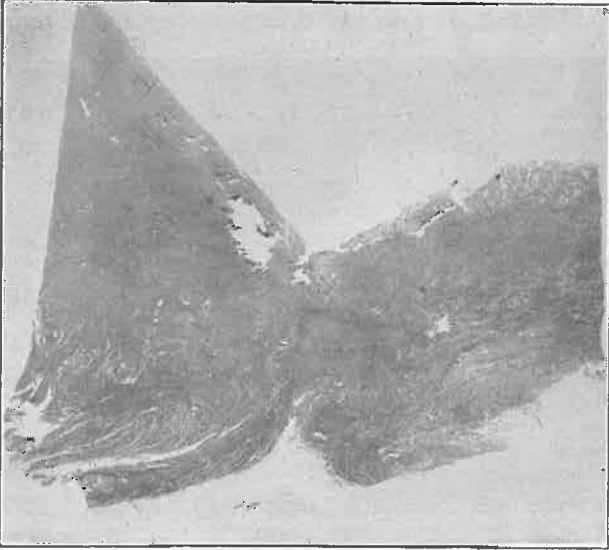


FIG. 4.—Section of scar area from same uterus as in Figs. 2 and 3.

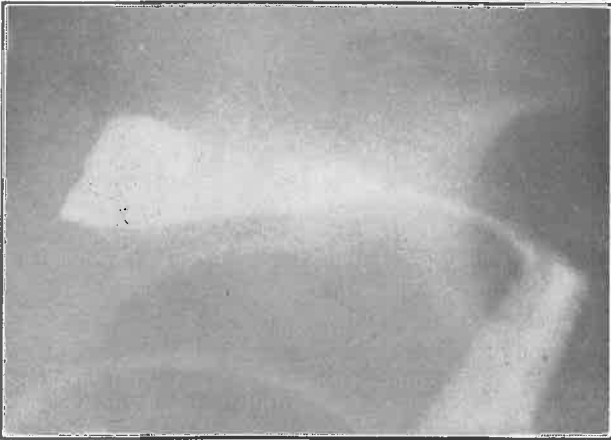


FIG. 5.—Hystero-gram six months after a normal vaginal delivery. Note smooth contour of anterior uterine and cervical walls.

who had vaginal deliveries and 43 who had caesarean section deliveries. The lateral x-ray view was used, and is again stressed because of the position of the lower-segment wound, which would not be expected to show up in an antero-posterior view. All the control cases showed a smooth anterior lower-uterine outline (Fig. 5). All the 43 section cases showed some

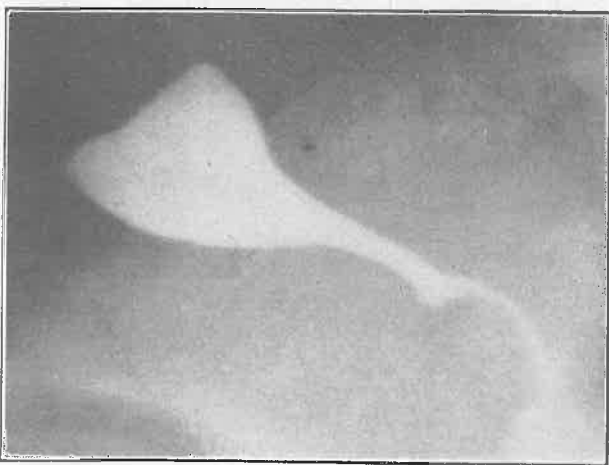


FIG. 6.—Hystero-gram nine months after a lower-segment caesarean section. Note wedge-type deformity on lower anterior uterine wall at site of scar. This is a typical finding.

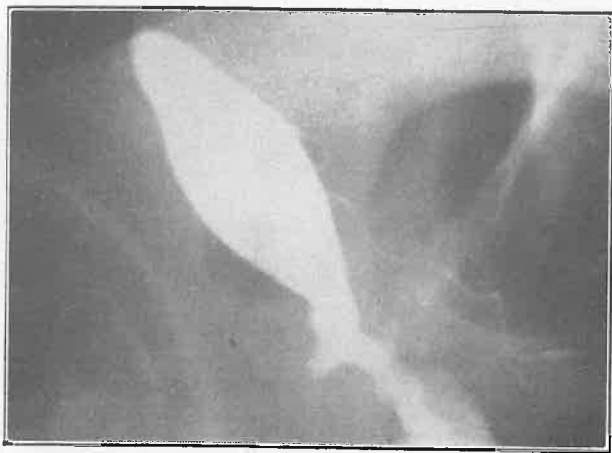


FIG. 7.—Hystero-gram 11 months after lower-segment caesarean section. Note irregular deformity at site of scar.

deformity. The deformities usually took the form of a wedge depression (Fig. 6), but occasionally a larger irregular deficiency was shown (Figs. 7 and 8):

Since this report, further cases have been examined hysterographically by Bockner, and again all previously sectioned uteri showed some deformity. (All figures used here are from the new series.)

The only other reported work on this subject that a previous search revealed was that of Baker (1955). His study concentrated on a digital palpation of the previous section area immediately following subsequent vaginal delivery, and found that 53 out of 64 examined had sound scars. In 24 he carried out hystero-grams, but was able to demonstrate a deformity in the lower anterior uterine wall in only five cases.

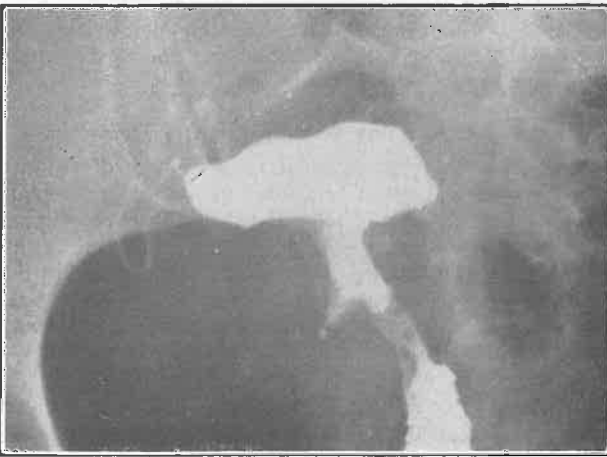


FIG. 8.—Same uterus as in Fig. 7, showing antero-posterior view. This demonstrates a lateral pouching.

Significance of the Deformity

It is not permissible to label all these deformities as defects. There is no proof that they are all defective. In fact, there is much proof to the contrary in the abundant clinical evidence of subsequent safe vaginal delivery in many cases. Further investigations and follow-up of our cases tend to confirm the view that the small wedge deformities—that is, those of 5 mm. or less in depth—are those on which reliance can be placed. On many occasions now, at repeat caesarean section in such cases, no deformity has been found in the lower segment

except the white scar line. No doubt as the lower segment is stretched out in late pregnancy over the enlarging presenting part this deformity, involving scar tissue, is pulled out and holds quite well.

One of the cases used in the previous report showed an irregular deformity high in the cervix. The patient subsequently passed uneventfully through an easy vaginal delivery, and then in the next labour suffered an extensive rupture from the site of this deformity in the cervix. The details of this case form the subject of another publication at present being prepared by Bockner.

In the search for the real significance of these x-ray findings this case seems to emphasize that deformities, other than the acceptable wedge type, are to be distrusted, and in the present state of our knowledge should serve as an indication for repeat caesarean sections. Further, in these irregular deformities the integrity of the scar should be suspect during the whole pregnancy.

Suggested Reasons for the Uterine Deformity

The lower uterine segment is composed of smooth muscle, and this tissue is known to heal by scar-tissue union (Schwarz *et al.*, 1938 ; Siegel, 1952). The original length of the uterine wound is approximately 3 in. (7.5 cm.) at the time of its surgical suture. Within the next few days scar tissue is laid down by fibroblastic activity, while concurrently a gradual and relatively rapid shrinkage of the whole uterus is occurring. Thus the scar tissue which sets out to heal a 3-in. (7.5-cm.) long wound is reduced, after a few weeks, to a $\frac{1}{2}$ -in. (1.3-cm.) long wound. This is an extraordinary situation which is found only in such an organ as the rapidly involuting uterus. Thus some redundancy of scar tissue is understandable in the resting state. Also, the union is by scar tissue rather than muscle regeneration, so that a narrowing of this part of the uterine wall (Fig. 4) is understandable. The wedge-shaped deformity is thus explained.

The larger and more irregular defects are most likely due to an initial failure of scar-tissue union. This could follow a technical defect, such as the giving way of the suture material, or the failure to close completely a torn angle wound or even haematoma formation. Could it also possibly be related to a residual inherent hypercortisonism of pregnancy ?

Defective union of wounds, due to a failure of fibroblastic reaction, is well known in such conditions as Cushing's syndrome and during cortisone or corticotrophin administration, both experimentally in animals and therapeutically in humans (Creditor *et al.*, 1950; Alrich *et al.*, 1951; Baxter *et al.*, 1951; Conway and Stark, 1951). In all these conditions we are able to attribute the failure of wound healing directly to the increased amount of circulating corticosteroids.

Pregnancy itself is another condition of marked adrenal cortical hyperactivity leading to increased amounts of circulating corticosteroids (Venning, 1946; Gemzell, 1953; Robinson *et al.*, 1955; Jailer, 1956; Gold, 1957; McKay *et al.*, 1957). This rise in steroid blood levels persists into the puerperium for a questionable time, Robinson *et al.* (1955) stating that six weeks is required before a return to normal levels is achieved. Could it be that, in some women, this inherent hypercortisonism of pregnancy, which continues into the puerperium, causes a failure of fibroblastic reaction and thus poor healing of caesarean section wounds?

Practical Considerations

The problem obviously is to find a measure by which the integrity of each caesarean section scar can be judged. In the absence of such a measure there are those who may legitimately believe and practise the old dictum, "Once a caesarean section, always a caesarean section." This should avoid any possibility of uterine rupture in labour, but will not prevent the rare rupture during pregnancy.

On the other hand, there are those who would argue that uterine rupture is so rare after the modern lower-uterine-segment operation that repeat caesarean section is unjustifiable when the original indication does not recur. They support their argument with statistics. This line of argument was suggested in the previous report (Poidevin and Bockner, 1958) when in the preceding five-year period, during 17,000 deliveries, there had not been a case of uterine rupture. Of 216 women who had previous caesarean sections, 83 were selected for subsequent vaginal delivery and safely conducted through, while 133 had repeat sections. Since then there have been two cases of uterine rupture in the clinic service of our teaching hospitals, both having had previous caesarean sections. One was the

case referred to previously with the grossly deformed upper cervix on hysterography, the other an emergency admission on whom no hysterography had been done. Thus the statistics have changed from no cases of rupture in 17,000 deliveries to 2 cases in 21,000 deliveries.

There are many reports of scar weaknesses and even scar ruptures found at the time of elective repeat caesarean sections ; conversely, there are many reports of large numbers of cases safely conducted through vaginal deliveries subsequent to caesarean sections. What, therefore, is the correct scientific approach to the individual under one's own care ?

I believe most of us who have been satisfied with the technical details and subsequent post-operative course of the previous caesarean section would trust that would to a future vaginal delivery. In spite of this faith, however, some large defects have been shown by hysterography in a series of cases that were each the responsibility of a specialist obstetrician.

X-ray evidence has been demonstrated as a means of visualizing the deformity in the uterus after caesarean section. From this an opinion can be given on whether the deformity is within the normal acceptable wedge type range or whether it is an irregular pouching.

We therefore have the alternatives of firstly judging the safety of caesarean section scars after an appraisal of the details of the previous operation and puerperium, or, secondly, of requesting any x-ray evidence of scar weakness as judged by an irregular deformity. Reliance on the former has been found insecure on occasion, whilst the small amount of x-ray evidence to date suggests that it may be safe to rely on the integrity of the commonly seen wedge deformity but not on large irregular ones. Both methods should be used in cases of doubt even if not practicable in all cases. So often new cases coming under one's care are already pregnant, giving one no opportunity to use hysterography. However, in the non-pregnant state, when evidence of scar safety is sought, hysterography has a definite place.

Conclusion

Hysterography is an advance in our search for evidence of the safety of lower-segment caesarean section scars. Experience strongly suggests that the usually seen wedge-shaped deformities may be

considered within acceptable limits of normal healing, and most reliance can be placed in them. The irregular deformities, of any size, should be suspect, and indicate subsequent caesarean section rather than vaginal delivery.

It is suggested that the inherent raised blood corticosteroid levels of pregnancy may play a part in defective union of caesarean section wounds of the uterus, although technical failures must accept the major blame.

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The value of hystero-graphy in the prediction of cesarean section wound defects

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AT PRESENT there is a relative complacency regarding the sequelae of cesarean section delivery. There has been a gradually rising rate during the past 10 year period. The well-known outstanding facts are that the maternal mortality from the operation has practically disappeared and the fetal salvage has improved with the rising rate. The invitation to perform cesarean section delivery is therefore freely accepted.

There is little doubt that the new decade will bring a still higher over-all rate and with this will come a still higher fetal salvage. The real effect on perinatal mortality is still debatable. The elimination of all traumatic vaginal deliveries will be sought and even the borderline forceps and breech deliveries will tend to disappear if the long-term morbidity of children is to be improved. A clearer understanding and detection of intrauterine anoxia will add impetus to the cesarean section rate. All this will not only increase the cesarean section rate in preference to these borderline traumatic deliveries but will involve more of what we at present refer to as "unnecessary cesarean sections." Eastman¹ has clearly pointed out the futility of this term in that regrets stem from failure to perform a cesarean section rather than from performing too many.

A prediction of the acceptable rate in 10 years' time would neither be prudent nor, in itself, of any real importance. Some in-

dividual obstetricians have already arrived at the stage when cesarean section delivery is resorted to for all women deviating at all from the bounds of accepted normality. This policy quickly brings the rate up to 20 per cent or more. There are, furthermore, those enthusiasts who go almost the whole way in order to protect the pelvic floor and lower genitals from natural childbirth! For those who fear the cesarean section rate will "get out of hand," let me predict that this tendency will automatically be corrected by one factor—uterine morbidity.

Uterine morbidity should no longer be crudely judged by the incidence of uterine rupture subsequent to cesarean section. The thinking of the next decade should be more delicate. Till now the rupture rate has been a very rough yardstick of the subsequent ability of any uterus after a cesarean section. In an infinite number of publications rupture rates have been compared and debated with the general conclusion that the classical scar is more vulnerable than the lower segment scar.

Explosive or complete rupture

Assuming an equal degree of faulty wound healing in both a vertical fundal incision and a transverse lower segment incision, it is easy to imagine that during labor the weak fundal scar would be more likely to rupture than that in the lower segment. The fundal wound is unsupported and is in the strongly active section of the uterus. The lower segment is supported on all sides by hard and soft relations and is also in a less

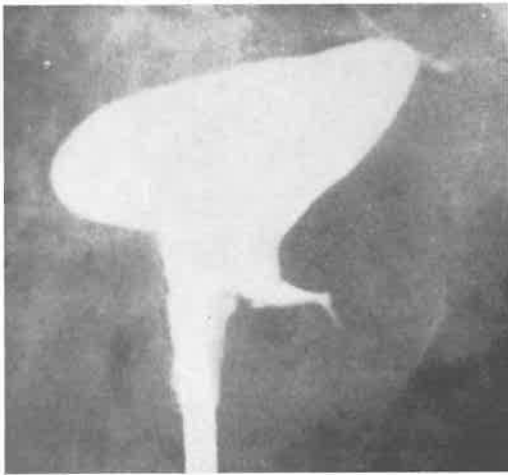


Fig. 1. Case A. Anteroposterior hystero-gram showing dye escaping from left lateral end of cesarean section wound.

active part of the uterus, hence the incision here is less likely to explode than one in the fundal area.

Silent or incomplete rupture

There is an ever-increasing body of evidence to suggest that many lower segment wounds either heal defectively in the first instance or rupture incompletely and silently in a subsequent pregnancy or labor. It is also known that these minor wound deficiencies are capable of a "safe" vaginal delivery.

Recently, we have seen a patient who had a lower segment cesarean section with a hystero-gram 6 months later showing a major defect. In her next labor, which was conducted elsewhere, she was allowed a vaginal delivery by an obstetrician with no knowledge of our hystero-gram findings. There was apparently no cause for alarm during this labor. However, in the next labor she suffered a large uterine rupture through the lower segment wound. Baker² found 11 of 64 patients that he examined digitally after vaginal delivery following previous section to have deficient scars. Whatever the future holds regarding the relative merits of upper versus lower segment operations, of one technique as against another, or of subsequent

vaginal delivery as compared with repeat cesarean section, it is certain that a more accurate measure of wound healing is required. Our experiences with hystero-gram have proved to us that the closer the examination the more deficient scars there are to be found.

Method of detecting scar weakness

A hystero-gram technique has been devised and practiced since 1955, the method and results of which, to 1957, have already been published.³ The work to that stage showed that all uteri in the control series examined 6 months or more after vaginal deliveries presented a smooth, even contour. In 43 cases examined 6 months or more after cesarean section no case showed a



Fig. 2. Case A. Old wound deficiency in among scar tissue lateral to the left extremity of the present wound.

smooth, even contour. This 6 month wait is important, for an earlier examination may reveal no deformity owing to wound edema. Twenty-seven showed a fairly typical small wedge-shaped deformity which we have learned to associate with sound healing and which we believe to be safe in a subsequent vaginal delivery. Eleven showed larger deformities. (Five cases were left unclassified.) At that stage we had no knowledge of the subsequent fate of the 11 women with the large deformities. Since then, however, we have detailed evidence of 3 of them. One

has already been mentioned. One went to another clinic, which was unaware of our finding of a large retrovesical spread of dye; she was allowed to go into labor, and she suffered a severe rupture of the uterus. The third case is reported below:

Case A (Q.V.M.H., 11664). The patient was a 34-year-old gravida vii. Her first 5 pregnancies terminated in uneventful labors. The sixth was terminated in August, 1956, by a lower segment cesarean section, with a transverse uterine incision, for cervical rigidity resulting from a Manchester operation after her fifth child. The operator recorded that "great difficulty was experienced in suturing the left extremity of the uterine wound which had extended laterally into the broad ligament." There was postoperative pyrexia up to 101° F. for the first 2 days followed by a low grade pyrexia for the next 9 days, associated with a breakdown of the abdominal wound.

In February, 1957, a hystero-graph was performed. Fig. 1 is an anteroposterior view showing dye escaping from the cesarean scar area out toward the left broad ligament.

She became pregnant again in June, 1958, and had a closely watched and uneventful pregnancy until near term when she noticed tenderness in the lower abdomen. On March 18, 1959, an elective cesarean section was performed by means of a transverse incision through the lower segment. After a baby weighing 9 pounds, 4 ounces, was extracted, an inspection of the lower



Fig. 3. Case B. Anteroposterior hystero-graph showing wound defect with dye spill from left lateral end of scar. Note filling defect due to granuloma in the wound.

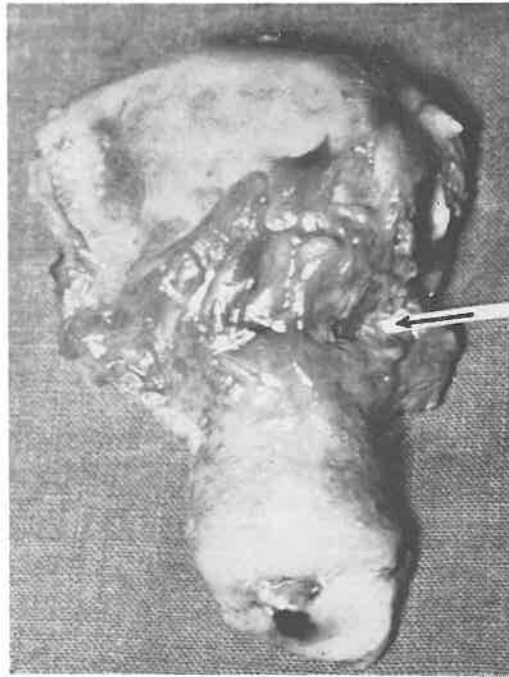


Fig. 4. Case B. The excised uterus. Arrow points to external appearance of wound defect.

segment was made; the findings are shown in Fig. 2. An old deficiency, in among scar tissue, can be seen lateral to the left extremity of the present wound. The tip of the gloved finger demonstrates the rounded edges of the hole.

This case shows to advantage the ease with which hystero-graphy can demonstrate a uterine wound deficiency. The proof of its interpretation was provided by actual visualization of the deficiency at subsequent cesarean section. The poor wound healing in this case was due to a technical difficulty at operation together with a subsequent wound infection. The case also highlights the silence of such a deficiency during pregnancy, even to term, except perhaps for some lower abdominal tenderness which, in itself, is so notoriously difficult to interpret in late pregnancy. This case happened to be the only one in the original series of a large deficiency associated with a severe pyrexia. Since then, a closer relationship does seem to be showing up between severe pyrexia and large defects. However, many

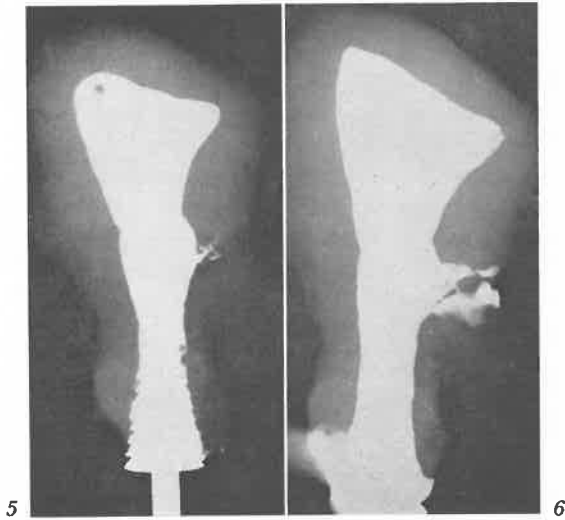


Fig. 5. Case B. Injection of radiopaque dye into specimen showing the early escape after 4 mils.

Fig. 6. Case B. Escape of dye after 6.5 mils had been injected.

cases show major deformities when no technical or postoperative difficulties were encountered.

Case B (Q.E.H., Maternity, 642). This case is one of the new series. The patient was a 30-year-old gravida vii. Her first 6 pregnancies were uneventful. During her seventh labor in February, 1959, the umbilical cord prolapsed from a transverse lie and after considerable vaginal manipulation, in order to keep pressure off the cord, a lower segment cesarean section was carried out by means of a transverse uterine incision. Although there was considerable bleeding, requiring wound edge clamps, there was no great difficulty in repairing the wound in two layers with continuous No. 2 plain catgut. She subsequently developed peritonitis, paralytic ileus, and abdominal wound breakdown with prolapse of small intestine. The wound was re-sutured and healed cleanly. For the next 6 months she complained bitterly of pelvic pain and dyspareunia.

A hysteroogram early in August, 1959 (Fig. 3), showed dye escaping from the uterus at the left end of the scar area. Another interesting finding radiologically was a filling defect diagnosed as a possible granuloma in the scar.

Because of the pelvic pain a total hysterectomy was performed after separation of adhesions. Both Fallopian tubes and ovaries were

conserved. The bladder was adherent to the anterior cervix and required more stripping than usual. Fig. 4 shows the excised uterus with the arrow pointing to a defect in the cesarean section scar. Injection of dye shows an escape along the sinus at the left end of the old cesarean section scar (Fig. 5). As more dye was injected it was interesting to see it slowly escaping from the sinus (Fig. 6). The greater the pressure exerted the more dye spilled out. This sinus was easily found on opening the uterus (Fig. 7). The granuloma also became apparent on sectioning the uterus, and microscopy confirmed its nature and showed also the catgut still present after 6½ months (Fig. 8).

Comment

Two cases have been presented to demonstrate the value of the hysteroogram after cesarean section. This method of investigation is capable of giving a detailed image of the uterine scar with little disturbance to the patient. No reason has been found to vary the technique from that previously reported. Further experiences are uncovering cases of scar deficiency even in women who have convalesced normally from operations relatively free of technical difficulty.

The greater our experiences with this form of investigation the greater has become the

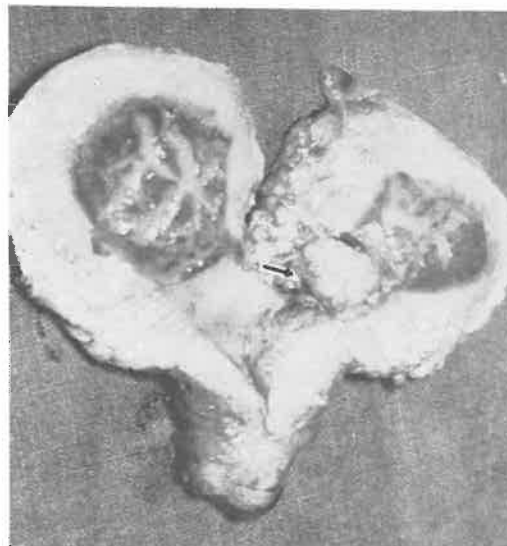


Fig. 7. Case B. The opened uterus showing granuloma in the scar and the position of the sinus at left end of the old wound.



Fig. 8. Case B. Section shows weak scar and much catgut still unabsorbed in the scar and both edges of the wound. ($\times 6$; reduced $\frac{1}{3}$.)

conviction of the necessity and value of a hysterogram after cesarean section. It is an essential investigation to determine wound security. Any pouching effect, other than the commonly seen wedge-shaped deformity, indicates an escape of radiopaque substance through a sinus and the necessity for a repeat cesarean section.

Recently, Harris and Nessim⁴ surveyed the subject of cesarean section in a most convincing fashion. Their paper made no reference to uterine morbidity following the operation. No doubt their lack of interest in this aspect is covered by their following the dictum of "once a section, always a section." The communities which do not follow this dictum still need all possible information regarding wound security in order to arrive at a logical decision on the future conduct. Even for those who practice the 100 per cent repeat cesarean section policy it may still be wise to have knowledge of scar defects because complications of pregnancy are not unknown with such weak scars.

We all agree that traumatic deliveries must be eliminated and that this achieve-

ment will mean a higher incidence of cesarean section. This increasing rate should cause no alarm for, in itself, it is of no moment if it is productive of less fetal morbidity, but let us not neglect completely the fact that the uterus has been wounded. Good uterine healing is far from automatic with our present techniques. The disappearance of the manipulative obstetric art should not be mourned.

The next decade should see a more critical attitude toward the uterine wound, particularly as this group in the general population will continue to grow. A reassessment of operative techniques is indicated, and modifications will undoubtedly be attempted.

Summary

1. Greater consideration will be given to uterine morbidity after cesarean section in the next 10 years.

2. The rupture rate is a crude and inaccurate measure of uterine morbidity.

3. Reference is made to previous work which demonstrated the value of hysterography after cesarean section.

4. Evidence is now available on 2 cases of rupture of the uterus in which previous hysterography had demonstrated large defects; one patient had an apparently normal vaginal delivery in between the demonstration of the defect and the later rupture.

5. Another case is presented in detail showing the hysterographic demonstration of a defective scar subsequently confirmed at cesarean section.

6. A fourth case is given in detail to demonstrate a scar deficiency detected by hysterography and confirmed subsequently by examination after total hysterectomy.

7. A plea is made for a more critical appraisal of uterine wound healing after cesarean section.

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