15 CHAPTER 15

Surgical complications: Prevention and management

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LEARNING POINTS

- Surgical abortion is one of the safest procedures in contemporary medical practice.
- Prophylactic antibiotics reduce the risk of postabortal infection, although the optimum regimen remains unclear.
- Failed attempted abortion occurs more commonly in women with uterine anomalies, such as a bicornuate uterus.
- Immediate postoperative tissue inspection confirms successful abortion and excludes the remote possibility of an unsuspected ectopic pregnancy in most cases.
- Postoperative hemorrhage, like obstetrical hemorrhage, usually results from atony, retained tissue, uterine trauma, or coagulopathy.

Introduction

Induced abortion is an impressively safe procedure, particularly but not exclusively where it is legal, accessible, and performed under modern medical conditions [1]. The near elimination of abortion-related mortality in most industrialized nations stands in stark contrast to conditions in many developing countries where tens of thousands of women die annually from preventable complications [2] (Chapter 2).

Many of the difficulties encountered during modern induced abortion are not foreseeable or avoidable. The self-limiting nature of most adverse events underscores how remarkably resilient the uterus and other pelvic organs are in circumscribing damage and acute loss of blood. These protective mechanisms, coupled with the astute diagnosis and management of complications that do occur, make serious sequelae of induced abortion rare.

This chapter focuses on surgical abortion complications, addressing the conditions and practices that influence the risk of complications and acceptable approaches to their clinical diagnosis and management. Complications associated with early medical abortion and labor induction abortion are described in Chapters 9 and 12, respectively.

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Mortality and morbidity

The risk of death from modern induced abortion is negligible. The US abortion-related mortality rate for 1988 to 1997 (the most recent period for which data are available) was 0.7 per 100,000 legal induced abortions [3]. The nationwide legalization of abortion in 1973 had a dramatic impact on abortion-related deaths; case-fatality rates subsequently declined by 85%, with most of the decrease occurring from 1973 to 1976 [3]. From 1991 to 1999, the risk of dying from live birth was about 12 times higher than that from induced abortion [2]. During that time period, induced or spontaneous abortion accounted for 4% of US maternal mortality whereas pregnancies resulting in live births accounted for 60% [4].

Gestational age is the most important risk factor for abortion-related mortality. Compared to the case-fatality rate for induced abortion at 8 weeks' gestation or less (0.1 per 100,000 procedures or 1 in a million), the risk of death increases by 38% for each successive gestational week [3] (Table 15.1). Race is another risk factor for abortion-related mortality in the USA. Women of races other than White are more than twice as likely to die from induced abortion. About one-fifth of the excess mortality risk among minority-race women is because of their later gestational age at the time of abortion.

The causes of abortion-related mortality have changed over time, and they differ by type of procedure [3]. Compared to the preceding decade, in 1988 to 1997 the

Table 15.1 Legal induced abortion-related deaths, mortality rates, and relative risks, by selected characteristics, USA, 1988–1997 (Reprinted with permission from Bartlett et al [3].)

Characteristic	Legal induced abortion-related deaths	Mortality rate[a]	Relative risk (95% confidence interval)
Gestational age (wk)			
First Trimester			
≤8	8	0.1	Referent
9–10	5	0.2	1.4 (0.5, 4.2)
11–12	6	0.4	3.4 (1.2, 9.7)
Second Trimester			
13–15	15	1.7	14.7 (6.2, 34.7)
16–20	19	3.4	29.5 (12.9, 67.4)
≥21	15	8.9	76.6 (32.5, 180.8)
Unknown	26	Not applicable	Not applicable
Race			
White	38	0.5	Referent
Black or other	56	1.1	2.4 (1.6, 3.6)
Time Period			
1972–1979	163	2.2	3.1 (2.4, 4.0)
1980–1987	80	0.8	1.1 (0.8, 1.4)
1988–1997	94	0.7	Referent
Age (y)			
≤19	20	0.7	1.2 (0.6, 2.2)
20–24	29	0.7	1.1 (0.6, 2.0)
25–29	18	0.6	Referent
30–34	16	0.9	1.5 (0.7, 2.9)
≥35	10	0.8	1.3 (0.6, 2.9)
Parity			
0	16	0.3	Referent
1–2	27	0.5	1.9 (1.0, 3.5)
≥3	7	0.5	2.1 (0.9, 5.2)
Unknown[b]	42	Not applicable	Not applicable

[a] Legal-induced abortion mortality rate is the number of abortion-related deaths per 100,000 legal-induced abortions.

[b] Denominators for calculating rates by parity use previous live births from abortion surveillance data; deaths with unknown parity are excluded.

proportion of abortion-related deaths attributable to anesthesia decreased substantially, as general anesthesia became both safer and less widely used for abortion. This decrease resulted in a proportionate rise in deaths because of hemorrhage and infection. Infection accounted for approximately one-third of deaths among women who had first-trimester vacuum aspiration abortions, whereas hemorrhage and embolism each accounted for 14%. In contrast, hemorrhage was the most common cause of mortality in the second trimester, accounting for about one-third of deaths attributable to labor-induction abortion and nearly 40% of deaths associated with dilation and evacuation (D&E) [3].

Morbidity with surgical abortion is also uncommon. For example, among 170,000 first-trimester surgical abortions performed in low-risk women by experienced providers, minor complications occurred in 8.46 per 1,000 cases and complications requiring hospitalization in 0.71 per 1,000 [5]. More recent reports confirm that fewer than 1 in 1,000 US women are hospitalized for abortion complications annually [6]. As with mortality, the risk of major complications is related to gestational age; it increases from about 2 per 1,000 procedures for abortions performed at 7 to 8 weeks' gestation, to 6 per 1,000 at 13 to 14 weeks, and 15 per 1,000 after 20 weeks [7].

Performing vaginal operations on obese women can be difficult or impossible, and almost half of US women of childbearing age are overweight or obese [8]. In a prospective study of 163 consecutive women having D&E abortion with preoperative laminaria, providers found that the procedures of obese women (body mass index ≥30) were significantly more difficult, took longer, and incurred greater loss of blood than those of women with normal body mass. However, the obese women were also older and had more prior pregnancies [9]. Others have confirmed a significant

association between increased blood loss and obesity among D&E patients [10]. Obesity may also present challenges for perioperative pain management (Chapter 8).

In a 2002 survey of members of the National Abortion Federation (NAF), the professional association of abortion providers in the USA and Canada, most respondents imposed no weight or body mass index restrictions on patient eligibility for abortion. Among those with a weight limit, the most common upper boundary (56%) was 300 pounds [11]. Hydraulic operating tables with lateral extensions, surgical assistants to help with retraction and visualization, large-sized surgical instruments, and adequate pain control are helpful in providing surgical abortions for obese women.

Comparison of labor induction versus D&E abortion

Historically in the USA, the method of abortion also has been an important risk factor. In a large prospective study of second-trimester abortion complications published in 1985, D&E was safer than instillation procedures using urea-prostaglandin or hypertonic saline [12]. According to legal abortion mortality data collected by the US Centers for Disease Control and Prevention (CDC) from 1972 to 1987, the number of deaths per 100,000 abortions was 0.5 for first-trimester vacuum curettage procedures, 3.7 for D&E, 7.1 for instillation abortions, and 51.6 for hysterotomy/hysterectomy [13]. At gestational ages of more than 20 weeks the difference in mortality rates for D&E and instillation procedures narrowed and was statistically nonsignificant for the period 1983 to 1987, presaging a trend that has continued in ensuing years.

More recent clinical reports suggest that if the higher rate of retained placenta associated with induction abortion can be overcome, medical procedures and D&E may have similar overall complication rates. Autry et al [14] retrospectively compared 297 pregnant women from 14 to 24 weeks' gestation undergoing either D&E or medical induction by a variety of methods. Apart from failed inductions, the only statistically significant difference was the high incidence of retained placenta (21%) in patients who had medical abortions. Those women who received misoprostol for induction rather than prostaglandin E_2 analogs had markedly fewer complications (OR 0.2, 95% CI 0.1–0.4). In another retrospective analysis of 425 women during the period 1996 to 2001 [15], induction patients experienced more complications than D&E patients in the same institution, but most of these events were associated with prolonged membrane rupture (four of nine cases), retained placenta or hemorrhage associated with prostaglandin E_2 analogs (two of nine cases), or complications unrelated to procedure method (abruption, deep vein thrombosis, one case each). This breakdown suggests that the inherent risk profile of the induction patients was greater than for D&E patients because of underlying obstetrical or maternal conditions, as is often the case in communities where both procedures are readily available.

Three recent induction abortion studies provide encouragement that aggressive regimens of misoprostol can achieve low rates of retained placenta and low overall complication rates, with high procedure success. In a multicenter study in Uzbekistan using vaginal misoprostol 400 μg every 3 hours, the incidence of retained placenta was less than 2% (two of 120 women) [16]. A study from Edinburgh, Scotland, reported curettage in 5% of 386 women using vaginal misoprostol 400 μg every 3 hours following a loading dose of 800 μg vaginally. These women had been primed with 200 mg of mifepristone 36 to 48 hours prior. The mean induction-to-abortion interval was 6.7 hours [17]. Finally, in a retrospective analysis, Green et al [18] reported a frequency of retained placenta of 6% in 233 women who received a loading dose of 400 μg of vaginal or buccal misoprostol plus 200 μg every 6 hours. The authors used a lower dose of misoprostol because they had induced fetal demise with intra-amniotic injection of digoxin 1 day prior to induction. Clinically stable patients were allowed 4 hours for spontaneous placental expulsion before intervening surgically. Patience in permitting natural placental expulsion is an important feature of induction protocols that achieve low rates of retained placenta.

In terms of the emotional burden of undergoing labor induction compared with D&E abortion, a recent prospective study of grief response showed no significant differences in depression and grief scores among 49 women with desired but severely compromised pregnancies who self-selected their method of pregnancy termination. This unique study had low power and a high dropout rate of approximately 40% at 4- and 12-month follow-up intervals [19].

Finally, data regarding risk of future adverse obstetrical outcomes subsequent to abortion are reassuring (Chapter 16). A Danish study found no differences in women who had had a previous first-trimester medical versus surgical abortion [20]. Three US studies [21–23] have described the subsequent obstetrical outcomes of women who underwent D&E abortion with preoperative cervical preparation. Among the collective total of more than 200 subsequent pregnancies, the only adverse outcome that occurred at higher frequency than that in historical or matched controls was preterm delivery in women with prior obstetrical histories of cervical incompetence or premature membrane rupture [22]. Case-control studies of obstetrical outcomes following first-trimester vacuum abortion have been plagued with recall bias. Women with adverse health outcomes are more likely to recall and acknowledge previous induced and spontaneous abortion. Risk of nondisclosure is higher in women subjected to domestic violence and those who regard their intimate relationships as weak [24]. Scandinavian studies largely overcome these methodological limitations by identifying subjects through cross-linked birth and abortion registries. In one such study the authors

[25] matched 670 primiparas with a prior vacuum abortion to 622 primiparas and 626 secundiparas who had had no abortions; they found no significant difference in obstetrical outcomes. In a more recent registry-linked study [26], the frequency of preterm delivery was significantly higher in women with histories of induced or spontaneous abortion only when the interpregnancy interval exceeded 12 months; this study did not control for socioeconomic status or smoking during pregnancy.

Hysterotomy as a means of pregnancy termination is generally regarded as an outmoded operation and has been associated with high risk of complications. However, the procedure is on rare occasion the most prudent option as when, for example, anatomical (e.g., large fibroids obstructing the cervical canal), medical (e.g., eclamptic shock or maternal acute major organ failure), or traumatic (uterine injury) conditions compel immediate delivery, surgical repair, or both [27]. Taking into account the putative risk of rupture or hemorrhage resulting from induction-type terminations may also sway clinicians to recommend hysterotomy, especially when no D&E option is available. A recent series from a teaching hospital in India recorded 10 nonemergent hysterotomies in women electing second-trimester abortion combined with permanent sterilization. Indications were two prior cesareans (five women); placenta previa (three women); psychiatric illness (one woman); rheumatic heart disease (one woman); and epilepsy (one woman). This facility routinely provides second-trimester induction abortions using prostaglandins. The only complication was hemorrhage occurring in one patient who was treated medically without transfusion [28].

Misestimation and failure in induced abortion

Underestimation of gestational age

Underestimation of gestational age can result in preventable complications, particularly when the gestational age lies beyond the surgical skills of the provider or when cervical priming is omitted in a patient with a noncompliant cervix. Facilities providing abortion without ultrasonographic confirmation of gestational age should advise patients about this possibility during the informed consent process. Clinical dating using the patient's history and pelvic examination can sometimes be inaccurate, irrespective of clinician experience (Chapter 6). Patient anxiety, obesity, and uterine retroversion make gestational age assessment particularly challenging. As a result, providers typically obtain ultrasound confirmation when uterine size is uncertain or exceeds 12 weeks.

In a series of 15 cases of uterine perforation during D&E, the authors found underestimation of gestational age by 2 weeks or more in six patients [29]. Seven patients had not undergone preoperative ultrasonography. In three cases the surgeon unwisely proceeded with the abortion despite an assessment that cervical dilation was inadequate.

Telltale signs of underestimation during D&E include more amniotic fluid than anticipated and larger-than-expected fetal parts or umbilical cord diameter. When underestimation is suspected, the provider should stop the procedure and use ultrasonography to estimate gestational age. In the case of an early- or mid-second-trimester pregnancy with a compliant cervix, an experienced surgeon may be able to dilate the cervix safely using mechanical dilation. Usually, however, the safer strategy is to stop and prepare the cervix with osmotic dilators or prostaglandins before completing surgical evacuation. An alternative is to switch the procedure to a labor-induction abortion. Amended consents and prophylactic antibiotics are advisable in these circumstances.

Failed attempted abortion

Failed surgical abortion is rare. In a large prospective study conducted from 1975 to 1978, the proportion of failed first-trimester surgical abortions was 2.3 per 1,000 procedures [30]. According to voluntary self-reports by NAF member clinics, the frequency following first-trimester surgical abortion has remained constant during the last decade at about 0.5 per 1,000 cases; some underreporting is likely, however. Several factors increase the risk for this complication. Uterine anomalies, whether congenital (e.g., bicornuate or septate uterus) or acquired (e.g., fibroids, synechiae), are associated with a high risk of failed attempted abortion. In a study of 33,000 first-trimester abortions, the relative risk of failed abortion in women with uterine anomalies was 90 times that of women with normal anatomy; multiple prior pregnancies, early gestational age, and operator inexperience also conferred increased risk [30]. In another series, involving 25 failed vacuum abortions, four patients had septate uteri, three had rudimentary horns, and eight had tubal ectopics [31].

Recent reports have addressed the risk of failure with early surgical abortion. Using a protocol involving sensitive human chorionic gonadotropin (hCG) testing, intraoperative ultrasonography, and manual vacuum aspiration, a physician performed surgical abortions on 2,399 patients with gestations of less than 6 weeks. Only three (0.13%) required reaspirations for continuing pregnancies, which were discovered expeditiously. Three additional reaspirations were performed for hematometra [32]. Among 1,132 patients having vacuum abortions at less than 6 weeks' gestation by several experienced physicians at a large Planned Parenthood affiliate, the risk of failed abortion was 2% after rigorous follow-up [33].

Failed attempted abortion is usually recognized by immediate gross tissue examination with backlighting or the use of magnification when necessary. Clinic staff members can be trained to become proficient examiners of tissue specimens. Routine screening of tissue aspirates may on occasion uncover important ancillary findings including suspicion of hydatidiform mole, multiple gestation, or fetal

deformity, disclosure of which may prove useful in genetic counseling [34].

Postoperative ultrasonography is usually diagnostic of failed attempted abortion, but formal ultrasound consultation is sometimes necessary. Collapsed sacs and small intact gestational sacs in bicornuate, septate, or large fibroid uteri, as well as cornual/interstitial implantations, can be challenging to visualize. A useful first-trimester evacuation technique with uterine duplication anomalies is to direct a malleable sound into the pregnant cavity under ultrasound guidance (Chapter 13).

In some instances, failed abortion is not recognized immediately. Patients who report persistent pregnancy symptoms after a week warrant evaluation for continuing pregnancy. However, not every woman with a failed abortion experiences or acknowledges pregnancy symptoms. Although current data do not support the need for a routine postabortion visit for all patients [35], scheduling follow-up for those with risk factors for failed abortion is prudent unless the provider unequivocally confirmed successful abortion at the time of the procedure. Low-sensitivity urine hCG assays offer a simple and inexpensive means of screening patients after surgical abortion. A positive latex-agglutination hCG slide test (sensitivity of about 1,500 to 2,000 mIU/ml) 2 weeks after surgical abortion warrants assessment for retained placenta, ongoing pregnancy, or gestational trophoblastic disease. When failed abortion is diagnosed, most patients choose to undergo repeat uterine evacuation, as did all patients in the aforementioned series by Kaunitz [30] and Valle [31].

Failed attempted abortion may or may not adversely affect obstetrical outcomes in women who continue their pregnancies. Data are limited to small case series. A recent US single-institution report described 18 failed attempted vacuum abortions, 11 (60%) of which occurred at 7 weeks' gestation or less. By 6 weeks after the procedure, only 12 failures (67%) had been discovered. Seven patients elected to continue their pregnancies, and another four exceeded the upper-gestational-age limit for an abortion. Among these 11 continuing pregnancies, seven (77%) had complications: growth restriction occurred in two; preterm labor in two, and premature membrane rupture in three. In all, eight of 11 newborns survived. Two mothers had postpartum depression and seven expressed guilt, underscoring the potential emotional burden of experiencing traumatic obstetrical outcomes after a reversal of the initial decision to abort [36].

Retained tissue

Incomplete abortion

Retained products of conception is one of the more common complications of surgical abortion. Worldwide, the frequency of reaspiration after first-trimester surgical abortion varies from 0.29 to 1.96% and in the second trimester, from 0.40 to 2.70% (Table 15.2).

Women with retained products commonly present with lower abdominal pain and bleeding. Although symptoms usually arise within the first week, patients with subtle symptoms may not seek immediate attention. Infection occurs infrequently provided the operators are well trained, use sterile technique, and the uterus has not been injured. The uterus may feel enlarged and soft, and ultrasonography reveals a heterogeneous echo complex in the cavity. However, gray-scale ultrasonography and bimanual uterine examination cannot distinguish between retained products of conception and hematometra unless placental tissue protrudes from the cervical os or fetal bone is seen on ultrasonography [37]. Also, intrauterine collections of varying echogenicity represent normal ultrasound findings after surgical abortion and do not usually warrant intervention in asymptomatic women [38,39].

The pathology report after reaspiration may also be unhelpful or misleading. In a pilot study with a convenience sample of 200 women undergoing first- and second-trimester surgical abortions by a single experienced operator, a pathologist identified scattered villi microscopically in 32% of specimens obtained by repeat vacuum curettage for 30 seconds immediately after clinically complete evacuation (Christensen D, 1995, unpublished observations). Thus, the presence of villi on pathology slides after successful surgical abortion is an expected finding and is not diagnostic of retained tissue.

After surgical abortion, small amounts of retained products may pass spontaneously, avoiding the need for further intervention. If large amounts of tissue are left, the patient is at risk for bleeding and infection. Endometritis following untreated incomplete abortion can evolve into salpingitis and, occasionally, sepsis [53]. Therefore, prompt vacuum reaspiration or prostaglandin therapy (e.g., misoprostol 800 μg vaginally) is the treatment in symptomatic cases; sharp metal curettage should not be used as the primary means of evacuation. Aspiration is preferred over expectant or medical management if signs of infection, hemorrhage, severe pain, or serious anemia are present. Antibiotic treatment after reevacuation is optional unless the provider suspects infection.

Thoroughness is the key in reducing the risk of retained products after surgical abortion. Proper surgical technique includes positioning the vacuum cannula well into the endometrial cavity and suctioning until tissue is no longer forthcoming; a gritty sensation is often detectable as the cannula moves against the emptied uterine cavity (Chapter 10). Intraoperative ultrasonography may be helpful in difficult cases. Although some clinicians perform a sharp curette check at the end of the procedure, no data exist concerning the advisability of this practice and it may carry some risk.

Hematometra

Hematometra refers to accumulation of blood in the uterine cavity. This gynecological term is preferable to obsolete

Table 15.2 Frequency of reaspiration[a] after induced abortion

Study	Study Period	Facility	Gestational Age (weeks LMP)	Total Patients	Comments	Frequency of Re-aspiration (%)
Grimes et al [40]	1971–1975	Multicenter, mostly inpatient (USA)	13–24	11,254	Induction with $PGF_{2\alpha}$ ($n = 1,241$) Induction with saline ($n = 10,013$)	36.10 28.27
Peterson et al [41]	1972–1981	One hospital clinic (USA)	13–22	11,720	Surgeon experience related. Some acute and some remote in time	0.30
Hakim-Elahi et al [5]	1971–1987	Freestanding clinics (USA)	≤14	170,000	Repeat suction on day of surgery: 0.18% (88% = hematometra) Repeat suction subsequently: 0.17%	0.35
Hodgson & Portmann [42]	1972–1973	Freestanding clinic (USA)	≤12	10,453	Retained tissue	0.43
Wulff & Freiman [43]	1973–1976	Freestanding clinic (USA)	≤14	16,410	Failed and incomplete abortion	0.54
Wadhera [44]	1975–1980	Hospitals (Canada)	≤13 (84% of cases)	351,879	Retained products of conception	1.96
Hill & MacKenzie [45]	1976–1987	Hospital (Great Britain)	14–19 (88% of cases) Induction, PGE_2	2,308	Readmission for surgical evaluation	1.40
Hern [46]	1977–1982	Freestanding clinic (USA)	17–25 (D&E plus urea)	1,000	Repeat aspiration, acute or remote	2.70
Altman et al [47]	1979–1980	Hospital (USA)	13–18 (83% of cases) Evacuation primarily by vacuum aspiration	1,392	Repeat aspiration	0.36
Jacot et al [48]	1986–1990	Hospital–attached clinic (Canada)	≤14 (vacuum) 15–20 (D&E)	3,225 547	Incomplete abortion Incomplete abortion	0.90 0.40
NAF [49]	1992–1995	Freestanding clinics (USA)	≤13 (87% of cases)	1,024,428	Repeat procedures (voluntary self-reporting)	0.29
Hern [50]	1990–1999	Freestanding clinic (USA)	18–34 Oxytocin induction	1,677	Reaspiration	1.60
Pridmore & Chambers [51]	1992–1998	Public ambulatory surgery center (Australia)	4–13	11,982	Need for repeat aspiration	1.65
Choudhary et al [28]	1997–2001	Teaching hospital (India)	≤12	961	Failed plus incomplete abortions	1.46
Patel et al [52]	2002–2003	19 affiliated outpatient clinics (USA)	12–23 6/7	2,218	One case only (associated with a perforation)	0.05
Kapp et al [16]	2006	13 maternity hospitals (Tashkent, Uzbekistan)	14–24 Induction MSP or saline/PGF	108 saline/PGF 120 MSP	Curettage for retained placenta (routinely performed after saline inductions by some physicians in this study)	64.8 1.7

[a] The terms repeat aspiration, reaspiration, and repeat suctioning are those of the investigators and are synonymous.
NAF = National Abortion Federation; MSP = misoprostol; PGF = prostaglandin $F_{2\alpha}$

descriptions such as "postabortal syndrome," "redo syndrome," "postabortal pain syndrome," and retained clot. The frequency of this complication after suction curettage is about 2 per 1,000 [5,54]. In one study of 170,000 vacuum abortions, 88% of patients requiring remote aspiration (n = 285) had hematometra rather than retained products of conception [5]. Studies comparing general anesthesia with local anesthesia have not shown differences in the frequency of hematometra [5].

The volume of liquid and clotted blood varies, as does the timing of presentation. For example, accumulation of 250 to 1500 ml of blood causes low midline pelvic pressure and cramping within 15 minutes and up to several hours after the procedure. When large volumes of blood are sequestered in the uterus, hypotension may occur. Alternatively, patients may have vasovagal reactions from the pain of uterine distension. Accumulations of less than 100 ml are more common and can remain asymptomatic, even for a few weeks. Patients may have sudden expulsion of clots, pelvic pressure, and mild fever. Typically, pelvic examination reveals an enlarged, firm, and tender uterus; ultrasonography shows an intrauterine heterogeneous echo complex (Fig. 15.1). The process is often self-limiting and responds immediately to repeat suctioning. Reaspiration can be accomplished with an electric suction machine, manual vacuum aspirator, or even wall suction in an emergency department. Mild temperature elevations are usually not indicative of infection; these usually resolve rapidly with reevacuation, regardless of antibiotic coverage.

Prophylactic uterotonic agents may reduce the risk of postabortal hematometra, although data are sparse. Approaches include oral ergot derivatives, such as ergonovine 0.1 mg intramuscularly or intracervically, or low-dose locally administered vasopressin [55,56]. Small intrauterine accumulations of blood visible on ultrasonography after surgical abortion are normal, may take several days to dissolve or expel, and should be regarded as a natural physiologic event that seldom requires intervention [38,39,57].

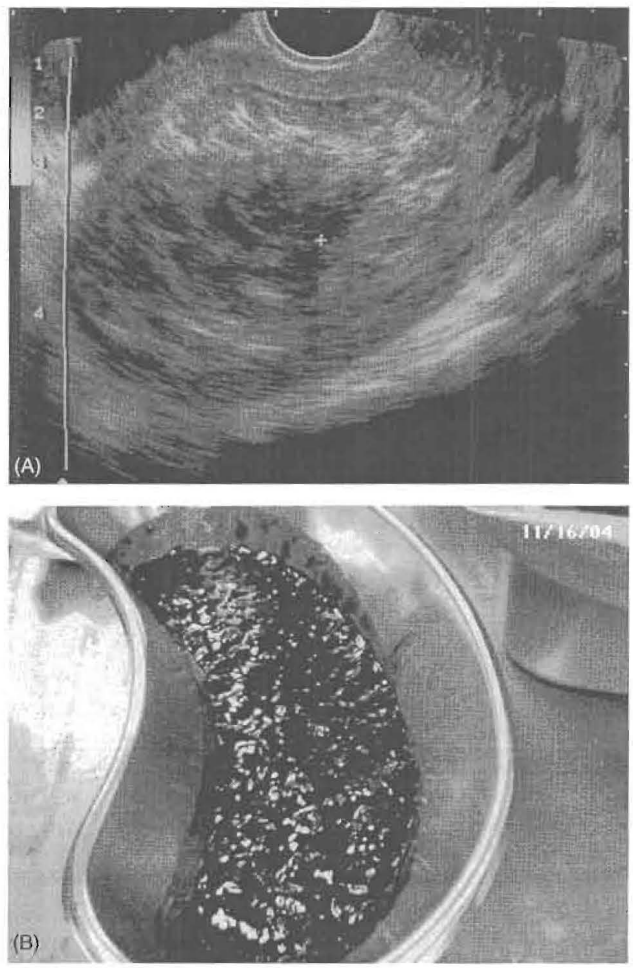

Figure 15.1 (A) Transvaginal ultrasound image showing intracavitary heterogeneous echoes in a patient with hematometra diagnosed 4 days after aspiration abortion at 12 weeks' gestation. (B) Uterine reaspiration yielded approximately 150 cc of blood clots and serum only.

Hemorrhage

Uterine hemorrhage associated with abortion can result from cervical laceration, perforation, retained tissue, uterine atony or rupture, uterine scar-related problems, arteriovenous malformations, placental abnormalities (accreta, increta and percreta), or coagulopathy. Because of the poor validity of estimates of blood loss and varying definitions of hemorrhage, sound comparisons of incidence are elusive. Over time, however, incidence rates in North America have trended downward, possibly reflecting greater surgical experience and more skill in the use of uterotonic agents (Table 15.3). The rare frequency of blood transfusion provides a better measure of serious blood loss.

Surgical inexperience and gestations beyond 10 weeks are associated with increased risk of uterine hemorrhage. Other risk factors include advanced maternal age and parity [62], prior cesarean delivery, number of uterine scars, uterine fibroids, and history of excessive postabortal or postpartum bleeding. By reducing uterine tone, halogenated anesthetic gases may also increase the risk of blood loss.

Several measures may reduce blood loss with abortion. Administration of vasopressin 4 units with paracervical anesthesia reduces bleeding with second-trimester D&E, and the effect increases with gestational age [63]. Peterson et al reported a decrease in the incidence of blood loss exceeding 500 ml from 9 per 1,000 D&Es to 2 per 1,000 in a large (n = 12,000) single-institution series after 1 ml of vasopressin was added to the local cervical anesthetic [41]. Pridmore and Chambers found similar improvement when 5 μg/ml of epinephrine was added to the intracervical block (n = 5,700 patients) [51]. Another study reported that local vasopressin produced a 50% reduction in blood loss at all gestations before 13 weeks [64].

Table 15.3 *Single-institution reports of hemorrhage rates with induced abortion.*

Study	Study Period	Facility	Abortion Method	Gestational Age (weeks LMP)	Total Patients	Blood Loss >250 ml/1,000 Cases	Comments
Hakim-Elahi et al [5]	1971–1987	Freestanding clinics (USA)	Vacuum aspiration	≤14	170,000	0.07[a]	No difference in morbidity between local (75%) and general (25%) anesthesia
Hodgson & Portmann [42]	1972–1973	Freestanding clinic (USA)	Vacuum aspiration	≤12	10,453	None	93% of patients <10 weeks LMP
Bozorgi [58]	1973–1974	Freestanding clinic (USA)	Vacuum aspiration	≤14	10,890	1.5	72% of patients <11 weeks LMP; 28% of patients 11–14 weeks LMP Increased incidence if surgeon less experienced
Wulff & Freiman [43]	1973–1976	Freestanding clinic (USA)	Vacuum aspiration	≤14	16,400	0.7	64% of patients <11 weeks LMP; 36% of patients 11–14 weeks LMP
Hodari et al [59]	1974–1976	Hospital (USA)	Vacuum aspiration	13–15	2,500	12.0[b]	97% of patients 13–15 weeks LMP No osmotic dilators used General anesthesia used in all cases, but agent(s) unspecified Oxytocin 10 units IV after operation completed Mean operating time 13 minutes
Pahl & Lundy [60]	1975–1977	Hospital (USA)	Saline, $PGF_{2\alpha}$, or both	13–25	1,839	20.0[c]	
Peterson et al [41]	1972–1981	One hospital clinic (USA)	D&E	13–22	11,720	0.9[d]	Incidence fell to 0.2% after 1 ml of vasopressin was added to the cervical anesthetic
Hill & MacKenzie [45]	1976–1987	Hospital (Great Britain)	Induction, PGE_2	14–19 (88% of cases)	2,308	5.6[b]	
Hern [46]	1977–1982	Freestanding clinic (USA)	D&E plus urea	17–25	1,000	21.0[d]	
Altman et al [47]	1979–1980	Hospital (USA)	Vacuum aspiration	13–18 (83% of cases)	1,392	8.6[c]	
Hern [50]	1990–1999	Freestanding clinic (USA)	Induction with oxytocin; digoxin or urea to cause fetal demise	18–34	1,677	38.0[d]	Only 3/27 required transfusion, 2 of whom had DIC
Choudhary et al [28]	1997–2001	Teaching hospital (India)	Vacuum aspiration	≤12	961	0.3	All were treated medically
Castleman et al [61]	1999–2002	Teaching hospital (Hanoi, Vietnam)	D&E	12–18	439	2.3	The only case had a large fibroid uterus
Patel et al [52]	2002–2003	19 affiliated outpatient clinics (USA)	D&E	12–23 6/7	2,218	4.1[d]	4 of 10 were associated with uterine perforation

[a] Enumerates only patients who required hospitalizations.
[b] Enumerates only patients who required transfusion.
[c] Blood loss >500 ml or patient required transfusion.
[d] Blood loss >500 ml.
DIC = disseminated intravascular coagulopathy.

Uterine atony

Uterine atony is a potentially serious complication of induced abortion. Clinicians should consider it whenever excessive blood loss occurs during or after an abortion.

Depending on the severity of bleeding, treatment may proceed sequentially or concomitantly. Treatment options include manual uterine massage, dilute intravenous oxytocin, intramuscular ergot derivatives, and low-dose cervical vasopressin injections (e.g., 4 to 6 pressor units injected in the paracervical tissue as part of cervical anesthesia). Intraoperative use of the four classes of uterotonic agents (oxytocin, ergot, vasopressin, and prostaglandins) reduces surgical blood loss in abortion, particularly after the first trimester. Elaborated at separate gene sites, they probably work synergistically to control bleeding.

For treating atony, rectal misoprostol has largely replaced intramuscular carboprost (250 μg, repeated every 15 minutes up to eight doses) in many centers as the initial high-intensity option. Five tablets per rectum (1000 μg) usually stop bleeding within a few minutes [65] and this regimen is both less expensive and potentially less noxious (vomiting, diarrhea, transient fever) than carboprost. Higher-dose vasopressin (10 units) in 20 ml of crystalloid, administered transcervically into the myometrium at multiple sites, produces rapid vasoconstriction that may last for up to 45 minutes.

Intrauterine tamponade with plain gauze [66] or with vasopressin- or thrombin-soaked [67] gauze packing can be an effective temporizing or therapeutic measure; so can balloon catheters [68]. Foley catheters with 30- to 75-ml balloons are standard equipment in many operative settings and have been inflated safely beyond their stated capacity in emergencies [68,69] with good clinical outcomes. For uterine cavities capable of greater distension, a larger intrauterine catheter [70] can inflate to volumes of 250 ml.

Surgical measures include encircling sutures around the uterus, hypogastric [71] or uterine artery ligation [72], and hysterectomy. B-Lynch [73] described a single suture surrounding the uterine wall. Of the simplified versions published since then [74,75], the modification by Pereira [76] is the only one that avoids entry into the uterus. A single-institution series of 28 postpartum cases using primarily the B-Lynch technique reported success in 82%. Among seven of these patients who underwent subsequent repeat cesareans, grooves or mild adhesions of the uterine serosa were observed in four cases [77]. Data are too limited to evaluate any effect on future fertility. Effective use of a Bakri balloon (Appendix, Fig. A-14) together with a B-Lynch compression suture has been reported [78].

Angiographic embolization is another treatment option for refractory atony [79,80]. Borgatta summarized 11 unpublished and seven published cases of embolization use in women undergoing spontaneous or induced abortions; three cases had atony as a contributing diagnosis. Seventeen of 18 women had successful treatment, including all 11 women with pregnancies beyond 14 weeks' gestation [79]. Angiographic embolization has clinical limitations; it takes about 1 hour to set up after the radiology team is assembled. It may be inadequate to treat multiple vessel injuries accompanying a large uterine laceration, and its success with placenta accreta/increta/percreta is mixed [79,80]. Occasionally, cases refractory to occlusion of the uterine artery alone will then respond when the utero-ovarian vessels are supplementally injected with occlusive agents [79]. On occasion, radiopaque dye alone may occlude a single damaged arteriole responsible for uncontrolled hemorrhage after D&E abortion [81].

Placental abnormalities

In ultrasonography studies, the reported prevalence of second-trimester placenta previa ranges from 2 to 6%; rates are higher if low-lying placentas are included [82]. Placenta previa itself (without placenta accreta) does not complicate abortion, including D&E [83,84]. Likewise, vasa previa has not been associated with abortion-related complications [85]. In terms of the pathophysiology of benign previas, serial ultrasonography of the progressing pregnancy illustrates an upward migration of the placenta toward the fundus as the placenta seeks the more fulsome blood supply available in the fundus, resulting in the relative atrophy of the portion overlying the less well-perfused lower segment and cervix [85]. As a result, unless placenta previa actually overlies a uterine scar (usually entailing a complete or wraparound previa), risk of abnormal placental adherence is low. Laminaria insertion is safe in the presence of benign placenta previa [86]. Even when an accreta is present, *insertion* of osmotic dilators does not usually trigger uncontrollable bleeding, but their removal may. Hence, the provider must be equipped to deal immediately with life-threatening hemorrhage at the start of any procedure in which placenta accreta is known or suspected. In a case-control study, Johnson et al [87] found that repeated sharp curettage procedures (OR 2.9, 95% CI 1.0, 8.5 for $\geq$3 abortions), but not multiple vacuum aspirations (OR 1.4, 95% CI 0.6, 3.1 for $\geq$3 abortions), were associated with risk of subsequent placenta previa. This finding carries stark implications for regions where sharp curettage is still commonly practiced for induced abortion or management of spontaneous abortion.

Placenta accreta carries the risk of torrential bleeding during uterine evacuation, and its frequency may be increasing as cesarean delivery becomes more common [88]. In a large series of D&E abortions, the estimated prevalence of placenta accreta was about 0.4 per 1,000 operations. All seven patients had at least one prior cesarean delivery, and all required hysterectomy for management of hemorrhage [89]. The most recent information on the relationship between cesarean delivery and placenta accreta comes from the Maternal-Fetal Medicine Units Network [90,91]. In these obstetrical populations the risk of placenta accreta,

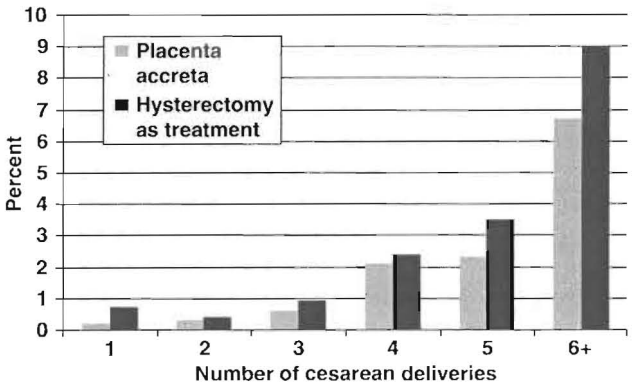

Figure 15.2 The relationship between number of cesarean deliveries and the risk of placenta accreta and hysterectomy for treatment (Data from Silver et al [90].)

and hysterectomy as its treatment, increased exponentially with the number of previous cesarean deliveries women had (Fig. 15.2).

Placenta accreta is rare in first-trimester abortion [92–94]. Second-trimester abortion patients with complete placenta previa and a history of cesarean delivery are at serious risk for placenta accreta. Placental localization for second-trimester patients with prior uterine incision may be helpful, with referral of suspicious cases to a skilled ultrasonographer. Color Doppler ultrasonography, computer-assisted tomography (CT) scanning, or magnetic resonance imaging (MRI) have varying diagnostic accuracy [95,96] (Fig. 15.3). The combination of initial color Doppler scanning (sensitivity 0.77, specificity 0.96) plus confirmatory MRI for equivocal cases (sensitivity 0.88, specificity 1.0) has been effective [97].

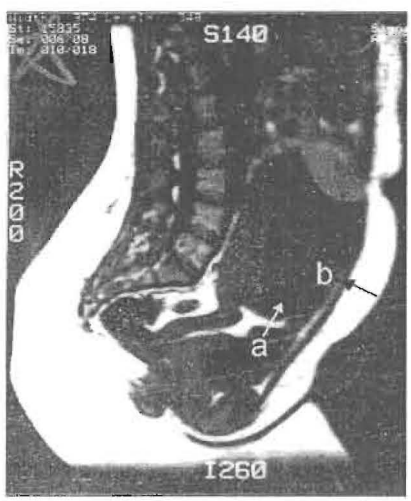

Figure 15.3 Magnetic resonance imaging (MRI) ruled out placenta accreta in a woman 23 weeks pregnant with placenta previa and a history of three prior cesarean deliveries. Sagittal T2-weighted image through the placenta previa. Normal placenta (a) remains dark and does not invade the anterior scar tissue (b), which remains lucid throughout.

Angiographic embolization has been used with mixed results to treat unremitting hemorrhage from placenta accreta following D&E. Borgatta [79] reported four successful preoperative embolizations among eight patients with high radiological suspicion of placenta accreta. These women underwent surgical abortion at or after 12 weeks' gestation. Steinauer and colleagues [80] reported successful uterine artery embolization in 38 of 42 patients. The four treatment failures had histologic confirmation of placenta accreta (increta or percreta) after hysterectomy. Eight women with cervical lacerations or perforations had successful embolizations.

When placenta accreta is suspected, performing the D&E in a hospital with full blood-bank capabilities is prudent. Second-trimester labor induction is contraindicated. The preoperative treatment plan should include extensive family counseling and mobilization of staff and supplies necessary to perform emergency hysterectomy with massive blood and clotting-factor replacement. Preoperative placement of an angiographic port is advisable in high-risk cases, especially those that suggest bladder involvement (placenta percreta). Prophylactic stenting of the ureter(s) deserves consideration as well. For select cases, allowing the adherent placenta to remain *in situ* is an option [98], sometimes in conjunction with administration of methotrexate to promote its reabsorption. Because these measures entail some risk of remote bleeding as well as infection [98] and no studies are available to gauge their overall benefit versus risk, expert consultation is advisable when contemplating their use.

Arteriovenous malformation

Uterine arteriovenous malformation (AVM) of the endometrium, a rare but life-threatening condition, can be congenital or acquired. Operations, trauma, infection, or neoplasm (e.g., gestational trophoblastic disease or carcinoma) can lead to abnormal communication between arteries and veins. With color Doppler ultrasound, CT scan, MRI, or angiography, an AVM appears as a loosely arrayed bundle of inchoate vessels resembling the findings seen at the site of a placenta accreta; hence they are sometimes misdiagnosed, one for the other [94].

An AVM can produce massive bleeding unresponsive to standard uterotonic therapy. In other instances, heavy or moderate persistent bleeding can occur hours, days, or months later. Hemorrhage associated with AVM has occurred spontaneously [99] and following spontaneous abortion [100], early medical abortion [101], and surgical abortion in the first [102] and second trimesters [103]. Conservative management has been successful for milder presentations [101], but serious bleeding warrants angiographic embolization, which has often been therapeutic, with anecdotal reports of subsequent successful delivery in five cases [104].

Disseminated intravascular coagulopathy

Disseminated intravascular coagulopathy (DIC) is an infrequent but dangerous complication. First-trimester frequency ranges from 0.0 to 0.08% [48,105] (Lichtenberg ES, 1995, unpublished observations) and in the second trimester, 0.0 to 0.5% [40,49,106]. The risk of DIC increases with advanced gestational age, prolonged fetal death, abruptio placentae, placenta previa or accreta, amniotic fluid embolism, and massive blood loss. DIC can follow an uncomplicated D&E in a patient without preexisting conditions (idiopathic DIC). In dedicated pregnancy termination facilities with experienced surgeons, idiopathic DIC is the most common clinical presentation of this condition. Intravascular infusion of amniotic fluid during the operation has long been hypothesized to trigger the clotting cascade, with the coagulopathy first becoming evident in the recovery room. In reality, fetal cells are invariably present in the maternal circulation beginning in early pregnancy, and no compelling evidence has explained why most pregnancies avoid this complication despite the obvious admixing of maternal and fetal elements in the maternal circulation.

In abortion practice, recognition of DIC is complicated by its infrequency, mimicry, and insidious onset. What begins as normal or absent bleeding may evolve into accumulation of intrauterine clot resembling postabortal hematometra before ultimately manifesting as DIC. The transformation from clotted bleeding to serosanguineous flow may take from 30 minutes to 6 hours or more. Differential diagnoses include uterine atony and operative trauma. Aggressive uterotonic therapy, reaspiration, and thorough digital examination of the uterus help to exclude these other conditions.

A coagulation panel is useful but not essential. Drops in fibrinogen level and platelet count and increased fibrinogen degradation products (fibrin split monomer) or D-dimer (molecules resulting from fibrinolysis of thrombi) are the most sensitive indices. Clinicians can diagnose DIC early in its course with a simple bedside test: failure of 10 cc of whole blood to produce a retracted, stable clot in a plain glass tube within 5 to 10 minutes indicates impaired clotting. Conversely, the presence of a solid clot excludes DIC from the differential diagnosis at that time.

Once the diagnosis of DIC is made, therapy consists of clotting factors and volume replacement and, if needed, red cell transfusions. Rapid treatment may forestall progression of DIC. Therefore, one or two large (16 to 18 gauge) intravenous ports should be established for rapid infusion. True blood loss may substantially exceed measured blood loss, because DIC is a systemic process involving small vessels throughout the body. When administered early in DIC, as little as 2 to 4 units of fresh frozen plasma (FFP) usually restore clotting function; occasionally, 5 to 8 units or more are needed. Each standard unit of FFP (200 to 250 ml) raises fibrinogen levels about 25 mg/dl. Although FFP derived from AB-negative donors is usual, specimens from AB-positive donors can be utilized safely if the patient receives full dose Rh-immune globulin.

Cryoprecipitate is another important acceptable clotting factor replacement. It is the cold precipitable fraction of FFP suspended in a minimal plasma volume and refrozen. Cryoprecipitate contains only fibrinogen (200–300 mg), factor VIII:C (80–120 units), von Willebrand factor, fibronectin, and factor XIII. Like FFP, cryoprecipitate is type-specific, has a shelf life of 1 year, and can be thawed rapidly by microwave. About 14 units are required to raise fibrinogen 100 mg/dl. The selection and number of units of products can be coordinated with blood bank personnel and guided by the severity of the coagulopathy; it has the advantage of equal effect at lower replacement volume but is more expensive.

Recombinant activated factor VII (rFVIIa) is a powerful, costly (US$9,000 to $18,000) synthetic procoagulant therapy [107]. Where available, it can serve as a last resort for unremitting hemorrhage because of tissue injury or coagulopathy [108]. Onset of action typically occurs 10 to 30 minutes after infusion. Thrombosis is a rare complication, mostly among patients extensively immobilized during convalescence.

Transfusion with packed red blood cells deserves consideration when orthostasis, confusion, or oliguria persist after volume replacement with crystalloid or plasma expanders. In a normal adult, blood volume comprises 8% of body weight (5,600 ml in a 70-kg [154-lb] adult). Young, healthy women with continuing acute blood loss below a hematocrit range of 15 to 19% may require transfusion [109,110]. Earlier transfusion may be indicated in women with cardiovascular or respiratory disease. Because the hematocrit does not equilibrate for several hours after acute blood loss, treatment is guided by a combination of blood pressure, pulse, urine output, and clinical judgment, and not solely by serial hematocrit levels. Attentive monitoring is the rule and should include periodic orthostatic vital signs, vaginal pad counts, measurement of urine output (>25–30 ml/hour), inspection for cutaneous bleeding sites, evaluation of patient consciousness, and serial hematocrit determinations and clotting indices. Cessation of vaginal bleeding is often the first sign of successful therapy. Once uncomplicated DIC is reversed, it rarely recurs.

Infection

Endoparametritis

Worldwide, the frequency of infection after first-trimester surgical abortion varies widely from 0.1 to 4.7% (Table 15.4). This disparity reflects differences in method of ascertainment, definition of infection, and inclusion of outpatient cases. In the second trimester, infection rates with both medical and surgical abortion methods have remained within the narrow range of 0.4 to 2% in North America and Great Britain, except during the 1970s when instillation regimens

Table 15.4 Frequency of infection following first-trimester vacuum aspiration abortion.

Study	Study Period	Facility	Gestational Age (Weeks LMP)	Total Patients	Antibiotic Prevention	Criteria for Diagnosis of Infection	Frequency of Infection (%)
Hakim-Elahi et al [5]	1971–1987	Freestanding clinics (USA)	≤14	170,000	None	Fever was not a requisite criterion Any pelvic tenderness Suspicious history	0.46
Hodgson & Portmann [42]	1972–1973	Freestanding clinic (USA)	≤12	10,453	Infrequently	Pain, fever, bleeding	0.28
Wulff & Freiman [43]	1973–1976	Freestanding clinic (USA)	≤14	16,400	Yes	Temp. ≥38°C ≥1 day	0.10
Wadhera [44]	1975–1980	Hospitals (Canada)	≤13	351,879	Variable	Not specified	0.18
Heisterberg & Kringelbach [111]	1980–1985	Hospital (Denmark)	≤12	5,851	None	Temp. ≥38°C Antibiotic therapy	2.40 3.20
Fried et al [112]	1987	Hospital (Sweden)	≤15	1,000	Preoperative doxycycline if chlamydia culture was positive	Not specified	4.70
Choudhary et al [28]	1997–2001	Teaching hospital (India)	≤12	961	Two oral antibiotics for each patient	Excessive discharge plus lower abdominal or adnexal tenderness; all were treated orally	1.8

of induction abortion were still being refined (Table 15.5). Higher rates reported in Scandinavia could in part reflect the larger number of providers, each of whom do a small number of cases annually, as well as more sensitive clinical triggers for invoking the diagnosis.

Typically, signs and symptoms of postabortal endometritis arise within the first few days. Some combination of reported pain, fever, pelvic tenderness, and white count elevation is usually, but not invariably, present. The cervix should be tested for sexually transmitted pathogens; blood or uterine cultures are rarely informative. Because untreated infection can result in chronic pelvic pain, dyspareunia, infertility, and, on occasion, sepsis, a high index of suspicion and expedient treatment are warranted.

Established risk factors for postabortal infection include age less than 20 years; previous pelvic inflammatory disease (PID); and the presence of sexually transmitted pathogens in the cervix at the time of abortion, particularly chlamydia [114–116] or gonorrhea. Studies of prophylactic treatment of bacterial vaginosis are of limited quality and thus inconclusive [117] (Chapter 7). Most postabortal infections occur in women without these risk factors.

Two randomized trials have addressed the efficacy of vaginal cleansing to prevent postabortal infection before surgical abortion. Chlorhexidine digluconate was not found superior to sterile saline washing or no vaginal preparation. Prophylactic antibiotics were not used in either study [118,119].

Administration of prophylactic antibiotics reduces the risk of infection following surgical abortion by about 40% [120]. This protective effect was evident not only in women with antecedent risk factors (history of PID, positive preoperative chlamydia culture, or preoperative bacterial vaginosis), but also in low-risk groups. Two recent US prevalence studies [121,122] showed that carriage rates of chlamydia and gonorrhea are highest among Black women and lowest among White women by a factor of two to four times, with higher rates found among females age 14 to 19 years and highest rates among those with a history of gonorrhea or chlamydia in the previous 12 months. At a large public hospital pregnancy termination clinic in the USA, 11.4 and 2.6% of women tested positive during 2006 for chlamydia and gonorrhea, respectively [123]. Knowing prevalence data in a specific demographic population seeking abortion may influence strategies for postabortal infection prevention (e.g., screen-and-treat versus routine coverage). Routine perioperative antibiotic coverage may prevent up to half of all postabortal infections in the USA and is highly cost-effective.

The optimum drug regimen for routine antibiotic prevention remains unclear. Most studies have used tetracyclines or nitroimidazoles (e.g., metronidazole or tinidazole). Penicillins, erythromycin, and ofloxacin are superior to placebo but were used in only one study each [120]. No randomized trial has compared routine preoperative versus postoperative antibiotic treatment in preventing postabortal infection. In the UK, the Royal College of Obstetricians and Gynaecologists (RCOG) recommends a more aggressive approach: presumptive therapy of chlamydia with doxycycline or azithromycin plus anaerobic bacteria coverage with rectal metronidazole, rather than short-course prophylaxis. However, the RCOG guidance also acknowledges that "other regimens may be equally appropriate" [124].

Ascending genital tract infections are typically polymicrobial, and patients who present with serious postabortal infection should receive a full course of broad-spectrum antibiotic therapy. Retained tissue evident clinically or radiographically warrants prompt reaspiration after an initial loading dose of antibiotics. Oral antibiotic treatment with one or more antibiotics is acceptable in a compliant patient who can tolerate the medications and has a favorable prognosis for cure in that she is not immunocompromised, severely ill, or suspected to have a tubo-ovarian abscess. A US multicenter trial has demonstrated effective outpatient treatment of mild-to-moderate PID in this favorable-prognosis group, including long-term follow-up of fertility preservation, using a single 2-gm injection of cefoxitin plus a single dose of 1 gm of probenecid orally followed by 100 mg of oral doxycycline twice daily for 14 days [125]. If patients fail to improve after 2 to 3 days of oral medication, parenteral therapy is warranted. For the period 1991 to 2001 in California, PID hospitalization rates declined by 62% and those for tubo-ovarian abscess decreased by 33%, possibly representing a shift to more outpatient therapy of PID [126].

Toxic shock syndromes

Toxic shock syndromes, heralded by shortness of breath, malaise, tachycardia, hypotension, and major organ system failure, are serious infections resulting from elaboration of bacterial cytotoxins that systemically attack integral cellular functions affecting vascular permeability, such as mitochondrial homeostasis [127]. These infections usually result in rapid multisystem deterioration and death. Sutkin and colleagues [128] reported acute onset of these symptoms 8 hours after insertion of a second set of laminaria prior to D&E abortion. Broad-spectrum antibiotics successfully treated amnionitis resulting from heavy growth of *Staphylococcus aureus* with staphylococcal enterotoxin C expression, permitting surgery to go forward. Mourton and Rich [129] have reported survival of a patient with classic findings of toxic shock syndrome 12 hours after endometrial biopsy. Her blood cultures grew Group A β-hemolytic *Streptococcus*. After fluid resuscitation and broad-spectrum antibiotics, she underwent total abdominal hysterectomy and bilateral salpingo-oophorectomy. The operative specimen was not tested for the presence of cytotoxins.

In addition to some strains of *Staphylococcus aureus* and group A *Streptococcus*, certain clostridial strains can also elaborate cytotoxins. *Clostridium perfringens* (formerly *welchii*) is the most common clostridial organism; like all clostridial

Table 15.5 Frequency of infection following second-trimester abortion.

Study	Study Period	Facility	Abortion Method	Gestational Age (Weeks LMP)	Total Patients	Antibiotic Prevention	Criteria for Diagnosis of Infection	Rate of Infection (%)
Grimes et al [113]	1971–1975	Multicenter, mostly inpatient (USA)	D&E	13–20	6,213	Unknown	Temp. ≥38°C for ≥1 day Endometritis	1.34 0.85
Hodari et al [59]	1974–1976	Hospital (USA)	D&E	13–18	2,500	13.4%	Temp. >38°C for ≥3 days and/or hospitalized for ≥2 days	0.40
Peterson et al [41]	1972–1981	One hospital clinic (USA)	D&E	13–22	11,720	100%	Temp. >38°C for ≥2 days after the first 24 hours	From 1.0 to 0.5 (p <0.004) after tetracycline routinized
Hill & MacKenzie [45]	1976–1987	Hospital (Great Britain)	Induction, PGE_2	14–19 (88% of cases)	2,308	1.9%	Two proven and six suspected cases	0.40
Hern [46]	1977–1982	Freestanding clinic (USA)	D&E plus urea	17–25	1,000	98.0%	Uterine tenderness responsive to outpatient antibiotics or brief temp. ≥38°C	0.60
Jacot et al [48]	1986–1990	Hospital-attached clinic (Quebec, Canada)	D&E	15–20	547	≥17 weeks LMP or history of PID	Any	2.00
							Three or more criteria (abdominal pain, uterine or adnexal tenderness, temp. ≥38°C for one day, elevated WBC or ESR, positive findings with laparoscopy)	0.70
							Hospitalization	0.40
Hern [50]	1990–1999	Freestanding clinic (USA)	Oxytocin induction; digoxin or urea to cause fetal demise	18–34	1,677	100%	All cases associated with PROM	0.30
Patel et al [52]	2002–2003	19 affiliated outpatient clinics (USA)	D&E	12–23 6/7	2,218	Not stated	One case only (sepsis/DIC/death)	0.05

WBC = white blood cells; ESR = erythrocyte sedimentation rate; LMP = last menstrual period; PID = pelvic inflammatory disease; PROM = premature membrane rupture; DIC = disseminated intravascular coagulopathy.

species, it is a spore-forming, rod-shaped, gram-positive anaerobe found predominantly in soil and contaminated water, and thereby in the intestines of grazing animals and humans. Experts theorize that anal-vaginal contamination results in vaginal carriage and that in some individuals these bacteria ascend the genital tract postpartum and after spontaneous or induced abortion [130]. *Clostridium sordellii* is a rare clostridial species found in about 1% of clostridial cultures. As of April 2008, seven deaths have occurred from clostridial infection in North American women undergoing first-trimester medical abortion. Six women used the evidence-based protocol of 200-mg mifepristone followed in 1 to 3 days by 800 μg of vaginal misoprostol, and one woman used mifepristone with buccal misoprostol. All exhibited a toxic shock-like presentation with absent or low fever, insidious onset, hemoconcentration, multiorgan failure and rapid demise. *Clostridium sordellii* was identified in six of these seven infections by a gene probe specific to this organism; the other case was identified as *Clostridium perfringens*. One case was reported from Quebec Province, Canada [131]; four cases, all from California, were reported by the CDC where bacteriologic subtyping identified each as associated with *Clostridium sordellii* [132]. Comparison by the CDC of the medication lot numbers eliminated pill contamination as a cause of infection [132].

Although reports have identified prolonged asymptomatic vaginal carriage of *C. sordellii* in 0.5 to 10% of healthy women, the precise etiology of this cluster of cases involving primarily an uncommon species of *Clostridium* remains unknown. From the time of its approval by the US Food and Drug Administration in 2000 until mid-2008, more than 840,000 doses of mifepristone have been sold in the USA (it is not commercially available in Canada), making the case-fatality rate from the six reported US deaths less than 1.0 per 100,000. All US *sordellii* mortalities have occurred in coastal states of the Western USA. The fatal *perfringens* case occurred in a noncoastal Western state. This distribution suggests a geographic predilection of clostridial species for certain geologic or climatic regions, and investigators are designing a large prevalence study to test this hypothesis. No reported *C. sordellii* or *perfringens* infections or toxic shock deaths have been reported among 2 million European women users of mifepristone.

Serious and often fatal clostridial infections have been reported during pregnancy unrelated to abortion and in women undergoing gynecologic procedures both in North America and Europe [130,133,134] (Zane SB, 2008, unpublished observations). One patient who had a spontaneous abortion at 18 weeks' gestation was treated after presentation with five antibiotics, dopamine, and fluid resuscitation. She is the sole surviving patient in the world literature among childbearing women infected with *C. sordellii* [130]. CDC laboratory testing confirmed that this strain of *C. sordellii* produced no lethal toxin.

In contrast to these disheartening outcomes, clinicians have achieved success by rapidly treating culture-proven clostridial endometritis following D&E abortion using periabortal oral doxycycline or standard broad-spectrum parenteral antibiotics, provided that the offending strain of clostridium does not produce endotoxin [135].

Pelvic abscess

Pelvic abscess is uncommon after second-trimester induced abortion and rarely occurs in the first trimester. Fifty per cent of patients with tubo-ovarian abscesses have a prior history of pelvic infection [136]. Increased susceptibility to abscess also exists in women with compromised immunity, as in those with human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) infection and high viral titers, or those debilitated and nutritionally deprived from substance abuse. Especially susceptible are women with poor nutrition and transport whose abortions are performed by untrained personnel. When these women develop infection resulting from natural occurrence, uterine injury, retained tissue, or unhygienic practices, they often experience long delays in obtaining trained medical evaluation and treatment, setting the stage for advanced infectious morbidity and mortality.

Most patients with untreated pelvic abscesses become acutely ill over time with severe abdominal or pelvic discomfort, high fevers, abdominal rebound tenderness, and exquisite adnexal pain on one or both sides. In acute, rapid-developing cases, leukocytosis is dramatic, ranging from 17,500/μl to more than 30,000/μl. Subtler and more slowly evolving cases can occur in patients with mature, walled-off abscesses or extensive adhesions from prior infection. Patients with life-threatening multiorgan involvement may present with mild or absent subjective, clinical, and laboratory findings other than severe malaise and toxic appearance because of failure of their immune system to mount an aggressive defense. Persistent low-grade fever, lack of energy, adnexal tenderness, and imaging studies point the way to diagnosis of this sometimes perplexing condition. In experienced hands, ultrasound has both high sensitivity (93%) and specificity (99%) in identifying abscesses [137].

Of the two widely used broad-spectrum intravenous antibiotic therapies, the beta-lactam-containing combination of doxycycline with cefoxitin or cefotetan has no advantage over the regimen of clindamycin plus an aminoglycoside [138]. Overall, 75% of patients with pelvic abscesses respond to medical therapy. Therapeutic surgical intervention is indicated in patients with progressive clinical deterioration and in those whose fever and pelvic pain remain unabated after 48 to 72 hours of medical therapy. Failure occurs more frequently in patients with recurrent infection; large (more than 8 cm), bilateral, or complex abscesses; compromised immunity; and chronic processes. Drainage of abscesses by ultrasound-guided needle aspiration can be highly effective

in selected cases, avoiding laparotomy. Given the current array of assisted reproductive technologies, preservation of the uterus and at least one ovary is highly desirable in women with pelvic abscesses who desire future childbearing. When unilateral adnexectomy is elected for well-confined disease, risk of recurrent abscess during a woman's fertile years remains high because of residual scarring and, possibly, dormant pathogens.

Patients with sepsis require supportive care with large volumes of intravenous fluids to restore normal perfusion; pressor agents (dopamine and dobutamine) may be needed. Acute respiratory distress syndrome, DIC, and renal failure can develop rapidly. Patients who do not respond to initial measures may require hysterectomy and bilateral salpingectomy as a life-saving measure [53,139].

Postabortal endocarditis

Postabortal endocarditis is rare, difficult to diagnose, and often resistant to aggressive broad-spectrum antibiotic therapy [140]. Up to 75% of patients who develop postsurgical endocarditis have preexisting abnormalities of the heart [141] that are often asymptomatic. Predisposing conditions include prior endocarditis, whether recognized or not (rheumatic fever); existing prosthetic valve or surgical shunts; intravenous exposure through illicit drug use, injection therapy, or recent tattoos; immunocompromise (e.g., HIV/AIDS); and poor dentition with caries or chronic periodontal disease. Few affected patients have reported these conditions owing to their subtle nature or to privacy concerns. Usually a single heart valve is affected with reports of tricuspid, aortic, and pulmonic involvement, but multivalvular vegetation has also been reported [142]. Group B *Streptococcus* is the most common culprit and is uniformly sensitive to penicillin G, but absence of initial symptoms referent to the heart often results in late discovery, when the condition is far advanced. Clinical recovery, ultrasound evidence of shrinking of valvular vegetations, and improved cardiac flow gradients are encouraging signs. Refractory or pernicious cases frequently require valve replacement.

Although providers may differ in their approach to women with high-risk conditions, the American College of Obstetricians and Gynecologists does not recommend endocarditis prophylaxis for dilation and curettage, abortion, sterilization, or insertion or removal of intrauterine devices, irrespective of patient cardiac risk status [141].

Uterine injury

Low cervical tears

Lacerations of the anterior lip of the cervical portio occur most commonly when the tenaculum releases under traction. A less common type of injury can occur when a large fetal part, typically the calvarium, is pulled or expelled through the cervix. This type of tear occasionally extends several centimeters into the body of the cervix and often requires suturing, but it rarely affects large enough branches of the uterine artery to require extensive dissection.

Using atraumatic tenacula and applying traction steadily can avoid some tears. A number of techniques are available to gain a secure purchase on the cervix. These techniques include grasping a generous bite of cervical tissue; placing a tenaculum on the cervix vertically with one tooth inside the cervical canal; or using tandem tenacula, one at the 3 o'clock and the other at the 9 o'clock position of the cervicovaginal folds. In addition, use of osmotic dilators significantly reduces the risk of cervical injury during abortion [143]. Peterson reported a decrease in serious cervical trauma in early midtrimester D&E (from 0.8 to 0.4%) and later D&E (from 5.2 to 1.5%) when laminaria replaced dilation solely with graduated rigid dilators [41].

Treatment options include observation alone; clamp compression for 5 to 10 minutes; the application of silver nitrate or other styptic solutions, such as ferric subsulfate solution (Monsel's solution), and finally suturing. Surgical repair is best accomplished using absorbable suture in a running, locking stitch. Occasionally the bladder flap requires dissection and retraction to provide exposure for repair of extensive tears of the anterior cervix. Better lighting, lateral retractors, and surgical assistants are often needed to repair severe cervical injuries properly; hence, an operating room may be necessary.

High cervical tears

High cervical tears (cervical fractures) result from stretch-induced injury to the internal cervical os. The injury may be partial- or full-thickness, the latter creating a passage into the paracervical space. These lacerations can occur during labor induction [45] as well as during surgical abortion. Development of cervicovaginal fistulas can occur during labor-induction abortions; the posterior cervix bulges into the vagina, then ruptures, with delivery through the fistula. These injuries were more common with abortions induced with intra-amniotic prostaglandin $F_{2\alpha}$ [144].

Tears of the distal endocervix can traumatize lower cervical branches of the uterine artery and vein, which lie in the retroperitoneum (Fig. 15.4). In these instances, a hematoma may form, and vaginal bleeding is often light. Large hematomas can develop, leading to hypovolemia. Because of tamponade within the retroperitoneum and arteriolar spasm, blood loss may be slowly progressing and laterally sequestered, avoiding the development of rebound tenderness and resulting in delayed diagnosis.

Tears of the proximal portion of the internal os can disrupt upper cervical branches of the uterine artery and vein, which generally lie above the peritoneal reflection (Fig. 15.4). No retroperitoneal envelope is available to provide tamponade in these cases, and life-threatening hemoperitoneum can develop rapidly.

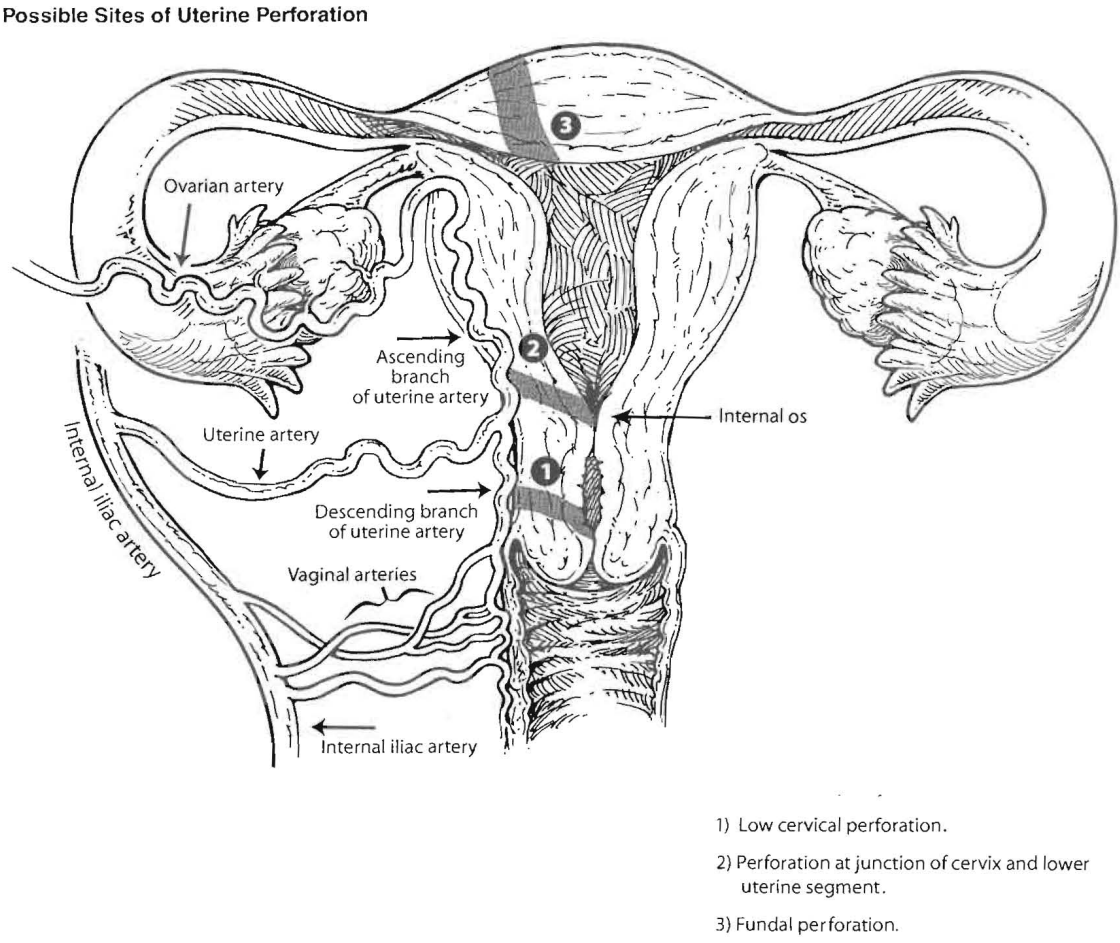

Figure 15.4 Possible sites of uterine perforation. (1) Low cervical lacerations can injure descending branches of uterine artery; (2) lacerations at the internal os (often related to overstretching of the sphincteric junction of cervix and lower uterine segment) can injure ascending branches of uterine artery; (3) fundal perforation. Regions lateral to the fundus and corpus are more vascular than in the midline.

The lateral aspects of the cervix are most vulnerable to stretch-induced injury, placing parametrial arterioles at risk. Spasm of these injured vessels results in episodic bleeding and can mislead the clinician in the belief that the injury has resolved spontaneously. Sudden massive internal and external bleeding has occurred with such tears up to 4 weeks after the original trauma.

Clinicians should suspect endocervical injury whenever postoperative bleeding persists despite a well-contracted uterus or when patients exhibit unexplained postoperative orthostatic hypotension unresponsive to fluid resuscitation. As fluid shifts occur and red cells are mobilized by means of demargination, serial hematocrit levels may show little or no drop for several hours, depending on the extent of the bleeding. Digital palpation of the endocervical barrel may reveal the defect. Bleeding from small non-perforating lacerations may stop permanently with application of Monsel's solution. Bleeding that stops temporarily when ring forceps are placed circumferentially at the level of the internal os, but resumes upon their removal, indicates a need for further therapy. Hysteroscopy can be diagnostic and therapeutic (cautery) when bleeding is light enough to permit endoscopic visualization [145]. Nonpenetrating injuries may respond to balloon tamponade after first-trimester [146] and D&E abortions [68]. Large or full-thickness penetrating lacerations usually require angiographic treatment or surgical repair using a vaginal or abdominal approach. Balloon tamponade or uterine packing (with vasopressin) can at times be curative and nearly always will temporarily slow bleeding enough to allow time for angiographic or surgical treatment.

A slowly developing pelvic hematoma may be insidious, with only mild tenderness, rectal pressure, and modest abnormalities of laboratory tests. Pelvic hematomas may be difficult to palpate if they are lateral or high, and rectal examination can be especially helpful in these circumstances. When palpated, fresh hematomas are uniformly tender. Pelvic ultrasound, CT scan, and MRI are sensitive, but sometimes nonspecific, diagnostic tests for hematomas.

Some hematomas can be managed with observation only. Repetitive hematocrit determinations and serial imaging measurements indicate when the hematoma has stabilized. Broad-spectrum antibiotic therapy may be prudent, given the communication with the vaginal flora. Large hematomas (more than 500–800 ml or 8–10 cm in diameter), failure of the hematoma to stabilize, or the appearance of infection should prompt intervention. Treatment options include ultrasonography- or CT-guided needle aspiration, angiographic embolization, and vaginal or abdominal surgical repair. When a hematoma resolves without intervening infection and without invasive therapy that breaches the peritoneum, adhesion formation within the pelvis is uncommon. Under these circumstances, fertility is not impaired, in contrast with the aftermath of most pelvic abscesses.

High cervical tears cannot entirely be prevented. However, avoiding forceful mechanical dilation and making appropriate use of osmotic dilators or cervical priming agents may lessen somewhat the risk of this complication.

Perforation

Perforation is an uncommon but potentially serious complication. The risk is highest with inexperienced providers and with advanced patient parity or gestational age [147]. Early reports of increased risk of perforation with general anesthesia were not confirmed in a subsequent study by the same investigators [148]. In a more recent large first-trimester study in which 51,000 of 170,000 patients underwent general anesthesia with intravenous methohexital, uterine perforation occurred in only 0.09 per 1,000 cases [5] (Table 15.6). However, some perforations are probably unsuspected and undetected. For example, only two of 14 uterine wall perforations were recognized in a series of 706 patients undergoing concurrent first-trimester vacuum abortion and laparoscopic sterilization [149]. On the other hand, Choudhary et al [28] more recently reported a single-institution series of 288 women undergoing simultaneous vacuum abortion and laparoscopic sterilization in which the one perforation visualized laparoscopically was in fact noted by the vaginal surgeon at the time of the uterine aspiration.

Suspicion of perforation is raised when instruments pass farther than expected, often without discernible resistance; when excessive bleeding occurs; or when contact with the gritty surface of the endometrium is lost during aspiration or curettage. Awake patients may exhibit sudden or unexpected pain, although this finding is nonspecific. Signs can include hypotension and occasionally detection of bowel or omentum in the cannula or cervix. Confirming all major fetal parts during or after D&E is advisable; failure to identify all major pregnancy elements raises suspicion of retained tissue or perforation with tissue in the peritoneal cavity [155]. Delayed recognition of these complications, especially bowel injury, can be life-threatening [156,157]. In general, any woman with protracted abdominal pain after abortion, especially if lateralized or accompanied by abdominal rebound tenderness, requires evaluation to exclude perforation, rupture, or dehiscence.

The most frequent site of perforation is the relatively avascular anterior or posterior midline surface (Fig. 15.4). In a series of 30 perforations in women undergoing vacuum abortion combined with laparoscopic sterilization [158], 60% occurred in the fundus, 30% in the midline of the corpus, and 10% on the side. Most penetrating injuries in the first trimester resolve without treatment or sequelae. Perforations likely to be more problematic are situated laterally, are larger than 1.2 cm in diameter, occur after the first trimester, result in acute pain or symptomatic blood loss, or involve bowel. Perioperative ultrasound may be useful in documenting whether a perforation has occurred and in monitoring the cul-de-sac for accumulation of blood [159]. Although laparoscopy is more expensive and inconvenient, it is a better diagnostic tool. Culdocentesis is an inexpensive and safe technique to assess blood in the cul-de-sac as well. Blood in the cul-de-sac may result from uterine injury, or from rupture of an ectopic pregnancy or ovarian cyst.

Experienced operators have safely completed first-trimester abortion immediately after known or suspected small midline perforations. Intraoperative ultrasound can guide completion of the procedure in such cases. Alternatively, the abortion can be deferred for a week or more to allow healing in patients with an intact sac who remain stable after an uncomplicated perforation. Preventative antibiotics are advised during the waiting period.

In the absence of heavy vaginal bleeding (i.e., more than 200 ml or suspected injury to abdominal contents), patients with small perforations can be observed closely in an outpatient setting for pain, orthostasis, declining hematocrit, and abdominal rebound tenderness. In most cases, patients who are clinically stable 2 to 4 hours after surgery can be discharged safely with a responsible chaperone. Oral antibiotics are advisable, and patients should receive explicit instructions and warnings, 24-hour emergency phone contact information, and a timely follow-up appointment. This conservative protocol for women with known or suspected low-risk perforations has been advocated by a variety of authors [149–151,153].

Unstable patients and those with other injuries require surgical intervention. Laparoscopy may fail to detect subtle but consequential injury to bowel. Whereas some surgeons can inspect the full length of the bowel with laparoscopy, others feel more comfortable performing this evaluation by laparotomy.

Small bowel is the most common viscera injured with uterine perforation because of its central pelvic location and length [156,160]. In a case series of surgical abortion-related bowel injuries referred to a large academic medical center in India [157], large bowel injuries (often the sigmoid colon)

Table 15.6 Frequency of uterine perforation with intrauterine instrumentation.

Study	Study Period	Surgical Site	Instrumentation	Total Patients	Comments	Perforation Frequency (per 1,000 cases)
White et al [150]	1974–1976	Hospital (USA)	Uterine sounding during sterilization	635	Teaching service	30.40
Chi & Feldblum [151]	1974–1976	Hospitals (international)	Uterine sounding during sterilization	20,757	18 medical centers in 11 countries surveyed	1.80 (laparoscopic tubal ligation), 1.20 (mini-lap tubal ligation)
Hakim-Elahi et al [5]	1971–1987	Freestanding clinics (USA)	Vacuum abortion ≤14 weeks LMP	170,000	No difference in rates between local (75%) and general (25%) anesthesia	0.09
Hodgson & Portmann [42]	1972–1973	Freestanding clinic (USA)	Vacuum abortion ≤12 weeks LMP	10,453		0.90
Freiman & Wulff [152]	1973–1976	Freestanding clinic (USA)	Vacuum abortion, first trimester	20,000	Rate in last 8,000 cases = 0.75	1.40
Bozorgi [58]	1973–1974	Freestanding clinic (USA)	Vacuum abortion ≤14 weeks LMP	10,890		0.20
Wadhera [44]	1975–1980	Hospitals (Canada)	Vacuum abortion or induction to 20+ weeks LMP	351,879	84% of cases ≤13 weeks LMP	1.30
Peterson et al [41]	1972–1981	One hospital clinic (USA)	D&E, 13–22 weeks LMP	17,720	Laminaria introduced in 1977. One surgeon did most cases >18 weeks LMP	2.00 (Excludes cases managed expectantly)
Lindell & Flam [153]	1982–1992	Hospitals (Sweden)	Vacuum abortion, first trimester	84,850	Records reviewed at six public hospitals in greater Stockholm	1.70
Kaali et al [149]	1986–1987	Freestanding clinic (USA)	Vacuum abortion, first trimester	6,408	Abortion alone	1.30
			Concurrent sterilization and vacuum abortion, first trimester	706	Concurrent laparoscopic tubal ligation and first-trimester vacuum abortion	2.80 (suspected), 15.60 (actual)
Pridmore & Chambers [51]	1992–1998	Public ambulatory surgery center (Australia)	Vacuum 4–12 weeks LMP	12,040		0.50
			D&E 13–20 weeks LMP	1,925	More osmotic dilator treatments for scarred cervices or uteri improved outcomes	3.10
Hern [50]	1990–1999	Freestanding clinic (USA)	Oxytocin induction; digoxin or urea to cause fetal demise; 18–34 weeks LMP	1,677	One case of cervical laceration (2,500 ml estimated blood loss)	0.60
Choudhary et al [28]	1997–2001	Teaching hospital (India)	Vacuum at ≤12 weeks LMP	961	30% had concurrent laparoscopic sterilization	1.00
Castleman et al [61]	1999–2002	Teaching hospital (Hanoi, Vietnam)	12–18 weeks LMP	439	Misoprostol only for cervical ripening	4.60
Patel et al [52]	2002–2003	19 affiliated outpatient clinics (USA)	12–23 6/7 weeks LMP	2,218	Buccal misoprostol (100%) + laminaria (43%) for ripening	0.45
De La Vega et al [154]	1998–2006	Hospital (USA)	D&E, 13–26 weeks LMP	2,291	Risk factors: advanced maternal age and gestation >20 weeks	2.60

were often associated with posterior uterine wall perforations, whereas anterior wall or fundal perforations more often resulted in small bowel injury. Reporting a series of small-bore bowel injuries associated with gynecologic laparoscopic procedures, Soderstrom [160] noted that free air was seen in only one-third of injured patients using flat plate radiographs, but most patients became symptomatic (pain, distension, fever, and anorexia) within 72 hours. Large bowel injuries became symptomatic earlier than damaged small bowel because of fecal content [160]. In another series, laparoscopically associated injuries to large bowel led to greater likelihood of developing intra-abdominal abscess and pleural effusion than those to small bowel [161]. During abortion, other adjacent pelvic organs, such as the bladder or ureter [27], can sustain injury as well.

Identifying the cause of the perforation can be difficult. In a Swedish study involving 145 first-trimester perforations, 47% were discovered during aspiration, and 21% were noted during dilation [153]. Many clinicians use a sharp curette or small forceps to confirm that the uterine cavity is empty; 31% of perforations were discovered during this phase, reflecting that this "security check" carries some risk.

Because of the rarity of perforation, randomized controlled trials cannot evaluate the potential benefit of intraoperative ultrasonography. A before-after study from one hospital found that use of intraoperative ultrasound guidance lowered the risk of perforation during D&E and shortened operating time [162]. In a large prospective study of risk factors for uterine perforation in first- and second-trimester abortions, use of osmotic dilators had a protective effect [147]. Use of a sound to measure the depth of the fundus has been associated with perforation during diagnostic dilation and curettage [150], and this practice may entail risk in the abortion setting as well. In a 13-year retrospective review from China of uterine perforations that occurred during first-trimester surgical abortion, the sound was the perforating instrument in 23% of cases [163].

Atraumatic dehiscence (complete separation of myometrium with preservation of overlying abdominal or bladder peritoneum) has been described in D&E abortion [164]. Second-trimester rupture or dehiscence may be slow to develop and initially confused with uterine atony, retained tissue, or pelvic infection.

Asherman syndrome

Asherman syndrome includes scarring either in the endometrial cavity or in the cervical canal [165]. Although they may coexist, the two lesions are usually seen separately. Reported consequences of this condition include amenorrhea, secondary infertility, spontaneous abortion, and preterm delivery, but failed attempted abortion can occur as well [166].

Asherman syndrome after surgical abortion is uncommon and is usually readily correctable. In a large, single-institution report of surgical abortions, the frequency of documented Asherman syndrome was about 16 per 100,000 cases [5]. Most reported cases have involved cervical agglutination without evidence of synechiae in the cavity. In an early case series, nine of 12 cases involved cervical stenosis, while three involved intracavitary adhesions [167]. Chapman and Chapman [168] reported seven cases associated with induced abortion, six of which had cervical agglutination; all were corrected by cervical dilation alone. In a report of the cervical agglutination form of Asherman syndrome attributable to induced abortion, all 10 women achieved normal periods after therapy. Three of the patients had abortions by sharp curettage rather than vacuum aspiration, and the average time to diagnosis for all subjects was 11 months (range: 5–18 months)[169]. No case of Asherman syndrome has been reported after medical abortion using any of the common regimens.

Asherman syndrome typically presents as diminished or no uterine bleeding. Further, the patient may have a history of cyclical cramping if the os is occluded; hematometra is uncommon [165]. Dilating the cervix to a diameter of 7 to 8 mm using paracervical anesthesia can be both diagnostic and therapeutic.

Although still widely used for diagnosis, hysterosalpingography has false-positive rates as high as 30%; three-dimensional (3-D) ultrasound is much more accurate, especially in identifying and categorizing cervical agglutination in the presence or absence of cavitary scarring [170]. Hysteroscopy offers the most precise diagnosis, a vantage for lysis of adhesions under direct vision, and a vehicle for the identification and removal of the conceptus during elective abortion [166]. Milder forms of Asherman syndrome have uniformly optimistic prospects [171]. Although feasible in an office setting, hysteroscopy requires additional expense and skill and is not without complications. In the series cited earlier using 3-D ultrasound as a screening tool [170], two of 18 patients who underwent simultaneous hysteroscopy and laparoscopy experienced uterine perforations. Efficacy of widely practiced nonsurgical therapies such as sequential hormone replacement therapy (e.g., 2 mg oral conjugated estrogen twice daily for 10–14 days), intrauterine stenting (catheter balloons such as the Cook balloon uterine tent or intrauterine contraceptive devices for several weeks), or antibiotics (e.g., oral doxycycline 100 mg twice daily for 10–14 days) is unproven.

The epidemiology of uterine adhesions remains unclear. Sharp curettage appears related to Asherman syndrome [169], providing yet another reason to abandon an archaic tool that dates back to the 1800s. Whether other variations in abortion technique (e.g., preoperative cervical priming with osmotic dilators or prostaglandins, size and type of instrument used as a cervical dilator, use of sharp "check"

curettage, or administration of perioperative antibiotics) influence the risk is unknown.

Thrombosis and embolism

Deep vein thrombosis

Deep vein thrombosis (DVT) is infrequently reported in association with abortion. It leads to pulmonary embolism in approximately 20% of cases. Heritable thrombophilias, such as Factor V Leiden deficiency, are strong risk factors, as are obesity, diabetes, age greater than 40 years, trauma, immobilization, and malignancy [172]. Pain, swelling, point tenderness, and inflammation vary greatly depending on the size and progression of the thrombus. Onset of DVT may be gradual, and the physiologic swelling associated with pregnancy may confound recognition of its symptoms. Noninvasive testing with plethysmography and ultrasound are imperfect screening techniques; venography is the definitive diagnostic tool.

Heparin is the mainstay of treatment; low-molecular-weight heparin (enoxaparin) is now widely used for both prophylaxis and the acute phase of treatment. Patients without risk factors who are undergoing short outpatient operations require no prophylactic measures. Those with risk factors may benefit from pneumatic compression devices, enoxaparin, or subcutaneous unfractionated heparin, particularly if a multiple-day hospitalization is contemplated (e.g., labor-induction abortion).

Pulmonary embolism

Pulmonary embolism is an important cause of abortion mortality [173]. The CDC described 10 cases of fatal pulmonary embolism from 1972 to 1975. These deaths occurred 2 to 50 days after abortion [174]. In addition to pregnancy, most patients had at least one other risk factor, including obesity, hypertension, cancer, family history of embolism, contraindicated recent use of oral contraceptives, or discontinuation of heparin therapy for DVT because of side effects. The authors estimated the overall incidence of fatal and non-fatal pulmonary embolism as 10 to 20 cases per 100,000 induced abortions [174].

Detection of pulmonary embolism is not always straightforward. Symptoms may be nonspecific and of variable severity. Classic signs include rapid or difficult breathing; pleuritic chest pain; and in about half of patients, anxiety, cough, and râles. Arterial hypoxemia occurs in most patients. Only a minority (approximately 5%) of pregnant women suspected of having pulmonary embolism will have the diagnosis radiographically validated after evaluation. Chest radiograph is required to rule out other causes and to interpret ventilation-perfusion scans. More recently, spiral computed tomography has supplanted ventilation-perfusion scans (60% indeterminate) on the grounds of both clinical benefit and cost-effectiveness [175]. Pulmonary angiography is the diagnostic gold standard but is expensive, invasive, and more risky than alternative tests. Anticoagulation with heparin initially, followed by warfarin therapy, is the mainstay of treatment. Treatment reduces mortality from approximately 15% to less than 1%.

Amniotic fluid embolism

Although rare, occurring in 1:10,000 to 1:80,000 pregnancies [176], amniotic fluid embolism has emerged as an important cause of death associated with second-trimester abortion, with a mortality rate as high as 80% [173]. This catastrophe is usually unforeseeable and often fatal. DIC complicates 40 to 60% of cases that survive beyond the initial insult. The risk of amniotic fluid embolism increases with advancing gestational age, as well as with older labor-induction methods and hysterotomy [177]. The most frequent presentation of amniotic fluid embolism is cardiorespiratory collapse. Sometimes a brief instance of dyspnea or feeling of impending doom precedes cessation of breathing, oxygen desaturation, cardiac electromechanical dissociation, and profound hypotension.

Although its etiology remains unclear, progress in identifying the presence and origin of this condition is ongoing. A number of studies have routinely identified trophoblasts and squamous cells of presumed fetal origin in the circulation of healthy gravidas after the first trimester [178–180]. Large volumes of homologous amniotic fluid are harmless in primate models. Because human maternal exposure to fetal elements is therefore a common occurrence, Clark [181] has posited that uniquely susceptible maternal-fetal pairs are necessary to produce amniotic fluid embolism. In such pairs, disturbance of the pregnancy may inoculate the pregnant woman with fetally derived antigen, which causes an anaphylactoid reaction. Gei and Hankins [182] have speculated that fetal particles in the maternal circulation may cause pulmonary microemboli that trigger release of arachidonic acid metabolites, stimulating an anaphylactoid response. These mediators may exist in the plasma, leukocytes, and fetal gut.

Pathological verification can be arduous and elusive. A diligent search should include central venous blood (for fetal squames, vernix, or eosinophilic leukocytic granules), sputum (for fetal squames), and bronchoalveolar lavage (for stained epithelial cells). Examiners should analyze maternal peripheral blood for the presence of fetally derived cells and debris and also test the blood with an array of highly specialized enzymatic markers (ZnCP-1, monoclonal antibody to TKH-2, and STN) before ruling out the diagnosis.

Treatment is supportive including endotracheal intubation, intracardiac epinephrine, and cardioversion. If the patient survives the primary event in an outpatient setting, she should be transferred promptly to a hospital for intensive care. Management may include replacement of clotting factors for DIC and intravenous dopamine plus prolonged ventilatory assistance for adult respiratory distress syndrome. Survival has been reported with an artificial

membrane lung, and in another case, full-scale cardiopulmonary bypass.

Other conditions

Anaphylaxis

Anaphylaxis requires prior sensitization. It results from IgE-mediated antigen stimulation on the surface of basophils and mast cells, causing release of an array of dermatologic, vasoactive, and bronchospastic proteins. Most manifestations are mild, causing flushing or urticaria. In severe forms, acute bronchospasm, increased alveolar-capillary permeability, and profound hypotension may lead to airway obstruction, hypotensive shock, and extensive bilateral pulmonary edema.

Once the suspected antigen is withdrawn, treatment consists of airway access, ventilation, cardiac support, and fluid maintenance. Initial drug therapy includes epinephrine (0.3–0.5 ml of 1:1,000 solution subcutaneously or 3–5 ml of 1:10,000 intravenously or via endotracheal tube, repeated periodically as needed) and diphenhydramine (0.5–1.0 mg/kg intravenously). Steroids can be added if the patient requires more intensive therapy (hydrocortisone, 250–1000 mg intravenously, or methylprednisolone, 1–2 g intravenously). Inhaled beta-agonists (metaproterenol 0.3 ml or albuterol 0.5 ml in 2.5 ml normal saline) and aminophylline (0.25–0.5 gm intravenously) are used to treat resistant bronchospasm. In an emergency department study of 103 cases, 19% had recurrences at a mean interval of 10 hours (range, 2–38 hours). These recurrences were variably associated with initial symptom onset at least 30 minutes after exposure, inadequate epinephrine dosing, and underuse of steroids [183].

Vasovagal syncope

In abortion practice, a vasovagal reaction can occur in association with paracervical anesthesia, cervical dilation, or venipuncture. Although its etiology is unknown, vasovagal reaction is associated with stressful conditions such as pain, emotional upset, and prolonged standing. Upon standing upright, healthy individuals normally experience a drop in intrathoracic pressure of approximately 15%, a reduction of stroke volume of about 20%, and a corresponding decline in arterial pressure [184]. During a vasovagal reaction, the patient's skin is cold and clammy, and she often reports light-headedness, nausea, or visual changes. Moderate hypotension and bradycardia in the range of 30 to 50 beats per minute are common. Transient seizure-like muscular activity can occur. Brief disorientation may follow momentary unconsciousness, but true postictal states are rare.

Resting in a horizontal position or with the legs elevated is all that most patients require. Most episodes resolve in a few minutes without treatment. Severe or prolonged incidents can be treated with atropine, 0.4 to 1.0 mg intravenously, antiemetics, hydration and, rarely, airway support.

Asthmatic reactions

Eight per cent of patients seeking abortion report current use of at least intermittent asthma medication. Patients with asthma who merit special concern during presurgical screening are those with (1) symptoms requiring continuous antiinflammatory or steroid therapy; (2) frequent exacerbations or nocturnal dyspnea (more than one to two episodes per week); (3) a recent attack requiring medical therapy; and/or (4) current acute symptoms. In an observational cohort study of pregnant asthmatic women at 16 US health centers for the period 1994 to 1999, obesity (BMI $\geq$30) was significantly associated with asthma exacerbations (cough, dyspnea, or wheezing, OR 1.3, 95% CI 1.1–1.7, $p = 0.01$) after controlling for smoking and race, but not with hospitalizations for asthma, need for steroid treatment, or worsening asthma pattern overall [185].

Although acute asthmatic attacks in well-prepared abortion patients are rare, facilities must be prepared to treat severe asthmatic complications. Mild dyspnea usually responds to two puffs of nebulized $beta_2$-adrenergic agonist (albuterol, salmeterol) using self-administration or mask. Puffer dosing can be repeated every 20 to 30 minutes for up to three doses. A calm nursing presence is therapeutic. Second-level therapy involves parenteral sympathomimetic agents (subcutaneous epinephrine, 0.3 to 0.5 ml of 1:1,000 solution every 20 minutes up to three doses, or subcutaneous terbutaline, 250 μg every 15 minutes up to three doses).

A third level of treatment consists of methylxanthine therapy. Aminophylline is the only agent available for parenteral dosing and is highly effective in conjunction with nebulized beta adrenergics, parenteral sympathomimetics, or inspired anesthetic gases. The aminophylline loading dose is 5 mg/kg/30 minutes intravenously, and the maintenance dose is 0.5 to 1.0 mg/kg/hour.

A fourth level of therapy as a final recourse for refractory bronchospasm is the use of inspired halogenated gases such as desflurane or sevoflurane. These agents, where available, are extremely effective in opposing severe bronchoconstriction. Because they act as tocolytic agents upon smooth muscle, however, they carry risk of inciting uterine hemorrhage, possibly requiring intensive uterotonic therapy as a countermeasure.

Hydration is a key feature of treatment in all cases. Pulse oximetry is pivotal in early detection of airway compromise and valuable in gauging therapeutic success. The goal is to maintain oxygen saturation at 95% or better. Failure over time to raise oxygen saturation to 90% calls into question the need for intubation. Prolonged desaturation after intensive outpatient therapy requires hospitalization.

Seizures

Although grand mal, petit mal, toxic drug-induced, and idiopathic seizures can be distinguished clinically, acute treatment of these conditions is the same. This treatment consists of chin thrust (to dislodge the tongue from the oropharynx), mask oxygen, and parenteral anticonvulsants. Most seizures encountered in abortion settings are self-resolving solely with supportive measures and do not recur acutely. Anxiety, *nil per os* (NPO) status, or physical discomfort may contribute to their causation. Repetitive or prolonged seizure episodes warrant referral for expert treatment and evaluation.

Parenteral benzodiazepines (diazepam 5–10 mg or midazolam 2.5–5 mg) usually stop seizures for a period of 30 to 45 minutes, while lorazepam 1 to 2 mg is usually effective for 2 to 3 hours. Short-acting barbiturates represent an alternative first-line therapy. Intravenous thiopental (75–150 mg), propofol (50–100 mg), and methohexital (50–100 mg) are highly effective in temporarily controlling seizure activity. Although these doses do not abolish the gag reflex in most patients, it is prudent to administer these drugs in a setting with an experienced airway manager, pulse oximetry, intubation equipment, and nursing staff assignable to continuous monitoring. Complete loading and daily dosages of anticonvulsive therapy are considerably higher than those used during acute treatment and are best left to clinicians who will undertake the long-term monitoring of the patient.

Conclusion

Legal-induced abortion is one of the safest and most thoroughly studied procedures in medicine. Although surgical abortion complications are not completely avoidable, the following practices can minimize their occurrence:

- Accurate determination of gestational age before abortion;
- Limiting procedures to those in which the surgeon is skilled and experienced;
- Appropriate emergency consultation and hospital referral when necessary;
- Simple regimens of anesthesia and evacuation of the uterus;
- Routine periabortal antibiotics or presumptive treatment of sexually transmitted infections;
- Use of only sterile instruments inside the uterus ("no-touch" technique);
- Judicious use of osmotic dilators or prostaglandins to soften and open the cervix, particularly after 14 gestational weeks;
- Adequate cervical dilation;
- Gentle and thorough uterine evacuation;
- Avoiding sharp curettage;
- Prompt use of uterotonic drugs to treat atony;
- Maintaining a high index of suspicion for occult injury and insidious medical complications;
- Careful tissue examination to confirm successful abortion;
- Assiduous monitoring during and after surgery; and
- 24-hour telephone access to a clinician knowledgeable about postabortal complications.

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