management of unintended and abnormal pregnancy

COMPREHENSIVE ABORTION CARE

Maureen Paul | E. Steve Lichtenberg | Lynn Borgatta
David A. Grimes | Phillip G. Stubblefield | Mitchell D. Creinin

WILEY-BLACKWELL

naf NATIONAL ABORTION FEDERATION

Management of Unintended and Abnormal Pregnancy

Comprehensive Abortion Care

Edited by

Maureen Paul, MD, MPH

E. Steve Lichtenberg, MD, MPH

Lynn Borgatta, MD, MPH

David A. Grimes, MD

Phillip G. Stubblefield, MD

Mitchell D. Creinin, MD

Illustrator: Lisa Peñalver, BA, AMI

WILEY-BLACKWELL

A John Wiley & Sons, Ltd., Publication

This edition first published 2009, © 2009 by Blackwell Publishing Ltd

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing program has been merged with Wiley's global Scientific, Technical and Medical business to form Wiley-Blackwell.

Registered office: John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial offices: 9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
111 River Street, Hoboken, NJ 07030-5774, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book, please see our website at www.wiley.com/wiley-blackwell.

ISBN: 978-1-4051-7696-5

A catalogue record for this book is available from the British Library.

Set in 9/12pt Meridien by Aptara® Inc., New Delhi, India
Printed and bound in the UK by TJ International

1 2009

11 CHAPTER 11
Dilation and evacuation

Cassing Hammond MD, and Stephen Chasen MD

LEARNING POINTS

- Dilation and evacuation (D&E) is a safe and effective method of induced abortion.
- Compared to labor-induction abortion, D&E offers more predictable timing of evacuation, greater cost savings, and safety advantages for patients with certain serious medical conditions. D&E also allows women to avoid the labor-like process of a medical induction.
- Cervical preparation using osmotic dilating devices prior to D&E decreases the risk of complications. Substantial research has documented the safety and efficacy of misoprostol as a cervical ripener in the first trimester; data regarding its use before D&E abortion are limited, but suggest positive outcomes.
- Preoperative injection to cause fetal demise may facilitate completion of D&E abortion, although published data are still limited. It also helps providers in the USA ensure compliance with the Partial-Birth Abortion Ban Act of 2003 and related state laws.
- Surgical skill and experience are paramount in assuring patient safety during D&E.

Introduction

The proportion of US abortions performed in the second trimester has varied little since 1992. According to surveillance data from the Centers for Disease Control and Prevention (CDC), roughly 12% of abortions occur at or after 13 weeks' gestation. Only 3.8% of abortions occur at 16 to 20 weeks and 1.4% at or after 21 weeks [1]. Ninety-six per cent of the more than 140,000 second-trimester abortions performed annually in the USA [1,2] are accomplished by the technique of dilation and evacuation (D&E), primarily in outpatient settings [3,4]. In many other countries, such as Canada, Cuba, the United Kingdom, and most other European nations, medical methods comprise a larger proportion, or the sole option, for second-trimester abortion (Chapter 12).

Where it is available, D&E offers a highly effective method of pregnancy termination. After providing some background information on the safety and benefits of D&E, this chapter focuses on the use of D&E in clinical practice including methods of cervical preparation, variations in surgical techniques, and postoperative care. Because of the plethora of legal requirements governing abortion provision in the USA, including the federal Partial-Birth Abortion Ban Act of 2003 [5] and related state laws, US physicians embarking on second-trimester abortion practice are advised to read Chapter 4 and consult with legal counsel as needed.

Historical perspective: Surgical innovation and evolution

In 1973, at the time of nationwide legalization of abortion in the USA, vacuum aspiration was generally available only through 12 weeks' gestation. Women requiring abortion in the second trimester either had hysterotomies or delayed abortion until 16 weeks in order to undergo intra-amniotic instillation [6]. The fundamental challenge to a transvaginal surgical approach was to find an atraumatic means to dilate the uterine cervix that would permit successful extraction of the enlarging second-trimester fetus. During the 1970s, European physician-innovators pioneered methods of dilation and extraction that overcame these barriers and remain cornerstones of today's D&E procedure [7].

Advances in methods of cervical dilation greatly facilitated uterine evacuation. Sir Arthur Finks recognized the advantage of cervical ripening for midtrimester abortion at a time prior to the importation of osmotic dilators to Great Britain. His innovation was to sever the umbilical cord overnight, resulting in fetal demise and cervical ripening, before attempting surgical extraction the following day [8]. Japanese and

Management of Unintended and Abnormal Pregnancy, 1st edition. By M Paul, ES Lichtenberg, L Borgatta, DA Grimes, PG Stubblefield, MD Creinin
 ISBN: 9781405176965.

European physicians had used hygroscopic, processed seaweed tents (*Laminaria japonica* or *digitata*) for more than a century to deliver compromised pregnancies [9] before their adoption in Eastern and then Western Europe.

Although use of a sizable suction cannula permitted fetal extraction through 14–16 weeks' gestation, it did not suffice for removing the larger fetus of later gestations. European innovators, such as Van Lith [10], fashioned sturdy, slim instruments similar to enlarged and reinforced ovum forceps with elongated jaws. These instruments enabled Dutch and other European surgeons to perform D&E abortion beyond 20 weeks of gestation.

The emergence of gradual overnight cervical dilation encouraged the development of larger instruments for fetal and placenta extraction. Sopher and Bierer [11] fashioned forceps of greater weight and surface area to enable more rapid removal of fetal parts at later gestations. American innovators, such as Hern, developed variants of extraction instruments specifically suited to rotate fetal parts prior to their removal. Variations in instrument length, size of extraction tip, contour, and location of instrument fulcrum permitted increasingly sophisticated extraction maneuvers resulting in safer, more efficient uterine evacuation.

The US adoption of laminaria tents in the 1970s [12] to dilate the cervix before uterine evacuation represented a landmark in abortion care, permitting safe D&E later in pregnancy. The advent of synthetic osmotic dilators, such as Dilapan® and Lamicel® devices, used alone or in combination with laminaria and applied as multiple serial treatments, facilitated even greater atraumatic cervical dilation, virtually eliminating the cervical barrier to second-trimester abortion [13].

Prevalence and safety

The proportion of US abortions performed by D&E at or after 13 weeks' gestation increased from 31% in 1974 to 96% in 2005, while the percentage performed by intrauterine instillation decreased from 57 to 0.4% [1]. This trend reflects D&E's safety and popularity as well as the proliferation of well-trained D&E surgeons and dedicated outpatient facilities offering specialized care in a cost-effective manner. In addition, physicians trained in the D&E procedure routinely employ and adapt the technique to treat women experiencing second-trimester pregnancy loss, such as intrauterine fetal demise, preterm premature rupture of membranes, and preterm labor with irreversible cervical dilation.

Observational data and several retrospective cohort trials in the 1980s consistently confirmed the safety advantages of D&E versus available methods of medical induction throughout much of the second trimester [7,14,15]. These studies included comparison with older induction agents, such as oxytocin, prostaglandin $F_{2\alpha}$, and urea. In a 2002 retrospective observational study by Autry that compared efficacy and side effects of induction using misoprostol with D&E abortion, the reported major disadvantage of induction abortion was a 30% incidence of retained placenta [16]. Subsequent use of higher dosages of misoprostol, or a combination of mifepristone and misoprostol, with prolonged observation until natural expulsion of the placenta lowered the incidence of retained placenta to 3 to 6% [17,18] (Chapter 12). Using modern techniques and drugs, complication rates of both second-trimester medical and surgical abortion are low; major complications occur in less than 1% of D&E cases [7,15,19,20].

Mortality associated with D&E abortion has dropped steadily over time in the USA. Lawson and colleagues at the CDC noted a reduction from 10.4 deaths per 100,000 procedures during 1972 to 1976 to 3.3 deaths per 100,000 cases during 1977 to 1982 [21]. Unfortunately, the CDC could not calculate national abortion case-fatality rates for 1998 to 2002, the most recent study interval, because a substantial number of the abortions occurred in states not reporting data to the CDC. Thus, the total number of abortions (denominator) is unknown.

Because of its impressive safety record as well as patient preference, D&E remains the most prevalent method of second-trimester pregnancy termination in the USA, accounting for 96% of all second-trimester abortions [1]. The British Royal College of Obstetricians and Gynaecologists (RCOG) recognizes D&E as a safe and effective option for abortion beyond 15 weeks' gestation when performed by practitioners with the requisite instruments and skills [22].

Procedure selection

Given the favorable safety profile of both medical induction and surgical abortion, patients would ideally select an abortion procedure based on their personal preference and medical circumstances. When Grimes and colleagues attempted to perform a randomized clinical trial in the USA comparing D&E with medical induction, most women did not consent to randomization because of the many apparent advantages of D&E [3]. Some of the advantages are discussed next.

Timing and predictability

D&E affords both patients and clinicians more predictable timing of the procedure. The patient typically undergoes 1 to 2 days of preoperative cervical preparation with osmotic dilators, chemical ripening agents, or a combination of the two. Experienced clinicians can usually accomplish D&E in less than 30 minutes as an outpatient procedure. Patients commonly return to work the day following the procedure, minimizing disruption at home and at work.

Psychosocial advantages

Many patients find that the predictability of surgical abortion and avoidance of prolonged labor make D&E less emotionally burdensome than medically induced abortion [23–25]. In contrast to D&E, most inductions occur in hospital settings. Women having induction abortions are often confined to a unit where obstetrical patients are also lying-in. Here, they may be exposed to women laboring and delivering highly desired pregnancies and to hospital staff with a strong moral antipathy to pregnancy termination.

Cost

Many patients in the USA incur the immediate cost of abortions themselves. In addition, indirect costs, such as those associated with treatment of complications and utilization of limited health system resources, are of increasing concern to hospital administrators and third-party payers. Cowett used decision tree analysis to compare the cost-effectiveness of hospital-based D&E versus misoprostol induction of labor (assumed induction-abortion interval 20 hours) during the second trimester [26]. No variation in the probabilities of morbidity or the costs made induction of labor a cost-effective alternative to D&E. Medical regimens using mifepristone taken orally at home 24 to 48 hours before induction and then followed by misoprostol result in substantially shorter induction-to-abortion intervals than regimens studied by Cowett. These regimens should reduce the cost of second-trimester induction abortion. Nonetheless, D&E can be performed as an outpatient procedure whereas induction abortion almost always entails either hospitalization or internment at an intermediate facility, thereby increasing costs substantially.

Prenatal diagnosis

Patients undergoing pregnancy termination because of fetal anomalies often prefer D&E to the longer and less predictable methods of labor induction. Shulman demonstrated that abortion by D&E does not necessarily prevent anatomic diagnosis of suspected fetal anomalies [27]. An advantage of the intact variant of D&E (sometimes called *dilation and extraction* or D&X) is to permit more complete morphologic evaluation of an extracted fetus.

Specific medical concerns

Experienced clinicians can safely achieve accelerated cervical preparation before D&E abortion up to 24 weeks' gestation in 12 to 16 hours without subjecting patients in perilous medical or obstetrical condition to appreciable metabolic or physical stress. In addition, D&E is an important option in cases of failed medical induction (Box A).

The availability of trained and experienced providers may affect a woman's choice of second-trimester abortion methods. A 2002 survey of members of the National Abortion Federation (NAF) found that two-thirds of clinician respondents who performed D&E abortions were aged 50 years or older [28]. Whether current levels of training will meet the need for second-trimester service provision in the USA as aging providers retire is unclear. Although abortion training has increased in recent years because of advocacy efforts and more explicit guidelines from the Accreditation Council on Graduate Medical Education, the relative lack of training in second-trimester D&E remains a concern. A survey of US obstetrics and gynecology residency program directors found that 51% of programs offered routine abortion training in 2004 compared to only 12% in 1992. In programs offering routine training, however, most (64%) trained less than half of their residents in D&E techniques, and very few offered the volume of procedures necessary to attain competence [29]. Notwithstanding these limitations, the increase in abortion-training curricula and establishment of fellowships and divisions of family planning at many academic centers of excellence will augment training, research, and availability of the full range of abortion services, including D&E [30].

Preprocedure preparation

Clinical setting and medical screening

Most women seeking abortion are young and healthy. This fact, coupled with the favorable safety profile of D&E, makes the procedure amenable to a variety of clinical settings, including licensed surgical centers, most outpatient clinics, and many physician offices. Pain management options, ranging from cervical anesthesia with or without oral medication to intravenous sedation or general anesthesia, depend on facility resources, patient and provider preferences, gestational age, and other factors (Chapter 8). Although a woman's medical history or physical examination findings can influence choice of procedure and clinical setting, the skill and experience of the D&E provider are paramount in assuring patient safety [14].

Requirements for a safe D&E program include:

- surgeons skilled and experienced in D&E provision;
- adequate pain control options with appropriate monitoring;
- requisite instruments, including aspirating cannulae and extraction forceps;
- staff skilled in patient education and counseling, procedural care, and patient recovery; and
- established procedures at freestanding facilities for transferring patients who require emergency hospital-based care.

Preoperative evaluation of the patient includes a pertinent history, targeted physical examination (including measurement of height and weight as well as pelvic examination), and an ultrasound scan to verify gestational age and to assess placental location as indicated. Pertinent history should include current medications; pertinent allergies; acute and

Box A

The patient is a 32-year-old nulliparous female with a history of chronic hypertension at 22 weeks' gestation who presented to the high-risk obstetric service complaining of increasing upper abdominal pain. Laboratory studies eventually confirmed HELLP syndrome* with liver enzymes three times the normal value and a platelet count of 60,000. Given poor maternal prognosis associated with continuation of the pregnancy, the patient chose to proceed with abortion by induction of labor. The patient's cervix was uneffaced and undilated when maternal fetal medicine consultants began induction using misoprostol 400 μg every 6 hours. Twelve hours after initiation of induction, the patient experienced spontaneous rupture of membranes and became increasingly uncomfortable but her cervix remained only minimally dilated. Her temperature had risen to 39.1°C (102.4°F), prompting initiation of ampicillin and gentamicin for chorioamnionitis. Meanwhile, her platelet count had decreased to 24,000 and her liver function had deteriorated. Obstetricians consulted family planning service staff who placed laminaria ×10 in the patient's cervix. Although the institutional protocol usually called for serial laminaria treatments over 24 hours between 20 and 24 weeks' gestation, the patient's pretreatment with misoprostol had already achieved considerable cervical ripening. Six hours after laminaria insertion, the patient underwent D&E with general anesthesia. The uncomplicated operation required approximately 20 minutes and resulted in estimated blood loss of 200 cc. The patient's medical condition progressively improved following uterine evacuation, and she was discharged home in stable condition a few days later.

* A severe form of pre-eclampsia characterized by hemolysis, elevated liver enzymes, and low platelet count.

chronic medical conditions; and gynecological factors such as uterine scarring, prior pelvic surgery, or uterine fibroids.

Low-risk D&E patients require minimal preoperative laboratory evaluation. Providers can benefit from knowing preoperative hemoglobin or hematocrit, particularly in the relatively uncommon event that a patient's surgical blood loss exceeds 500 cc. Unless their Rh(D) status is documented in writing, all patients should have Rh(D) antigen testing and receive anti-D immune globulin when indicated. Glucometer testing on the day of surgery for patients with labile insulin diabetes is helpful (Chapter 7).

Patient education and counseling

As with any medical procedure, providers must assure that women presenting for abortion after the first trimester have all the information they need to make informed decisions about their care. In addition, some women may desire further counseling to address emotional, logistical, or psychological issues (Chapter 5). Women who terminate wanted pregnancies because of maternal health issues or detection of fetal anomalies may benefit from counseling by staff well versed in perinatal loss.

Second-trimester patients in the USA undergo termination for a variety of reasons, but most often because of delay in recognizing pregnancy or obtaining necessary funds and support [31,32]. This type of delay may reflect inadequate access to health services, ambivalence about the decision to terminate the pregnancy, familial conflict, or peer-group pressure. Teenagers are likelier than older women to delay abortion until the second trimester [1,33,34] (Chapter 3).

Occasionally, women undergoing preparation for second-trimester pregnancy termination reverse their decision to abort and request removal of osmotic dilators. Although data are inadequate to determine risks of infection or preterm delivery in these circumstances, patients need to be informed of possible sequelae. A case series from Israel described 17 women (gestational age range 6–18 weeks) who chose to continue pregnancies after laminaria removal [35]. Fourteen of these patients delivered at term, one delivered prematurely at 36 weeks, one was induced at 35 weeks for severe preeclampsia, and one had a first-trimester spontaneous abortion. Although chlamydia tests were positive in four women, none experienced amnionitis or preterm delivery despite discontinuation of antibiotic prophylaxis after laminaria removal.

Misoprostol, increasingly used to enhance dilation before second-trimester abortion, might also increase the risk of premature fetal expulsion or anomaly should a patient change her decision to undergo uterine evacuation. Although misoprostol exposure in the first trimester has been associated with Möbius syndrome, a constellation of craniofacial and other abnormalities, no current data confirm or refute teratogenicity following second-trimester exposure [36,37].

Several states in the USA require that women receive information related to so-called fetal "pain" before obtaining an abortion. In 1997, an expert panel convened by RCOG concluded that minimal sensory input reaches the fetal brain before 26 weeks' gestation and that fetal reactions to noxious stimuli could not be interpreted as pain perception [38]. Requisite US courses in research-related human subjects' protection cite 28 weeks of gestation as the earliest time in fetal development when cognition may be present. In a recent thorough review of published studies addressing this subject, Lee and colleagues concluded that fetal perception of pain is unlikely before the third trimester [39]. At this time, available evidence demonstrates that the second-trimester fetus lacks the capacity to perceive pain.

Cervical preparation

Adequate cervical preparation decreases the morbidity associated with second-trimester surgical abortion, including the risk of cervical injury, uterine perforation, and incomplete abortion [40,41]. Knowledge of methods to achieve

adequate cervical preparation is important to provision of safe D&E abortion.

Osmotic dilators

Types

Three types of osmotic dilators are or have recently been in current use in modern settings: *Laminaria japonica* and *digitata*, Lamicel®, and Dilapan-S™ (Appendix, Fig. A-13).

Laminaria tents (MedGyn: Lombard, IL, USA, and Norscan: Westlake Village, CA, USA), the oldest and most commonly used osmotic dilator, are dried, compressed Japanese seaweed tents derived from *japonica* or *digitata* plants. Laminaria come in at least 11 diameters ranging from 2 to 10 mm, in the standard 60-mm length as well as an extra long 85-mm model. Their dimensions are far more varied than those of synthetic dilators, which can be a distinct advantage. When exposed to fluid, laminaria swell to three to four times their dry weight without changing length. They achieve cervical dilation by exerting direct radial pressure outwardly against surrounding cervical stroma and by causing the release of F-series prostaglandins, fostering a disruption in the collagen matrix of cervical tissue. Laminaria thereby both soften and dilate the cervix, making them an effective primary dilating agent as well as an effective adjunctive agent in combination with other types of osmotic dilators or prostaglandins. They achieve most of their clinical effect in 3 hours but reach maximal diameter in 24 hours [42,43].

Lamicel® are dry polyvinyl alchohol sponges impregnated with 450 mg of magnesium sulfate. They measure 67 mm in length and come in two diameters, 3 mm and 5 mm. Lamicel® work by absorbing fluid from the surrounding cervix, reversibly decoupling collagen cross-linkages and increasing sensitivity to E-series prostaglandins within the cervical stroma. They begin working within 2 hours and achieve maximal clinical effect by 4 to 6 hours [44]. Lamicel® devices dilate to 8 mm when placed 6 hours before D&E, and they provide adequate dilation for most D&Es at 17 weeks' gestation or less [45]. Although Lamicel® exert little radial force, they have great utility in early second-trimester procedures, particularly by ripening the cervix before using rigid osmotic dilators. Unfortunately, in 2008 Lamicel® were no longer commercially available in the USA.

Dilapan™ devices (J.C.E.C. Co., Inc., Kendall Park, NJ) are synthetic, hygroscopic polyacrylonitrile rod-shaped dilators. The original model, Dilapan®, was retooled in 1998, underwent several years of clinical testing outside the USA, and is now available as Dilapan-S™. Each Dilapan-S™ rod comes in two lengths, 55 mm or 65 mm, and two diameters, 3 mm or 4 mm. Whereas Lamicel® work primarily chemically and laminaria® work both chemically and mechanically, Dilapan-S™ devices cause cervical dilation predominantly by exerting radial pressure. A 4-mm Dilapan-S™ tent swells to nearly 15 mm, shortening its length by about one-fifth in the process (Appendix, Fig. A-13). Although the device continues to expand up to 24 hours following placement, significant effect is noted in 2 hours and most dilation is achieved within 4 to 6 hours. Many providers use Dilapan-S™ following an initial treatment with laminaria or in combination with Lamicel® or laminaria to soften or predilate the cervix.

In the past, Dilapan™ devices occasionally fractured, leaving plastic debris in the endometrial cavity; these bits could be confoundingly difficult to remove and reconstitute [46]. The retooled Dilapan-S™ model became commercially available in 2002, but its distribution is limited to a few countries. The retooled version is cast longitudinally, conferring increased tensile strength when stretched during a difficult removal and resulting in far fewer instances of fragmentation.

Insertion techniques

Most clinicians can easily learn how to insert osmotic dilators, and techniques and protocols for use are quite varied. Experienced providers gradually acquire dexterity and acumen in tailoring the use of osmotic dilating devices to the great variety of cervical responses they encounter. A general technique of insertion is described here:

- After inserting a speculum into the vagina and optionally cleansing the cervix, grasp the cervix with a single-tooth or vulsellum tenaculum, long Allis clamp, or similar device. This maneuver permits stabilization of the cervix during insertion. Some providers prefer to inject local anesthetic into the cervical lip before grasping it; others prefer to administer full cervical anesthesia prior to osmotic dilator placement. Patient anxiety and sensitivity to pain may govern these choices;
- Before placing the first set of osmotic devices, many providers like to "test" the cervix by passing one or a series of small-caliber rigid plastic or metal dilators past the internal os. This maneuver defines the angle and length of the cervical canal while permitting initial assessment of tissue resistance at the internal os. Modest dilation with rigid mechanical dilators prior to insertion of osmotic devices also permits placement of more osmotic dilators, thereby increasing the width of dilation eventually achieved;
- Grasp the end of the osmotic device with a ring or packing-style forceps and insert it into the endocervical canal such that the tip extends just beyond the internal os (Fig. 11.1). Coating the osmotic dilator with lubricant jelly often eases insertion. Some providers also bathe the devices in a disinfectant such as iodine-povidone solution, although this step is of unproven value as a safety or performance-enhancing technique;
- Osmotic dilators are usually placed in "sets" by sequentially inserting one device after the other until several

devices fit snuggly, but not tightly, within the cervix. Ideally, the distal end of laminaria should extend a few millimeters beyond the external os in order to facilitate removal (Fig. 11.1). Lamicel® are inserted full length up to the flared knob. Similarly, the provider should see the end or knob of the Dilapan-S™ device protruding from the external os;

- Digital examination after insertion of osmotic dilators confirms that the devices have not slipped out of the cervix and are not packed too tightly;
- Most providers place one or more gauze sponges in the vagina following osmotic device insertion to absorb blood and vaginal fluid. The sponges also may help prevent dilators from sliding out prior to swelling. The clinician can hold the sponge(s) in place with packing forceps while removing the vaginal speculum;
- Document in the patient's record the number, size, and type of osmotic dilators placed. These devices are packaged as single units, so counting the wrappers before discarding them or attaching the wrappers to the chart helps assure an accurate account of placed devices.

Women whose osmotic dilators will remain in place overnight can be discharged after receiving appropriate instructions. Patients can resume normal activity following placement. Many will experience mild to moderate cramping, especially in the first few hours postinsertion, but the pain usually responds to low dose nonsteroidal analgesics. Many providers begin antibiotic prophylaxis at the time of osmotic dilator placement. Forewarn patients about the rare possibility that the gauze sponge(s), as well as some of the dilators, might dislodge prior to surgery. Asking patients to track the number of devices expelled or to bring them to the facility helps to account for all devices. Occasionally, patients will experience spontaneous rupture of membranes during or after osmotic dilator insertion. This event is not an emergency and rarely requires additional therapy prior to surgical evacuation of the uterus. However, these patients should be monitored closely for fever, especially if multiple-day cervical preparation is planned. If fever should ensue, some clinicians add parenteral antibiotics or a second antibiotic orally. Finally, clinicians should stress the importance of returning as scheduled for the D&E procedure

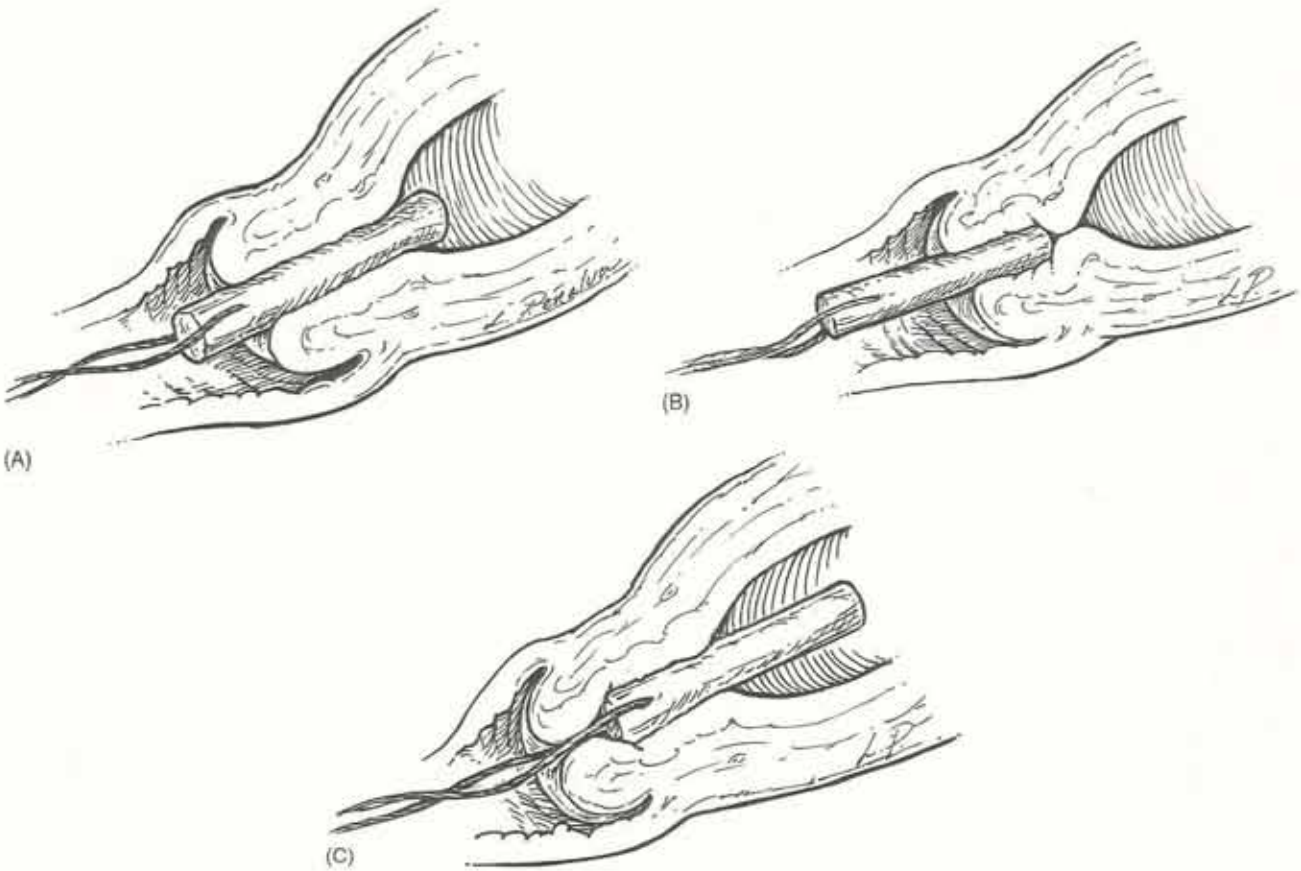

Figure 11.1 Osmotic dilator insertion. (A) Laminaria placed appropriately through the internal os. (B) Laminaria does not pass through the internal os. Swelling results in funneling of the endocervical canal and inadequate dilation of the internal os. (C) Laminaria inserted too far into the endocervical canal. This placement may result in rupture of the membranes and difficult removal.

to avoid the risk of infection from prolonged retention of the dilators.

Addressing challenges

Many special issues and problems can complicate osmotic dilator insertion, particularly for less experienced clinicians. Helpful strategies are addressed next as well as in Chapter 13.

Placing an adequate number of dilators

Obtaining sufficient dilation for an effective "first set" of osmotic dilating devices frequently requires predilation with rigid mechanical dilators, particularly at later gestational ages. Although predilation protocols vary, many clinicians dilate sequentially to 10 to 12 mm when feasible before inserting osmotic devices. To minimize the risk of traumatizing the cervix or creating a false channel, experienced clinicians avoid dilating the cervix too aggressively or packing it too tightly. Performing a digital examination of the endocervical canal before placing the first tent helps to assess its angle, path, and integrity. When placing multiple dilators, consider using devices without plastic stops or remove the stops prior to insertion.

Devices "falling out" of a partially dilated cervix

When the cervix is widely dilated, especially if placental membranes have entered the endocervical canal, the dilators may persistently extrude from the cervix. The problem is exacerbated if the patient bears down, changes position, or is experiencing uterine contractions. In such circumstances, clinicians often digitally insert osmotic devices in a cluster. Using gauze pads to build a "dam" against the cervix helps to prevent extrusion of already placed devices. Exceptionally uncomfortable or anxious patients may benefit from parenteral analgesics or anxiolytics; in rare instances (e.g., some cases of sexual assault), women may require deeper levels of anesthesia in order to tolerate an osmotic dilator treatment.

Strategies for difficult removal

The assumption that more is better can backfire when inserting osmotic dilators. Osmotic dilating devices frequently "hourglass," particularly in resistant or stenotic cervices, and multiple laminaria wedged together have a tendency to meld into a uniform, intractable mass. Because laminaria are neither pliable nor easily transected, they can be difficult to remove after swelling ensues (Fig. 13.5). Dilapan-S™ devices can stretch to remarkable lengths before fragmenting, but on occasion they too can become incarcerated. All types of osmotic dilators can migrate into the uterine cavity resulting in ongoing pain, bleeding, or infection before removal [47].

Several strategies can aid removal of incarcerated devices (Chapter 13). The most effective approach is to exercise caution when choosing how many devices to place, although hourglassing can still occur if the cervix is noncompliant. Slow extraction of device(s) from the middle of the set often aids removal of the entire pack. Many clinicians place one osmotic dilating device near the center of the set, leaving it slightly more extended from the external os than the others. Should difficulties arise when removing the devices, extracting this "key" device first facilitates removal of the remainder.

Because even the reformulated Dilapan-S™ devices can occasionally fragment during removal, many providers use them in combination with laminaria. Laminaria achieve their ripening effect partly through direct contact with the cervix, so they should be placed at the periphery of the bundle.

Protocols for insertion

The amount of dilation required before D&E varies based on gestational age and fetal size, the latter sometimes magnified as a result of certain fetal anomalies such as hydrocephaly. In order to obtain adequate dilation, clinicians usually place sets of osmotic dilating devices over 1 to 2 days preceding uterine evacuation. Cervical response to osmotic dilation can vary considerably, however. Some patients have stenotic cervices that barely admit a first "set" of two or three laminaria but then soften and dilate easily thereafter. Alternatively, a clinician may encounter a multiparous patient whose cervix appears pliable with the first set but then fails to ripen as anticipated with several sets of assorted osmotic dilators.

Providers use a variety of osmotic dilation protocols that dictate the number of devices, number of sets, and the timing of reinsertions (Table 11.1). Protocols may entail laminaria alone, in combination with other osmotic dilators, or in combination with pharmacologic agents such as misoprostol. Package labeling for Lamicel® and laminaria references use of a single device only, although it does not countermand multiple device placement. Package labeling for Dilapan-S™ recommends two tents between 13 and 15 weeks' gestation, three between 16 and 18 weeks, and four at 18 weeks or more [37]. Notwithstanding various recommendations, providers must constantly adapt to individual variations in anatomy in order to optimize patient safety.

The number of devices included in a "set" varies but usually entails the maximum number of devices the clinician can place without undue force. A first "set" in a typical patient after 14 weeks' gestation might consist of three to seven laminaria (Table 11.1). After placing the initial set of devices, the patient returns for insertion of more devices either by the withdrawal of all the previous devices (the "replacement method") or the addition of new devices alongside the previously placed set (the "addition method"). Placing all new osmotic devices enhances dilation but incurs higher cost. No studies address whether the addition method poses greater risk of infection; however, consistent evidence

Table 11.1 Sample osmotic dilator protocols.

Gestational Age in Weeks	Family Planning Associates Medical Group, Ltd. (Chicago, IL)	Northwestern University Section of Family Planning
12.0–13.5		3–5 laminaria
>13.5–14.0	1–2 laminaria[a]	
>14.0–15.5	2–3 laminaria	
>15.5–17.0	4–5 laminaria	
>17.0–19.5	5–8 laminaria	Two sets of 3–5 laminaria. Second set placed 6–8 hours following first set. *[Minimum number of laminaria = Gestational age minus 10]*
>19.5–20.5	6–9 laminaria or 4 Dilapan-S™	Day 1:
>20.5–22.0	7–10 laminaria or 5–6 Dilapan-S™	• First set: 3–5 laminaria
>22.0–23.5	Day 1: 5 laminaria	• Second set: 7–20 laminaria
	Day 2: 20 laminaria	Day 2:
		• 20 laminaria
		[Minimum number of laminaria = Gestational age minus 10]

[a] The standard size laminaria used by Family Planning Associates Medical Group, Ltd. is a 5-mm tent, with exceptions as clinically indicated for extremes of cervical noncompliance or cervical laxity.

indicates that, overall, osmotic dilating device treatments do not increase infection risk in patients having second-trimester abortions [37].

In most circumstances, all three types of hygroscopic dilators achieve considerable, although not maximum, dilation by about 8 hours. Thus, most devices can be added or replaced in 4 to 8 hours. When the cervix is exceedingly stiff, a second dilator treatment in a single day is a prudent and often effective strategy. This approach can also reduce by 1 day the duration needed to achieve cervical ripening in late D&E abortion (20 weeks' gestation or greater). These protocols often use Dilapan-S™ to take advantage of its greater radial force for cervical dilation compared to laminaria and Lamicel® models.

A single set of osmotic devices placed for several hours or overnight usually suffices for gestations in the early second trimester, but clinicians often insert serial sets of laminaria over 1 to 2 days for later gestational ages. Stubblefield performed a randomized trial of 60 patients comparing a 1-day and 2-day laminaria protocol preceding D&E at 17 to 19 weeks' gestation. Although the 2-day protocol resulted in greater dilation (22.4 mm vs. 18.2 mm diameter; $p < 0.001$), the authors questioned whether the additional dilation justified the patient inconvenience and discomfort associated with an additional day of preparation [48].

The minimal cervical dilation required to complete a given D&E varies somewhat based on gestational age, parity, the patient's cooperation, and the provider's skill and equipment. Digital examination of the cervix, similar to that performed among laboring patients, may mislead a less experienced examiner, because the second-trimester cervix can feel underdilated while having become pliable enough to admit required instruments easily. Therefore, part of the digital examination should involve testing the pliability of the cervix when subject to gentle stretch (Box B).

General safety of osmotic dilators

Osmotic dilators decrease the risk of cervical trauma [37,41] and increase the safety of second-trimester D&E abortion [37,49]. Like all medical devices, however, they may carry some risk.

Several minor, short-term risks are associated with insertion of any osmotic dilator. Five to 20% of women may develop vasovagal symptoms during insertion [37]. Dilators may create a false passage in the cervix or, when placed forcefully, result in cervical fracture, a stretch-induced injury of the internal os (Chapter 15). On some occasions, placement of osmotic dilators results in spontaneous rupture of membranes or otherwise facilitates the onset of labor and fetal expulsion before scheduled surgery.

Laminaria, the most frequently used osmotic dilator, are a natural product and can theoretically harbor potential genital pathogens, even after gas sterilization [50]. Fortunately, infection attributable solely to osmotic devices occurs infrequently. Reported rates of infection following abortion with laminaria use are comparable or lower than those associated with abortion without osmotic dilation [46,51]. No studies document whether the initiation of antibiotics concurrent

Box B

The cervix's ability to permit the entry, expansion, and free mobility of extraction forceps offers the most practical gauge of cervical adequacy.

with insertion of osmotic dilators changes rates of infection [37]. Serious infections have occurred in association with retained devices, making it essential that providers document successful removal of all devices at the time of surgical evacuation [52]. Localizing a retained osmotic dilator using conventional radiography is difficult, because osmotic dilators are not radiopaque. Ultrasound often assists in localization, although dilated laminaria can still resemble blood clots even on endovaginal scan [53]. Sonohysterography remains unstudied for this purpose but theoretically is a promising modality.

Anaphylaxis has been reported in response to laminaria placement [54,55]. Lichtenberg has described effective substitution of Lamicel® in this situation [46], but Dilapan-S™ are an alternative if the cervical stroma is minimally pliable.

Most recent studies suggest that use of osmotic dilators followed by D&E exerts no deleterious effect on cervical integrity or subsequent rates of spontaneous abortion or preterm birth. Postoperative studies examining laxity of the internal cervical os following second-trimester D&E suggest no persistent laxity when pretreatment occurs with osmotic dilators. In a small study involving women at 17 to 19 weeks' gestation who were treated with single or multiple insertions of laminaria before D&E, the mean diameter of the internal cervical os 2 weeks postoperatively was less than that before initial treatment [48]. In Kalish's retrospective review of 600 patients who had undergone D&E between 14 and 24 weeks' gestation, the overall rate of preterm birth in subsequent pregnancies was lower than that for the general US population (6.5% vs. 12.5%)[56]. Similarly, Jackson et al compared subsequent pregnancy outcomes among 317 women undergoing second-trimester D&E with 170 matched controls who had no history of midtrimester D&E. Although patients with a history of prior D&E delivered slightly earlier in gestation than controls (38.9 weeks vs. 39.5 weeks, $p = 0.001$), the researchers found no statistically significant difference in birth weight, spontaneous preterm delivery, abnormal placentation, or the frequency of overall perinatal complications [57].

Misoprostol for cervical ripening

Although many studies document the safety and efficacy of misoprostol for cervical ripening before first-trimester aspiration abortion (Chapter 10), Goldberg et al have performed the only randomized, double-blinded, controlled trial to date comparing misoprostol with the traditional practice of overnight laminaria before second-trimester surgical abortion [58]. Subjects at 13 to 16 weeks' gestation ($n = 84$) received either 400 μg of vaginal misoprostol 3 to 4 hours preoperatively or overnight laminaria. The primary outcome was procedure time; secondary outcomes included completion of the procedure on the first attempt, procedural difficulty, and patients' pain scores and preferences. Second-trimester abortions following same-day misoprostol took approximately 4 minutes longer and were technically more challenging (particularly in nulliparas) than those following overnight laminaria. Dilation effect was greater with laminaria (43F vs. 33F, $p < 0.001$). Patients, however, preferred a same-day procedure to overnight treatment. The vast majority of procedures in both groups were accomplished safely and with adequate dilation. No D&E trial has yet compared same-day presurgical use of osmotic dilators versus misoprostol.

Patel and colleagues analyzed data from 2,218 D&E procedures between 12 and 23 completed weeks of gestation in which providers at multiple clinic sites applied cervical preparation consisting of various regimens of buccal misoprostol with or without osmotic dilators [59]. The dose of misoprostol ranged from 400 to 800 μg, but most patients received 400 μg buccally at least 90 minutes preoperatively. Cervical preparation was considered adequate if the cervix did not require additional dilation before D&E or the physicians rated additional dilation as "not difficult." Adequacy was generally greater for laminaria versus no laminaria regardless of misoprostol use. For instance, patients receiving buccal misoprostol but no laminaria had *inadequate* cervical preparation 18% of the time, whereas those receiving both buccal misoprostol and laminaria failed to achieve adequate cervical preparation only 2% of the time. When misoprostol was used alone, the 800-μg dose achieved adequacy significantly more often than lower doses but at a cost of more frequent side effects. In the misoprostol-only group, a strong association emerged between need for additional dilation and lower gestational age. Providers completed the D&E procedures as scheduled in all but five patients, and complication rates were low. Patel and coworkers concluded that buccal misoprostol is safe and holds promise as a primary cervical ripening agent in the second trimester. Given the study's limitations, further research is needed to define the optimal role of misoprostol in second-trimester cervical preparation protocols.

To determine whether adjuvant buccal misoprostol improves cervical preparation with laminaria, Edelman et al performed a randomized double-blinded, placebo-controlled trial comparing overnight laminaria and either placebo or misoprostol 400 μg administered buccally 90 minutes before D&E at 16 to 21 weeks' gestation [60]. Although some surgeons subjectively reported easier dilation following misoprostol priming, this study recorded no objective differences in cervical dilation measured by passage of rigid dilators, need for additional dilation, or duration of procedures at less than 19 weeks' gestation. However, for procedures at 19 to 21 weeks, preoperative use of misoprostol had a positive effect on dilation (54F vs. 49F, $p = 0.01$). As in the study by Goldberg [58], patients receiving misoprostol experienced more discomfort than those in the nonmisoprostol arm.

Where cost and availability permit its use for cervical ripening, mifepristone has clinical value either alone or in combination with misoprostol or laminaria. Carbonell and colleagues [61] evaluated the efficacy of mifepristone among 900 women undergoing D&E at 12 to 20 weeks' gestation. They randomized patients to one of four groups: 200-mg mifepristone plus 600-μg sublingual misoprostol; 200-mg mifepristone plus 600-μg vaginal misoprostol; 600-μg sublingual misoprostol alone; or 600-μg vaginal misoprostol alone. Mifepristone was administered 48 hours before D&E, and misoprostol was given 1.5 to 2.5 hours preoperatively. The combination of mifepristone and misoprostol before D&E decreased operating time and the risk of cervical injury. However, mifepristone increased cost by approximately 25 euros per procedure, the total number of patient visits, and the number of pre-D&E fetal expulsions. Noted advantages of adjuvant mifepristone included decreased waiting time after administering misoprostol (1.7 ± 0.6 hours vs. 2.1 ± 0.7 hours, $p < 0.001$), a significant reduction in the number of osmotic dilators used, and greater preoperative cervical dilation. The difference in degree of mean cervical dilation obtained following mifepristone was noted in both the sublingual misoprostol groups (12.6 ± 2.1 mm vs. 8.9 ± 3.0 mm) and the vaginal groups (12.4 ± 3.3 mm vs. 8.1 ± 3.3 mm).

Injections to cause fetal demise

Indications

Injections to cause fetal demise prior to operative evacuation may have certain benefits. At gestational ages when a live birth is possible, these injections avoid that possibility, including in patients who experience labor following cervical preparation [62]. Some clinicians believe that the process of cortical bone softening, which begins within 24 hours of fetal death and makes fetal tissue more pliable, may facilitate evacuation and avoid lacerations caused by sharp fragments of fetal bone. Some patients may find solace in knowing that fetal death occurred prior to operative evacuation.

US abortion providers may prefer using these injections to ensure compliance with the federal Partial-Birth Abortion Ban Act of 2003 [5] and related state laws. The act is an intentionally imprecisely worded statute prescribing criminal sanctions against offending physicians but applicable only when a "living fetus" is present at the outset of evacuation [5] (Chapter 4). The federal law bans abortions in which the physician first intentionally removes a "living fetus" to the point at which either its entire head or any part of its trunk above the navel is outside the woman's body, and then performs an overt act, separate from delivery, that kills the fetus. According to the US Supreme Court, it does not apply to "most" nonintact D&Es [63]. Injection to cause fetal demise is one of many ways to assure compliance with this law. Whatever method is chosen, providers who intend to remove (or who know there is a strong possibility of removing) the fetus in a way that would violate the ban if the fetus were still living must ensure fetal demise before the fetal head or any part of the trunk above the navel is outside the woman's body.

Precautions

The two agents used to cause fetal demise are digoxin and potassium chloride (KCl). The only known contraindications to digoxin are Wolff-Parkinson-White syndrome and allergy to the medication. Cardiac auscultation should be performed prior to administration of digoxin, followed by electrocardiogram (EKG) if the clinician detects evidence of arrhythmia. Potassium chloride has no known contraindications.

The safety of administration of digoxin or KCl for this purpose depends on injection of the agent in the desired location and avoiding maternal intravascular injection. Factors such as morbid obesity or oligohydramnios can limit sonographic visualization of the needle, thereby increasing the risk of maternal complications. The practitioner should consider foregoing the injection if technical limitations prevent safe administration of digoxin or KCl.

Agents

Digoxin, which decreases conduction of electric impulses through the atrioventricular node, is administered via intraamniotic or intrafetal injection. KCl requires direct fetal intracardiac or intraumbilical (funic) injection. In toxic doses, KCl results in depolarization of the membrane potential of cells and impairment of impulses in the cardiac conduction system, ventricular tachycardia, and asystole.

Techniques

Overview

To minimize the risk of chorioamnionitis, use of sterile technique is standard practice. The abdomen is cleansed with an antiseptic solution, and a sterile cover (e.g., a sterile glove) is placed over the ultrasound probe. Arranging sterile supplies (a prefilled syringe containing the digoxin or KCl, spinal needle[s], and gauze sponges) on a nearby tray facilitates access. Most providers use a 20-gauge or a 22-gauge spinal needle, but having available needles of different lengths will accommodate women with varying abdominal wall thickness.

Whichever technique is used, ultrasound evaluation prior to needle insertion permits the clinician to confirm gestational age, evaluate amniotic fluid volume and placental location, and identify uterine abnormalities that can complicate the procedure, such as large leiomyomata. Although amniocentesis can be accomplished without it, real-time ultrasound guidance helps to confirm proper needle placement and direct the injection of digoxin or KCl to a precise location. The injection of the solution causes a turbulent stream

that may be visible sonographically, aiding confirmation of proper placement.

Physicians experienced at ultrasound-guided obstetric procedures, including genetic amniocentesis, chorionic villus sampling, and injections to cause fetal demise, use a variety of techniques of needle insertion based on training and experience. Differences include ultrasound imaging techniques (longitudinal vs. transverse placement of the ultrasound probe), needle placement (at the end of the probe vs. in the middle of the probe), and needle angle (straight and close to the probe vs. angled and farther from the probe). Inserting the needle while holding the ultrasound transducer allows the clinician to estimate the required angle and depth of insertion, although some clinicians prefer to have an assistant hold the probe. No evidence suggests that any single technique is safer than others, and individual practitioners should adopt methods based on ease, experience, and personal outcomes.

Some ultrasound machines contain a probe and attachments for a needle guide. This method involves placing the needle through a slot attached to the probe. Prior to needle placement, the probe is angled so that the needle pathway appearing on the screen will intersect the desired target. Needle guidance may be helpful for funic or intracardiac placement. It is not required for intra-amniotic needle placement but may be useful in the presence of morbid obesity or oligohydramnios.

Injection sites

Intra-amniotic digoxin

For intra-amniotic digoxin injection, a dose of 1.0 mg undiluted or in 3 to 5 ml of saline [64] is a common regimen, but doses in the 1.0- to 2.0-mg range are acceptable. Aspiration of amniotic fluid confirms appropriate placement of the needle. Fetal death does not occur immediately after intra-amniotic injection.

Intrafetal digoxin

Based on large published series of outpatient abortion procedures after the first trimester, intrafetal injection of digoxin in doses of 1.0 to 1.5 mg appears to effect fetal demise [65,66]. Providers may feel a change in resistance at the needle tip as it enters the fetus. Unless the needle is in the fetal cardiac chambers, aspiration will not usually yield fetal blood. Haskell, in a personal case series of 67 consecutive patients receiving 2.0 mg of intrafetal digoxin, reported that sonographically confirmed fetal demise occurred in 43% at 2 hours; 75% at 3 hours, and 98% in 5 hours (Haskell M, 2008, personal communication). Fetal cardiac asystole may be visible on ultrasound within 1 to 2 minutes of intracardiac injection.

Intracardiac or funic potassium chloride

Potassium chloride will not achieve fetal demise when injected into the amniotic fluid; injection into the fetal heart or umbilical cord is required. To achieve fetal death, 5 to 10cc of KCl at a concentration of 2 mEq/ml (10–20 mEq total) suffice. Injection of KCl into the fetal heart or umbilical cord typically causes cardiac asystole within 1 minute. Needle placement should be maintained until fetal death is confirmed sonographically.

These technically challenging procedures are performed most commonly for multifetal pregnancy reduction or selective termination of an abnormal fetus (Chapter 21), and a relatively small number of physicians possess the requisite skill and experience. Expertise in performing intracardiac or funic injections may not be available in many outpatient settings that offer midtrimester abortion services.

Confirmation of fetal demise

Clinicians typically administer agents to cause fetal demise 1 to 2 days before D&E, often in conjunction with cervical preparation. Because intra-amniotic or intrafetal digoxin does not result in immediate fetal death, ultrasound can be used prior to uterine evacuation to confirm absence of fetal cardiac motion. If demise has not occurred, the advisability of a repeat injection will require weighing the putative benefits of fetal death prior to evacuation with the risks of another injection, possible maternal anxiety and discomfiture, and the possible need to delay uterine evacuation. Intracardiac or intrafunic injection, if feasible, will accomplish immediately verifiable fetal death and avoid surgical delay. If US providers decide to proceed with D&E after an injection fails to cause fetal demise, they will have to consider alternative means of complying with the Partial-Birth Abortion Ban Act of 2003 [5] and related state laws.

Monitoring

Based on available data, routine monitoring of the patient's vital signs or EKG is not necessary during or after digoxin or KCl injections. Specific patient complaints should be investigated as clinically indicated.

Safety and efficacy

Published data on the use of injections to cause preoperative fetal demise are limited primarily to retrospective case series. Although most of these studies report no maternal complications, their small size does not permit evaluation of uncommon complications or side effects attributable to these injections. Moreover, most studies are uninformative about the putative surgical benefits of preoperative fetal demise, because they did not include a control group for comparison.

One small observational study assessed maternal side effects of intra-amniotic digoxin. Drey and colleagues examined maternal serum digoxin levels and EKG changes

following intra-amniotic injection of 1 mg of digoxin in eight patients at 19 to 23 weeks' gestation [67]. Peak serum digoxin levels occurred approximately 11 hours after administration. The peak concentrations were in the low therapeutic range, and no level approached the potentially toxic concentration of 2 ng/ml. EKG monitoring did not identify any patterns indicative of digoxin toxicity. Reported side effects associated with digoxin toxicity (e.g., nausea, blurred vision, and light-headedness) were uncommon, and they did not correlate with peak digoxin levels in the affected patients. No laboratory evidence of coagulopathy was observed.

Research suggests that maternal serum digoxin levels are far higher than maternal tissue levels after injections to cause fetal demise, conferring an extra measure of safety. Haskell and Kade recorded serial maternal serum digoxin levels in 60 consecutive women undergoing intrafetal injection with 2.0 mg of digoxin (Haskell M, 2008, personal communication). Single values in two women substantially exceeded the reference range of 0.8 to 2.0 ng/ml (6 ng/ml and 7 ng/ml, respectively) within 1 hour of injection, but neither patient exhibited clinical signs of cardiac toxicity. The investigators attributed this lack of serum and clinical correlation to the fact that digoxin takes at least 8 hours to redistribute from serum to tissues. Because of digoxin's long half-life of 30 hours, a steady state concentration is not achieved for 5 days or more. Published reference ranges for digoxin apply to serum levels observed after redistribution, and samples taken within 8 hours of digoxin administration will falsely imply elevated tissue levels [68].

Spontaneous abortion prior to operative evacuation has been reported in women who received intra-amniotic or intrafetal digoxin. Jackson and colleagues, in a pilot study preceding a subsequent randomized controlled trial, described an "unacceptably high rate of spontaneous abortion" with digoxin injected 48 hours prior to evacuation. However in their randomized study, in which the injection was performed 24 hours prior to abortion, they reported no cases of spontaneous abortion [64]. In Molaei's series of 1,795 women receiving intra-amniotic or intrafetal digoxin the day before D&E, nine patients (0.5%) were sent to the hospital for "spontaneous contractions" prior to their scheduled return visit [66]. It is not clear whether spontaneous abortion is related to fetal death or possibly to the presence of digoxin in the amniotic fluid, which is known to increase muscular contractility. If spontaneous abortion is due to fetal death, similar risks would be expected with the use of intracardiac or funic KCl. Although this occurrence has not been reported, preinduction fetal intra-cardiac KCl did result in more rapid delivery in patients undergoing second-trimester medical abortion using prostaglandin agents [69].

One case report described maternal cardiac arrest within 1 minute of attempted fetal intracardiac injection with 5 mEq of KCl. The case involved a patient with advanced cervical dilation at 23 weeks' gestation who declined further tocolysis. The administration of KCl occurred on a labor and delivery suite using a bedside ultrasound machine that lacked magnification. According to the authors of the case report, this arrangement deviated from their normal protocol for effecting fetal demise. Cardiac arrest was attributed to direct rapid injection of KCl into the maternal circulation [70].

Any procedure associated with transabdominal needle placement into the uterine cavity can result in maternal infection. Although this complication is extremely uncommon given the large number of amniocenteses performed in obstetric practice, a few case reports describe maternal sepsis following genetic amniocentesis [71,72]. A single case of maternal sepsis following funic KCl administration has been reported [73]. Although no report has described sepsis following intracardiac KCl or intra-amniotic digoxin, the similarities between these procedures and amniocentesis suggest that they may carry a small risk.

Although many providers believe that fetal bone and joint softening induced by fetal demise facilitates uterine evacuation, only one published study has evaluated the medical benefit of these injections. Jackson et al randomized 126 women at a mean gestational age of 22.5 weeks to receive 1 mg of intra-amniotic digoxin or placebo. The study found no differences in procedure duration, estimated blood loss, operator-perceived procedure difficulty, or frequency of complications. Intra-amniotic digoxin induced fetal death in 57 (92%) of the 62 patients in the study group. Women who received digoxin reported vomiting significantly more often than those who did not (16% vs. 3%) [64].

Molaei and coworkers examined the efficacy of digoxin to cause fetal demise in a retrospective cohort analysis of 1,795 women at 17 to 24 weeks' gestation who received the drug before laminaria placement on the day prior to D&E [66]. Most patients (n = 1,665; 93%) in this study had intrafetal (described as "in the fetal heart region") digoxin injections with doses ranging from 0.125 to 1.0 mg; the remaining patients received intra-amniotic digoxin in doses ranging from 0.125 to 0.50 mg. In the intrafetal digoxin group, the overall rate of failure to achieve fetal demise was 4.7% (95% CI 3.7, 5.8%); the failure rate decreased from 14.3% (95% CI 8.0, 22.8%) in patients who received the lowest dose of digoxin (0.125 mg, n = 98) to 0 (95% CI 0.0, 3.4%) in those who received a 1-mg dose (n = 107). Failure occurred in nearly one-third of the 131 women who had intra-amniotic injections, most likely because of the low doses of digoxin used. No patients experienced palpitations or visual changes suggestive of digoxin toxicity; rates of nausea and vomiting were not reported. To date, no study has examined efficacy by site of injection in the fetus.

Data on the efficacy of KCl to cause fetal demise are limited. In the largest study of 239 patients at a median gestational age of 22 weeks, no failures or complications occurred using an average fetal intracardiac dose of 4.7 ml (15% KCl; 20 mM/10 ml) [74]. In a smaller series of 106 patients,

Bhide et al found that funic injection required lower doses of KCl compared to intracardiac injection, although the average doses used exceeded those reported in more recent studies. However, the failure rate was higher with funic injection [75]. Gill and colleagues attempted funic KCl injection in 60 patients. In eight cases (13%), funipuncture either could not be achieved or did not result in fetal cardiac asystole, mirroring the higher rate of failure reported by Bhide. These cases required intracardiac administration to accomplish fetal demise [76].

In conclusion, injection to cause fetal demise appears to be a safe procedure with low complication rates based on the limited data available. Intra-amniotic or intrafetal digoxin is likely to be the procedure of choice in most settings, as funic or intracardiac KCl administration is technically much more difficult. Fetal death is not inevitable with intra-amniotic or intrafetal digoxin, however. Published data confer no clear medical benefit of causing fetal demise, although individual practitioners may want to consider it if: (1) in their experience fetal cortical bone softening makes the procedure easier; (2) a patient expresses a preference for fetal death prior to operative evacuation; (3) they desire to avoid the possibility of unscheduled delivery of a live fetus; or (4) they are concerned about compliance with the Partial-Birth Abortion Ban Act of 2003 [5]. To minimize the risk of spontaneous abortion prior to surgical evacuation, providers should avoid performing the injection longer than 24 hours prior to planned evacuation if possible. Clinicians who use these injections should consider monitoring outcomes, including rates of success and complications such as chorioamnionitis or spontaneous abortion prior to operative evacuation.

D&E procedures

Instruments

A variety of specula, tenacula, and extracting forceps are available for surgical abortion after the first trimester. Although many surgeons base these choices on their exposure during training and their practical experience, certain instruments may be useful in particular circumstances.

Specula

A speculum allows the surgeon to have access to the cervix. Its length should not impede the clinician's effort to draw the cervix toward the vaginal introitus. The speculum should provide sufficient room to manipulate extracting forceps during fetal removal. The blades of the speculum can also be used as a fulcrum, to change the angle of the endocervical canal and ease entry into the endometrial cavity.

The two basic types of specula are the Graves and weighted versions. Several modifications of the Graves speculum have foreshortened blades of varying width, number, and design (e.g., the Klopfer model) (Appendix, Figs. A-2 and A-3). A juvenile or pediatric speculum may prove useful in patients with a narrow introitus. In patients with converging vaginal walls, a tri-blade design (e.g., the Guttmann vaginal retractor) can allow for appropriate visualization of the cervix.

Despite their apparent size and forbidding appearance, patients generally tolerate weighted specula well, particularly if they receive intravenous sedation along with cervical anesthesia. Late in the second trimester, when forceps extraction is likely to be necessary, a weighted speculum accommodates larger fetal parts and allows more angulation of the forceps, particularly in patients with considerable vaginal depth. Weighted specula can be modified by beveling any sharp edges of the blade and by increasing the angle between blade and stem to reduce the chance of their spontaneous release from the vagina, especially when awake or semiconscious patients exhibit guarding or uncontrolled movements.

Tenacula

Traction on the lip of the cervix brings the cervix closer to the vaginal introitus and straightens the endocervical canal. The tenaculum chosen must maintain its attachment through strong and steady traction. A long instrument facilitates access to the cervix, and many surgeons prefer models with a pelvic curve (vulsellum design). If the cervix is firm and not very dilated, a tenaculum with teeth can be especially useful. With a soft dilated cervix, instruments with an Allis tip or ring-forceps design can maintain traction while minimizing the risk of cervical mucosal laceration (Appendix, Fig. A-6). These superficial lacerations or bleeding puncture sites are treated easily with tamponade, cauterizing agents (e.g., silver nitrate or ferric subsulfate [Monsel's] solution) or, in the last resort, one or two absorbable sutures.

Forceps

The choice of forceps depends on cervical dilation and gestational age, as well as provider preference. Available models vary in length, size of the jaws, and grasping surfaces (Appendix, Fig. A-11). Experienced surgeons may use a combination of forceps in individual cases to accommodate changes in uterine size as the emptying cavity contracts or to remove retained portions of fetal anatomy when other forceps do not suffice.

Ring forceps require minimal cervical dilation (10–12 mm), and they can be used early in the second trimester to extract fetal parts that are not easily removed with large-bore suction. Because of their relatively short length, small grasping area, and minimal serrations, they do not suffice for most gestations beyond 17 to 18 weeks. After this gestational age, longer and weightier forceps are essential. Sopher forceps have weightier, longer shafts with bulkier grasping surfaces. About 13 and 15 mm of cervical dilation are required to open widely the jaws of the small and large Sopher forceps, respectively. Sopher forceps lack a pelvic curve, limiting their ability to explore the uterine cornua.

Of the commonly used types of forceps, Bierer forceps are the weightiest and largest-jawed. The fenestrated and sharply serrated jaws provide the most traction, and the pelvic curve and long length maximize access to all aspects of most uterine cavities in the later second trimester. Bierer forceps require more than 15 mm of cervical dilation to permit maximal expansion of the jaws. Hern forceps are longer than either Sopher or Bierer forceps and, like Blumenthal forceps, they are useful in cases of extreme uterine depth. The jaws of Hern forceps have fewer and smaller teeth, making them especially useful when traction or rotation of an intact fetus, is desired (e.g., when attempting intrauterine version of the fetus to a more favorable lie).

Uterotonic agents

As the fetus and placenta are removed during surgical abortion, contraction of the uterine cavity is necessary to prevent hemorrhage. The most important step in minimizing the risk of uterine atony, which is more common with advancing gestational age, is to ensure complete removal of fetal and placental tissue. Limited data suggest that prophylactic use of uterotonics for surgical abortion beyond the first trimester also helps to lessen blood loss [77]. Oxytocin can be given in concentrated form intramuscularly, intracervically, or intravenously (10–20 units) or in diluted form as an intravenous infusion (20–80 units/500–1000 cc). Some surgeons administer oxytocin at the beginning of the procedure, whereas others prefer to wait until complete removal of the fetus because of a concern about entrapment of fetal parts. No data or clinical consensus address this issue of timing. Giving dilute oxytocin as an intravenous drip allows clinicians to discontinue the infusion during surgery if increased myometrial tone is preventing safe completion of the procedure. Continuing oxytocin infusion for 30 to 60 minutes after the abortion procedure may help to maintain uterine tone and prevent postoperative uterine atony.

When cervical anesthesia is used, dilute vasopressin (1–6 units/20 ml) can be added to the anesthetic solution (Chapter 8). In one randomized controlled trial, paracervical injection of vasopressin lessened blood loss compared to placebo, particularly after 15 weeks of gestation [77]. A recent study randomized 36 women at a mean gestational age of 16 weeks to paracervical injection of saline with or without 4 units of vasopressin, with the primary objective of evaluating hemodynamic changes in blood flow through the uterine artery. In these early second-trimester patients, vasopressin was not associated with changes in uterine blood flow or in estimated blood loss [78]. Vasopressin also can be administered as a dilute intravenous infusion, similar to the use of oxytocin. One protocol uses 4–8 units per 500 ml of crystalloid prior to 20 weeks' gestation, and 8–16 units per liter of crystalloid at or beyond 20 weeks' gestation.

Other agents used to improve uterine tone after vaginal or cesarean birth, such as methylergonovine, misoprostol, or tromethamine carboprost (Hemabate®) may be used during D&E as well [79]. No controlled studies have evaluated their efficacy in women undergoing surgical abortion after the first trimester. Ergot derivatives (e.g., methylergonovine) should be avoided in women with poorly controlled hypertension and used cautiously, perhaps primarily intramuscularly, in women with well-controlled hypertension. Carboprost tromethamine, an F-series prostaglandin, is contraindicated in asthmatics.

Risk factors for uterine atony include advancing gestational age, chorioamnionitis, grand multiparity, multiple pregnancy, prior uterine scarring, and general anesthesia using halogenated gases [79]. In the presence of any of these risk factors, clinicians should strongly consider the use of uterotonic agents. If uterotonic agents are not used routinely, they must be readily available in the event of hemorrhage resulting from uterine atony or other causes.

Most physicians employ a stepwise approach to uterotonic medications. Dilute infusions of oxytocin or vasopressin or direct injection of methylergonovine (0.2 mg intramuscularly or intracervically) are commonly administered routinely or as an initial step in managing uterine atony. Refractory cases of uterine atony may respond to treatment with misoprostol (400–1,000 μg per rectum), or direct injection of carboprost (250 μg) or vasopressin (10–20 units/20ml) into the cervix or endomyometrium. The different classes of uterotonic medications (oxytocin, vasopressin, ergot alkaloids, and prostaglandin derivatives) are complementary in their action (different gene sites) and can thus be used concurrently or sequentially.

Patient positioning

Some D&E procedures are technically challenging even under optimum circumstances. If the patient is not positioned properly, the speculum may not permit adequate visualization and mobilization of the cervix. Optimum patient positioning enhances the surgeon's ability to straighten and negotiate the cervical canal and maneuver the forceps into all areas of the endometrial cavity. When difficulty is encountered in a procedure, particularly in the presence of obesity or a narrow pelvis, the surgeon's success may depend on having achieved proper positioning at the outset of the case.

Standard examination tables are suitable for performing D&E. Hydraulic operating tables, if available, allow greater control and variety in customizing the height and angle of the table. The patient's hips should extend slightly beyond the table's edge, tilting the vagina posteriorly and providing room for angling the forceps acutely in all directions.

Removing osmotic dilators

Remove osmotic dilators by inserting two fingers into the vagina, grasping the gauze and strings, and pulling gently. If a "keyhole" dilator has been placed, taking out this device first usually facilitates removal of the remaining dilators. If

gentle traction on the strings does not extract the dilators easily, then exposing the cervix with a speculum and grasping the end of one dilator at a time with a ring forceps usually works. Some patients require cervical anesthesia or intravenous sedation to accomplish this step.

The number of dilators removed should equal the number inserted. If a discrepancy exists, one or more of the first devices placed may be intrauterine, having been pushed beyond the internal os by subsequent dilators. In this case, the surgeon must inspect closely all material removed from the uterine cavity to identify missing dilators. To avoid searching for devices that the patient may have passed spontaneously, the clinician should ask the patient if any dilators fell out beforehand. Numerous approaches are available for addressing the problem of retained osmotic dilator fragments (Chapter 13).

Once the osmotic dilators are removed, a digital examination is often highly instructive. With this maneuver the surgeon can assess the degree of cervical dilation and pliability; the presence in the endocervical canal of any niches, fossae, or lacerations created by improper insertion of osmotic dilating devices; and often, fetal presentation.

Ultrasound guidance

For decades, experienced providers have been performing surgical abortion after the first trimester without routine ultrasound guidance and with very low complication rates. Regardless of the surgeon's skills and experience, however, ultrasonic monitoring can help in performing D&E abortions in certain circumstances.

One study in a residency training program assessed the frequency of uterine perforation during D&E performed at 16 to 24 weeks' gestation before and after adopting routine use of intraoperative ultrasound. In 353 cases performed without routine ultrasound, five perforations (1.4%) occurred. In the subsequent 457 procedures accomplished with routine intraoperative ultrasound, only one uterine perforation (0.2%) occurred [80]. Although these data have been used to support a policy of routine intraoperative ultrasound, the use of a historical cohort as a control is not ideal and a teaching setting is not necessarily representative of community practice at dedicated facilities staffed with highly experienced D&E surgeons.

Imaging in a sagittal plane enables the surgeon to visualize the entire depth of the uterus, from cervix to fundus. Imaging in a transverse plane provides circumferential visualization at a specific depth and can help the provider guide the jaws of the forceps around a fetal part. In cases that require a considerable degree of force to remove fetal parts, visualizing movement of fetal tissue caused by traction without concomitant movement of the uterine wall can reassure the surgeon that myometrium has not been grasped. Intraoperative sonographic views are not three-dimensional; thus, sagittal and transverse planes cannot be seen at the same time. Additionally, extracting forceps shift constantly during uterine evacuation. These movements cause moment-by-moment repositioning of visual landmarks, making continuous monitoring a moving target and explaining in part why intraoperative ultrasound cannot prevent all occurrences of iatrogenic injury.

When not employed routinely, ultrasound imaging should be readily available in facilities offering D&E, and the surgeon should have a low threshold for using it. A 2002 NAF-member survey found that approximately half of respondents routinely use intraoperative ultrasound during D&E, and most of the remaining respondents use it selectively. Younger physicians were more likely to use ultrasound routinely [28]. Clinicians should strongly consider ultrasound guidance in patients with uterine abnormalities, such as large leiomyomata; in morbidly obese patients, in whom the uterine fundus is not palpable; and when repeated insertion of forceps fails to grasp or remove fetal parts. If the surgeon has difficulty identifying some fetal parts following evacuation, ultrasound may help to rule out retention of large fragments containing fetal bone.

Although ultrasound is extremely useful in some cases, it is not a substitute for good judgment. Ultrasound does not provide continuous visualization of the entire uterus or of all fetal or placental tissue. The surgeon must not ignore other important crucial information, such as the sensation of tissue contacting the forceps blades, the degree of resistance encountered in removing fetal tissue, the patient's pain response, an inventory of pregnancy elements already removed, and direct visualization of tissue emerging from the cervix.

Operative technique: Standard D&E[1]

Early in the second trimester, suction may suffice to remove the fetus and placenta without the use of forceps (suction D&E). This technique is similar to vacuum aspiration for first-trimester abortion. A 12- or 13-mm cannula is often adequate to evacuate a gestation of approximately 14 weeks, and a 14- or 15-mm cannula is typically used at 15 weeks. A 16-mm suction cannula usually removes a fetus of 16 weeks' size, although forceps may be needed to extract some fetal parts such as the calvarium or spine. The suction-only approach poses problems when a stiff cervix limits dilation or when the intact calvarium becomes incarcerated in the cornua or lower uterine segment. In most of these cases, some form of forceps extraction becomes necessary. After about 16 weeks' gestation, the 16-mm suction cannula alone is not sufficient, and forceps extraction is necessary [81].

[1] While the authors here adopt the term "standard D&E" as the US Supreme Court used it in *Gonzales v. Carhart*, 127 S. Ct. 1610 (2007), to refer to non-intact D&Es, the term is not medical, and the authors in no way suggest that any one variation of D&E is more or less standard than another.

Skill in utilizing forceps to remove fetal tissue requires special apprenticeship training and ongoing operative experience. Before performing procedures late in the second trimester, the surgeon should be comfortable performing surgical abortion at earlier gestational ages. Providers vary in their approaches to fetal extraction, as with any common surgical procedure. Nonetheless, the following suggestions may facilitate evacuation and minimize the risk of complications:

- Prior to inserting the forceps, determine the location of fetal tissue by ultrasound or digital examination. The digital examination involves placing one or two fingers through the cervical canal while applying gentle pressure on the uterine fundus in an attempt to palpate fetal parts. This maneuver usually does not require removing the speculum (especially a weighted speculum) or the tenaculum.
- When inserting forceps, stabilize and straighten the endocervical canal by applying firm, steady traction with the tenaculum. Once the forceps has passed through the internal os, open the jaws as widely as possible to encircle the fetal tissue and avoid pushing fetal parts deeper into the fundus (Fig. 11.2).
- The uterine cavity can be explored with forceps by rotating the jaws to explore the anterior and posterior walls. After 16 weeks' gestation, fetal skeletal development is such that the surgeon can manually sense the presence of fetal parts within the closed jaws. If fetal parts are not present, open the jaws once again and rotate them to explore other areas of the uterine cavity.
- Removing the fetus from the lower uterine segment, rather than the fundus, lessens the risk of uterine perforation (Fig. 11.2). After grasping a fetal part, withdraw the forceps while gently rotating it. This maneuver brings the fetus into the lower uterine segment before the grasped fetal part is separated (if necessary) and removed from the cervix.
- Minimizing the number of forceps passes into the uterus may lessen the risk of surgical trauma. Ample cervical dilation helps to achieve this objective. If a fetal extremity is brought through the cervix without separation, advance the forceps beyond the extremity to grasp part of the fetal trunk. Bringing the fetal trunk into the lower segment markedly reduces the number of instrument passes into the fundus.

When fetal tissue must be removed from the uterine fundus, take care to avoid perforation. If ultrasound guidance is not used to visualize the relationship of the forceps to fetal tissue, placing an abdominal hand on the fundus, as described by Hanson, may be of value [82] (Fig. 11.3). The abdominal hand accomplishes two goals. It allows the clinician to palpate the movements of the forceps against the uterine wall, providing reassurance that perforation has not occurred (or immediate evidence that it has). By manipulating the uterine fundus, the abdominal hand also helps to bring fetal tissue into contact with the forceps.

During the procedure, try to identify and keep track of fetal parts as they are removed. A "pouch" or surgical pan at the edge of the table to catch fetal parts can assist this process. Knowledge of what fetal parts remain in utero may affect decisions regarding selection of forceps and administration of uterotonic and anesthetic medications.

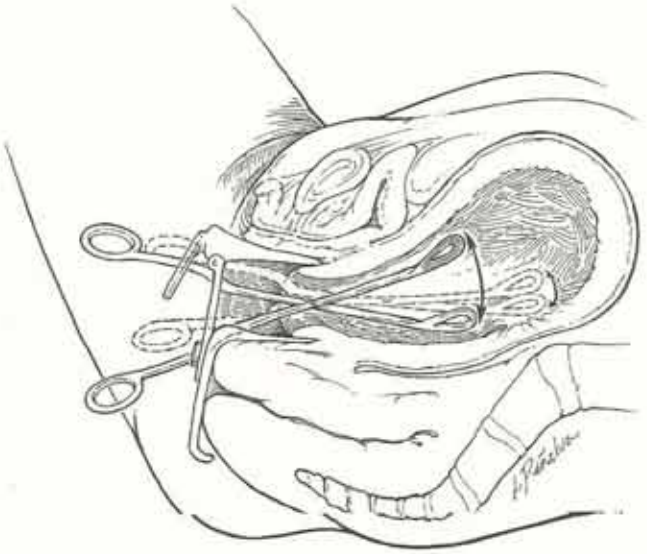

Figure 11.2 Placement of forceps in the lower uterine segment. Hinge remains at the level of the cervix, allowing maximum range of motion of the jaws to extract pregnancy elements from the lower uterine segment. When deeper insertion of the forceps is necessary to explore the fundus and cornua, care must be taken to apply cervical traction and follow the axis of the uterus to minimize the risk of trauma to the uterine wall.

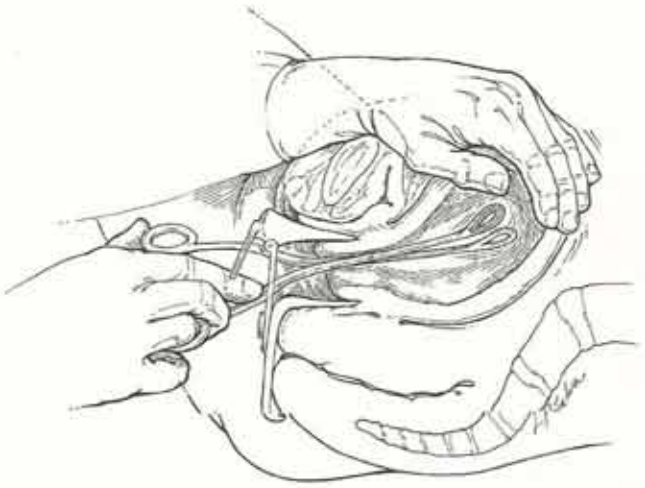

Figure 11.3 Hanson maneuver. By palpating the uterus with the nonoperating hand, the provider may be able to decipher the location of fetal parts relative to the jaws of the forceps. Also shown is a proper method for holding the extraction forceps. Placing the thumb outside the ring on the handle allows the jaws to open wider.

This inventory also will prevent patient injury resulting from fruitless attempts to remove fetal parts that have already been evacuated.

The timing of placental delivery depends on placental position and ease of fetal extraction. The placenta typically feels softer and bulkier than fetal tissue when grasped with forceps. After the placenta is grasped, light traction with the forceps accompanied by vigorous fundal massage will help the placenta detach from the myometrium. Once placental tissue is brought through the cervix, the surgeon can regrasp it until it delivers completely. Intact delivery of the placenta is preferable, as it obviates the need for repeated instrument passes and vigorous curettage. No evidence supports the contention that selective removal of the placenta at the outset of a D&E prevents amniotic fluid embolism or disseminated intravascular coagulopathy, and this strategy is often impossible to execute.

After extracting the fetus and placenta, some surgeons routinely explore the uterine cavity with a blunt-edged rake or large curette to remove any residual placental tissue and confirm complete evacuation. This gentle exploration ("check" curettage) also can confirm the integrity of the myometrium and help rule out an unrecognized perforation. Most providers perform suction curettage as a last evacuating step to remove blood clots and any residual tissue. Although the endocervical canal may accommodate a cannula greater than 12 mm in diameter, a smaller device (8–12 mm) may improve the surgeon's ability to explore the entire uterine cavity, particularly when the uterus is well contracted. After removal of the tenaculum and speculum, digital examination of the uterine cavity, with particular attention to the integrity of the entire length of the endocervical canal just beyond the internal cervical os, can confirm absence of injury.

Tissue examination

Even when the surgeon inventories fetal parts during their removal, tissue examination at the end of the procedure helps to verify complete evacuation. Identify major fetal parts, including the calvarium, pelvis, spine, and extremities, and confirm that the volume of placental tissue is adequate for gestational age. If not all major fetal parts are present, examine surgical drapes and sponges thoroughly before considering reexploration of the uterine cavity. Ultrasound examination of the uterine cavity can identify fetal tissue, although blood clots may on occasion obscure nonbony fetal tissue or decidua.

Measurement of fetal foot length has been used to estimate gestational age after abortion, and refined formulae provide greater accuracy [83,84]. Routine postoperative measurement of foot length is not necessary in most settings, but it may be useful when the surgeon perceives a size-dates discrepancy or elects documentation for medicolegal purposes.

Operative technique: Intact D&E

The challenge of removing a large volume of tissue through a small opening is not unique to abortion after the first trimester. Obstetrician-gynecologists, for example, may encounter similar challenges during vaginal birth and vaginal hysterectomy. In both instances, the risk of injury increases with the extensive use of instruments. In obstetrics, use of operative forceps is associated with higher rates of vaginal and perineal injury, making unassisted or manual delivery preferable. Similarly in vaginal hysterectomy, morcellation of tissue can cause bladder, bowel, or vascular injury, and intact removal of the uterus is preferred.

Similar principles apply to D&E. As a general rule, when cervical dilation is sufficient, fewer instrument passes are needed to remove the fetus. In some cases, intact delivery is feasible. Because the cranium represents the largest and least compressible structure, it often requires decompression. This situation has precedent in obstetrics, as cranial decompression has long been used to facilitate delivery in the presence of obstructed labor with fetal death or severe fetal brain anomalies associated with hydrocephalus and hydranencephaly [85].

In addition to a potentially safer fetal extraction, intact extraction may have other advantages. Removal of an intact or near-intact fetus minimizes the risk of retained tissue. When abortion is performed for fetal anomalies, an intact fetal specimen can improve the quality of autopsy. The opportunity to view or hold an intact fetus may facilitate the grieving process for some patients and their partners.

Intact D&E is generally accomplished with serial laminaria insertion over 2 or more days, with the goal of achieving adequate cervical dilation. Although some clinicians use this variant only when the fetus presents as a breech, others perform manual or instrumental conversion of the fetus to a breech presentation if necessary, followed by breech extraction. Decompression of the calvarium is necessary if it becomes lodged in the cervix. Decompression can be accomplished with forceps or by making an incision at the base of the skull through which the intracranial contents are suctioned. If the fetus is in cephalic presentation with the calvarium well-applied to the cervix, the surgeon can pierce the calvarium with a sharp instrument and collapse it externally with forceps or internally with suction. Provided cervical dilation is sufficient, the physician can then extract the fetus otherwise intact.

In 1995, McMahon presented a personal series of 1,362 intact D&E procedures, with only four major complications (McMahon J, 1995, personal communication). This low rate (2.94 per 1,000 cases) of complications was comparable to that reported in a large series of D&Es performed at earlier gestational ages [14]. In addition, Haskell described his experience of more than 1,500 consecutive intact D&E procedures at 20 to 26 weeks' gestation without any serious complications (Haskell M, 1992, personal communication).

One study retrospectively compared outcomes in 383 women undergoing surgical abortion at or after 20 weeks' gestation; in this study, the surgeon intended to perform intact D&E when technically feasible. A total of 263 women underwent standard D&E[1] and 120 women had intact D&E procedures. Compared to standard D&E[1] intact D&E was associated with higher parity, later gestational age (median 23 weeks vs. 21 weeks), and more preoperative cervical dilation (median 5 cm vs. 3 cm). No differences were found in estimated blood loss or operative time between the two groups. The overall rate of minor and major complications was 5% in both groups. Four major complications (i.e., complications requiring blood transfusion, laparotomy, or hospitalization) occurred in the patients who had standard D&E[1] versus none in those who underwent intact D&E [86].

Based on available data, intact D&E is a safe procedure associated with a low rate of complications. In the second trimester, intact extraction minimizes or eliminates the need for forceps and is a reasonable consideration when sufficient cervical dilation can be achieved.

Postoperative care

In women undergoing surgical abortion after the first trimester, not all complications occur or are apparent during the procedure. In the immediate postoperative period, staff must observe patients for bleeding or pain that may signal uterine atony, retained tissue, disseminated intravascular coagulopathy, or uterine perforation. For patients who have abortions early in the second trimester using cervical anesthesia, an observation period of 45 minutes to 1 hour usually suffices. Women having abortions at later gestational ages or those requiring sedation during the procedure may need a longer period of observation. Patients often require analgesia for cramps, and they generally respond well to low doses of narcotics or nonsteroidal antiinflammatory agents. Serial temperature and red cell determinations, abdominal palpation to elicit rebound tenderness, orthostatic vital signs, and crude bleeding times are useful adjuncts to clinical diagnosis of potential complications in patients whose full recovery is prolonged. They can be performed swiftly and accurately within the recovery area of facilities with a minimally equipped laboratory.

Conclusion

D&E is a safe and effective method of second-trimester abortion, and it may be preferable to labor induction for some patients. Adequate cervical dilation achieved with osmotic dilators clearly decreases the risks of complications. Although the efficacy of misoprostol for first-trimester cervical preparation is well documented, further study is necessary to evaluate its role in cervical ripening before second-trimester D&E abortion. Data regarding the benefits and risks of injection to cause preoperative fetal demise are limited. Some surgeons feel that fetal demise facilitates operative evacuation by softening fetal cortical bone, and providers in the USA may use these injections to ensure compliance with various laws. Although variations in operator techniques are numerous, these aspects are less important than intraoperative judgment and operator experience in assuring the safety of D&E abortion.

References

1 Gamble S, Strauss L, Parker W, Cook D, Zane SB, Hamdan S; Centers for Disease Control and Prevention (CDC). Abortion Surveillance-United States, 2005. *MMWR Surveill Summ* 2008; **57**: SS–13.

2 Jones RK, Zolna MRS, Henshaw SK, Finer LB. Abortion in the United States: Incidence and access to services, 2005. *Perspect Sex Reprod Health* 2008; **40**: 6–16.

3 Grimes DA, Smith MS, Witham AD. Mifepristone and misoprostol versus dilation and evacuation for midtrimester abortion: a pilot randomized controlled trial. *BJOG* 2004; **111**: 148–153.

4 Stubblefield PG, Carr-Ellis S, Borgatta L. Methods for induced abortion. *Obstet Gynecol* 2004; **104**: 174–185.

5 Partial-Birth Abortion Ban Act of 2003. 18 U.S.C. §1531. (2003).

6 Stubblefield PG. Surgical techniques of uterine evacuation in first- and second-trimester abortion. *Clin Obstet Gynaecol* 1986; **13**: 53–70.

7 Grimes DA, Schulz KF, Cates W Jr, Tyler CW Jr. Mid-trimester abortion by dilatation and evacuation: a safe and practical alternative. *N Engl J Med* 1977; **296**: 1141–1145.

8 Finks AA. Mid-trimester abortion. *Lancet* 1973; **1**: 263–264.

9 Manabe Y. Laminaria tent for gradual and safe cervical dilatation. *Am J Obstet Gynecol* 1971; **110**: 743–745.

10 Van Lith DAF, Beekhuizen W, van Schie KJ. Complications of aspirotomy (AT): a modified dilatation and curettage procedure for termination of early second-trimester pregnancies. In: Zatuchni GI, Sciarra JJ, Speidel JJ, eds. *Pregnancy Termination: Procedures, Safety, and New Developments*. Harper and Row, Hagerstown, 1979.

11 Bierer I, Steiner V. Termination of pregnancy in the second trimester with the aid of laminaria tents. *Med Gynaecol Sociol* 1972; **6**: 9–10.

12 Hale RW, Pion RJ. Laminaria: an underutilized clinical adjunct. *Clin Obstet Gynecol* 1972; **15**: 829–850.

13 Hern WM, Oakes A. Multiple laminaria treatment in early midtrimester outpatient suction abortion. *Adv Plann Parent* 1977; **12**: 93–97.

14 Hern WM Serial multiple laminaria and adjunctive urea in late outpatient dilatation and evacuation abortion. *Obstet Gynecol* 1984; **63**: 543–549.

15 Peterson WF, Berry N, Grace MR, Gulbranson CL. Second-trimester abortion by dilatation and evacuation: an analysis of 11,747 cases. *Obstet Gynecol* 1983; **62**: 185–190.

16 Autry AM, Hayes EC, Jacobson GF, Kirby RS. A comparison of medical induction and dilation and evacuation for second-trimester abortion. *Am J Obstet Gynecol* 2002; **187**: 393–397.

17 Kapp N, Borgatta L, Stubblefield P, Vragovic O, Moreno N. Mifepristone in second trimester medical abortion: a randomized controlled trial. *Obstet Gynecol* 2007; **110**: 1304–1310.

18 Green J, Borgatta L, Sia M et al. Intervention rates for placental removal following induction abortion with misoprostol. *Contraception* 2007; **76**: 310–313.

19 Jacot FR, Poulin C, Bilodeau AP et al. A five-year experience with second-trimester induced pregnancy terminations: no increase in complication rate as compared to the first trimester. *Am J Obstet Gynecol* 1993; **168**: 633–637.

20 Goldberg AB, Greenberg MB, Darney PD. Misoprostol and pregnancy. *N Engl J Med* 2001; **344**: 38–47.

21 Lawson HW, Frye A, Atrash HK, Smith JC, Shulman HB, Ramick M. Abortion mortality, United States, 1972–1987. *Am J Obstet Gynecol* 1994; **171**: 1365–1372.

22 Royal College of Obstetricians and Gynaecologists. The care of women requesting abortion. *National Evidence-based Clinical Guideline No. 7* [Online]. London: Royal College of Obstetricians and Gynaecologists Press; 2004 [cited 2008 Aug 11]. Available from: URL:http://www.rcog.org.uk/resources/Public/pdf/abortion_summary.pdf

23 Freeman EW. Abortion: subjective attitudes and feelings. *Fam Plann Perspect* 1978; **10**: 150–155.

24 Rooks JB, Cates W Jr. Abortion methods: morbidity, costs, and emotional impact. 3. Emotional impact of D&E vs. instillation. *Fam Plann Perspect* 1977; **9**: 276–277.

25 Kaltreider NB, Goldsmith S, Margolis AJ. The impact of midtrimester abortion techniques on patients and staff. *Am J Obstet Gynecol* 1979; **135**: 235–238.

26 Cowett AA, Golub RM, Grobman WA. Cost-effectiveness of dilation and evacuation versus the induction of labor for second-trimester pregnancy termination. *Am J Obstet Gynecol* 2006; **194**: 768–773.

27 Shulman LP, Ling FW, Meyers CM, Shanklin DR, Simpson JL, Elias S. Dilation and evacuation for second-trimester genetic pregnancy termination. *Obstet Gynecol* 1990; **75**: 1037–1040.

28 O'Connell K, Jones HE, Lichtenberg ES, Paul M. Second-trimester surgical abortion practices: a survey of National Abortion Federation Members. *Contraception* 2008; **78**: 492–499.

29 Eastwood KL, Kacmar JE, Steinauer J, Weitzen S, Boardman LA. Abortion training in United States obstetrics and gynecology residency programs. *Obstet Gynecol* 2006; :**108**: 303–308.

30 Landy U. Is family planning a subspecialty of obstetrics and gynecology? *Contraception* 2005; **72**: 399–401.

31 Drey EA, Foster DG, Jackson RA, Lee SJ, Cardenas LH, Darney PD. Risk factors associated with presenting for abortion in the second trimester. *Obstet Gynecol* 2006; **107**: 128–135.

32 Finer LB, Frohwirth LF, Dauphinee LA, Singh S, Moore AM. Timing of steps and reasons for delay in obtaining abortions in the United States. *Contraception* 2006; **74**: 334–344.

33 Bracken MB, Swigar ME. Factors associated with delay in seeking induced abortions. *Am J Obstet Gynecol* 1972; **113**: 301–309.

34 Fielding WL, Sachtleben MR, Friedman LM, Friedman EA. Comparison of women seeking early and late abortion. *Am J Obstet Gynecol* 1978; **131**: 304–310.

35 Schneider D, Golan A, Langer R, Caspi E, Bukovsky I. Outcome of continued pregnancy after first- and second-trimester cervical dilatation by laminaria tents. *Obstet Gynecol* 1991; **78**: 1121–1123.

36 Pastuszak AL, Schuler L, Speck-Martins CE et al. Use of misoprostol during pregnancy and Möbius syndrome in infants. *N Engl J Med* 1998; **338**: 1881–1885.

37 Fox MC, Hayes JL; Society of Family Planning. Cervical preparation for second-trimester surgical abortion prior to 20 weeks of gestation. *Contraception* 2007; **76**: 486–495.

38 Royal College of Obstetricians and Gynaecologists. *Fetal Awareness. Report of a Working Party*. Royal College of Obstetricians and Gynaecologists Press, London, 1997.

39 Lee SJ, Ralston HJ, Drey EA, Partridge JC, Rosen MA. Fetal pain: a systematic multidisciplinary review of the evidence. *JAMA* 2005; **294**: 947–954.

40 Grimes DA, Schulz KF, Cates WJ Jr. Prevention of uterine perforation during curettage abortion. *JAMA* 1984; **251**: 2108–2111.

41 Schultz KF, Grimes DA, Cates WJ Jr. Measures to prevent cervical injury during suction curettage abortion. *Lancet* 1983; **1**: 1182–1185.

42 Eaton CJ, Cohn F, Bollinger CC. Laminaria tent as a cervical dilator prior to aspiration-type therapeutic abortion. *Obstet Gynecol* 1972; **39**: 535–537.

43 Krammer J, O'Brien WF. Mechanical methods of cervical ripening. *Clin Obstet Gynecol* 1995; **38**: 280–286.

44 Norstrom A, Bryman I, Hansson HA. Cervical dilatation by Lamicel before first trimester abortion: a clinical experimental study. *Br J Obstet Gynaecol* 1988; **95**: 372–376.

45 Tan SL, Cheng H, Ho KK, Mitra R, Hii J, Yeo KC. Lamicel is more effective in preparing the cervix for midtrimester termination of pregnancy than *Laminaria japonicum*. *Aust N Z J Obstet Gynaecol* 1988; **28**: 49–52.

46 Lichtenberg ES. Complications of osmotic dilators. *Obstet Gynecol Surv* 2004; **59**: 528–536.

47 Borgatta L, Barad D. Prolonged retention of laminaria fragments: an unusual complication of laminaria usage. *Obstet Gynecol* 1991; **78**: 988–990.

48 Stubblefield PG, Altman AM, Goldstein SP. Randomized trial of one versus two days of laminaria treatment prior to late midtrimester abortion by uterine evacuation: a pilot study. *Am J Obstet Gynecol* 1982; **143**: 481–482.

49 Newmann S, Dalve-Endres A, Drey EA; Society of Family Planning. Clinical Guidelines. Cervical preparation for surgical abortion from 20 to 24 weeks' gestation. *Contraception* 2008; **77**: 308–314.

50 Evaldson GR, Fianu S, Jonasson A, Larsson B, Nord CE, Olund AR. Does the hydroscopic property of the laminaria tent imply a risk for ascending infection in legal abortion? A microbiological study. *Acta Obstet Gynecol Scand* 1986; **65**: 257–261.

51 Jonasson A. Contractile activity in the human uterine cervix and corpus during cervical dilatation by laminaria tent in first trimester legal abortions. *Acta Obstet Gynecol Scand* 1989; **68**: 401–404.

52 Gusdon JP Jr, May WJ. Complications caused by difficult removal of laminaria tents. *Am J Obstet Gynecol* 1975; **121**: 286–287.

53 Hirsh MP, Levy HM. The varied ultrasonographic appearance of laminaria. *J Ultrasound Med* 1988; **7**: 45–47.

54 Nguyen MT, Hoffman DR. Anaphylaxis to Laminaria. *J Allergy Clin Immunol* 1995; **95**: 138–139.

55 Cole DS, Bruck LR. Anaphylaxis after laminaria insertion. *Obstet Gynecol* 2000; **95**: 1025.

56 Kalish RB, Chasen ST, Rosenzweig LB, Rashbaum WK, Chervenak FA. Impact of midtrimester dilation and evacuation on subsequent pregnancy outcome. *Am J Obstet Gynecol* 2002; **187**: 882–885.

57 Jackson JE, Grobman WA, Haney E, Casele H. Mid-trimester dilation and evacuation with laminaria does not increase the risk for severe subsequent pregnancy complications. *Int J Gynaecol Obstet* 2007; **96**: 12–15.

58 Goldberg AB, Drey EA, Whitaker AK, Kang MS, Meckstroth KR, Darney PD. Misoprostol compared with laminaria before early second-trimester surgical abortion: a randomized trial. *Obstet Gynecol* 2005; **106**: 234–241.

59 Patel A, Talmont E, Morfesis J et al. Planned Parenthood Federation of America Buccal Misoprostol Waiver Group. Adequacy and safety of buccal misoprostol for cervical preparation prior to termination of second-trimester pregnancy. *Contraception* 2006; **73**: 420–430.

60 Edelman AB, Buckmaster J, Goetsch MF, Nichols MD, Jensen JT. Cervical preparation using laminaria with adjunctive buccal misoprostol before second-trimester dilation and evacuation procedures: a randomized clinical trial. *Am J Obstet Gynecol* 2006; **194**: 425–430.

61 Carbonell JL, Gallego FG, Llorente MP et al. Vaginal vs. sublingual misoprostol with mifepristone for cervical priming in second-trimester abortion by dilation and evacuation: a randomized clinical trial. *Contraception* 2007; **75**: 230–237.

62 Fletcher JC, Isada NB, Pryde PG, Johnson MP, Evans MI. Fetal intracardiac potassium chloride injection to avoid the hopeless resuscitation of an abnormal abortus: II. Ethical issues. *Obstet Gynecol* 1992; **80**: 310–313.

63 *Gonzales v. Carhart*, 127 S. Ct. 1610, 1629 (2007).

64 Jackson RA, Teplin VL, Drey EA, Thomas LJ, Darney PD. Digoxin to facilitate late second-trimester abortion: a randomized, masked, placebo-controlled trial. *Obstet Gynecol* 2001; **97**: 471–476.

65 Hern WM, Zen C, Ferguson KA, Hart V, Haseman MV. Outpatient abortion for fetal anomaly and fetal death from 15–34 menstrual weeks' gestation: techniques and clinical management. *Obstet Gynecol* 1993; **81**: 301–306.

66 Molaei M, Jones HE, Weiselberg T, McManama M, Bassell J, Westhoff CL. Effectiveness and safety of digoxin to induce fetal demise prior to second-trimester abortion. *Contraception* 2008; **77**: 223–225.

67 Drey EA, Thomas LJ, Benowitz NL, Goldschlager N, Darney PD. Safety of intra-amniotic digoxin administration before late second-trimester abortion by dilation and evacuation. *Am J Obstet Gynecol* 2000; **182**: 1063–1066.

68 Barclay M, Begg E. The practice of digoxin therapeutic drug monitoring. *N Z Med J* 2003; **116**: U704.

69 Elimian A, Verma U, Tejani N. Effect of causing fetal cardiac asystole on second-trimester abortion. *Obstet Gynecol* 1999; **94**: 139–141.

70 Coke GA, Baschat AA, Mighty HE, Malinow AM. Maternal cardiac arrest associated with attempted fetal injection of potassium chloride. *Int J Obstet Anesth* 2004; **13**: 287–290.

71 Erez Y, Ben-Shushan A, Elchalal U, Ben-Meir A, Rojansky N. Maternal morbidity following routine second trimester genetic amniocentesis. *Fetal Diagn Ther* 2007; **22**: 226–228.

72 Elchalal U, Shachar IB, Peleg D, Schenker JG. Maternal mortality following diagnostic 2nd-trimester amniocentesis. *Fetal Diagn Ther* 2004; **19**: 195–198.

73 Li Kim Mui SV, Chitrit Y, Boulanger MC, Maisonneuve L, Choudat L, de Bièvre P. Sepsis due to *Clostridium perfringens* after pregnancy termination with feticide by cordocentesis: a case report. *Fetal Diagn Ther* 2002; **17**: 124–126.

74 Pasquini L, Pontello V, Kumar S. Intracardiac injection of potassium chloride as method for feticide: experience from a single UK tertiary centre. *BJOG* 2008; **115**: 528–531.

75 Bhide A, Sairam S, Hollis B, Thilaganathan B. Comparison of feticide carried out by cordocentesis versus cardiac puncture. *Ultrasound Obstet Gynecol* 2002; **20**: 230–232.

76 Gill P, Cyr D, Afrakhtah M, Mack L, Easterling T. Induction of fetal demise in advanced pregnancy terminations: report on a funic potassium chloride protocol. *Fetal Diagn Ther* 1994; **9**: 278–282.

77 Schulz KF, Grimes DA, Christensen DD. Vasopressin reduces blood loss from second-trimester dilatation and evacuation abortion. *Lancet* 1985; **2**: 353–356.

78 Crawford JT, Edelman AB, Pereira L, Bednarek P, Buckmaster J. The effects of vasopressin injection on uterine artery blood flow during dilation and evacuation. *Am J Obstet Gynecol* 2007; **196**: e38–e39.

79 American College of Obstetricians and Gynecologists, Committee on Practice Bulletins – Obstetrics. *ACOG Practice Bulletin 76: Postpartum Hemorrhage*. The American College of Obstetricians and Gynecologists, Washington (DC), 2006.

80 Darney PD, Sweet RL. Routine intraoperative ultrasonography for second trimester abortion reduces incidence of uterine perforation. *J Ultrasound Med* 1989; **8**: 71–75.

81 Stubblefield PG, Albrecht BH, Koos B, Frederiksen MC, Williford JF, Kayman DJ. A randomized study of 12-mm and 15.9 mm cannulas in midtrimester abortion by laminaria and vacuum curettage. *Fertil Steril* 1978; **29**: 512–517.

82 Hanson MS. Discussion: medical aspects of abortion. In: Hern WM, Andrikopoulos B, eds. *Abortion in the Seventies*. National Abortion Federation, New York, 1977, p.52.

83 Mercer BM, Sklar S, Shariatmadar A, Gillieson MS, D'Alton ME. Fetal foot length as a predictor of gestational age. *Am J Obstet Gynecol* 1987; **156**: 350–355.

84 Drey EA, Kang MS, McFarland W, Darney PD. Improving the accuracy of fetal foot length to confirm gestational duration. *Obstet Gynecol* 2005; **105**: 773–778.

85 World Health Organization. (2008) Craniotomy and craniocentesis. In: *Managing Complications in Pregnancy and Childbirth: A Guide for Midwives and Doctors* [Online]. Geneva: World Health Organization; 2003 [cited 2008 12 Aug]. Available from: URL: http://www.who.int/reproductive-health/impac/index.html

86 Chasen ST, Kalish RB, Gupta M, Kaufman JE, Rashbaum WK, Chervenak FA. Dilation and evacuation at > or = 20 weeks: comparison of operative techniques. *Am J Obstet Gynecol* 2004; **190**: 1180–1183.