INTRODUCTION — Vasectomy is the most effective mode of male contraception, and the only method that is widely available. The techniques used for interruption or occlusion of the vas deferens are discussed here. An overview of vasectomy including patient counseling is discussed elsewhere. (See "Overview of vasectomy").

METHODS — The only effective method available for male contraception is vasectomy, which divides the vas deferens in a minor surgical procedure [1]. The procedure takes about 15 minutes and can be performed in an appropriately equipped office or ambulatory surgery center [2]. No-scalpel vasectomy is the preferred vasectomy technique in the United States (US) because of its lower complication rates, but it has yet to be adopted world-wide. Because reversal of vasectomy cannot be guaranteed, other methods of vasal occlusion are being investigated.

Three techniques are used for interruption or occlusion of the vas deferens. This topic will focus primarily on vasectomy; vasal occlusion and vasal injection techniques have been described but are not in general use.

Vasal transection — Vasectomy involves transection of the vas deferens, and is typically performed in an outpatient setting with local anesthesia.

Conventional vasectomy — The traditional vasectomy approach involves bilateral scrotal incisions through which the vas deferens is mobilized and transected. This technique accounts for a small proportion of vasectomies performed in the US, but remains the most common technique in many other areas of the world [3]. (See 'Vasectomy procedure' below.)

No-scalpel vasectomy — The no-scalpel vasectomy technique was developed in China [4]. Instead of incisions, a puncture is made through the scrotal skin overlying the vas deferens and widened only enough to externalize the vas deferens for transection [5]. The remainder of the procedure is performed in a similar fashion to the open incision method. (See 'Vasectomy procedure' below.)

Vasal occlusion — Vasal occlusion with a plug (eg, 'Shug' or medical grade silicone rubber), requires microsurgery for implantation and later removal [1]. Either a conventional open or no-scalpel technique may be used to isolate the vas deferens for the implantation of these devices. Surgical vasal occlusion
procedures claim to produce reversible azoospermia without affecting spermatogenesis, but there are no human data on success rates.

Vasal injection — Percutaneous methods can be used for injecting chemicals directly into the vas deferens to effect temporary (polymer) or permanent (sclerosing agents) occlusion [1,6-8].

One technique intended for permanent sterilization involves first injecting two dyes into the vas, using a different color for the left and right vas. Then, a sclerosing agent is then injected into the vas lumen distal to the previously injected dye. Successful occlusion is determined by having the patient void to see which, if any, dye is excreted in the urine. The chemicals required for this procedure are not available for use in the US.

Another technique, reversible inhibition of sperm under guidance (RISUG) involves injection the non-sclerotic polymer, styrene maleic anhydride (SMA) [1,9]. It is claimed to offer long-term contraception without adverse side effects [1,7,8]. The purported advantages of this method are that it provides long term contraception without the side effects associated with male hormonal contraception, and in contrast to the other techniques listed above, is reversible without surgery. Clinical trials are ongoing.

SURGICAL ANATOMY — Knowledge of surgical anatomy is important to minimize complications (eg, hematoma) and perform the procedure in a timely fashion. Injury to the vessels of the spermatic cord can cause significant bleeding.

- Innervation - The anterior scrotal skin and spermatic cord are innervated by fibers from the ilioinguinal nerve and genital branches of the genitofemoral nerve (figure 1). Local blockade of these nerves provides adequate anesthesia for vasectomy.
- Layers of the scrotum - Just beneath the scrotal skin lie (from outermost to innermost) the dartos fascia and muscle, the external spermatic fascia, and the cremasteric fascia and muscle (figure 1). The internal spermatic fascia is deep to these structures and covers the spermatic cord, which contains the vas deferens and vessels and nerves.
- Blood vessels - The spermatic cord also contains the deferential artery to the vas deferens which anastomoses with the testicular artery and the veins (pampiniform plexus) (figure 1).

The pampiniform plexus consists of 8 or 10 veins that lie adjacent the vas deferens and ultimately drain into the testicular vein. These veins are easily injured. Dilatation of the pampiniform plexus (termed varicocele) is a common abnormality and usually occurs on the left. A varicocele can make isolation of the vas deferens more difficult.

PATIENT COUNSELING — Men who choose to undergo vasectomy should clearly understand that the goal of the procedure is permanent sterilization; they will no longer be able to father a child. Because many patients believe that vasectomy is routinely and easily reversed, it is important to emphasize that reversal is a much more complicated surgical procedure than vasectomy, may not be successful, is costly, and usually not covered by insurance [10]. (See "Overview of vasectomy", section on 'Patient counseling'.)

CONTRAINDICATIONS — Bleeding diathesis, or presence of a local anatomic abnormality (eg, varicocele, hydrocele, scrotal mass, cryptorchidism) are relative contraindications to vasectomy [1]. Contraindications to vasectomy include the presence of scrotal hematoma, genitourinary or groin infection, and sperm granuloma but the procedure can often be performed if these issues can be resolved.

PREOPERATIVE PREPARATION — Prior to proceeding with the procedure, the patient should have a complete urologic evaluation to confirm the presence of a single vas deferens and testicle on each side
and absence of anatomic abnormalities.

Routine preoperative laboratory tests, prophylactic antibiotics [11], and fasting are unnecessary. The patient should be instructed to have someone available to drive him home after the procedure.

Patients should avoid taking aspirin and non-steroidal anti-inflammatory medications for seven days prior to the procedure, as these may increase the risk of postoperative bleeding. (See "Perioperative medication management", section on 'Medications affecting hemostasis'.)

An anxiolytic (eg, diazepam 10 mg orally) can be given approximately one hour prior to the procedure to help the patient relax. This also helps surgical isolation of the vas deferens as it facilitates relaxation of the scrotal and cremasteric muscles.

Application of an anesthetic cream (eg, EMLA) reduces the pain of the anesthetic injection [12]. To be effective, EMLA should be applied by the patient to the anterior scrotum approximately one hour prior to the procedure. Wrapping the area (eg, plastic wrap) minimizes evaporation and facilitates absorption of the cream. Dosing is weight dependent and systemic toxicity (ie, methemoglobinemia) is unlikely if EMLA cream is applied correctly [12,13]. (See "Clinical features, diagnosis, and treatment of methemoglobinemia", section on 'Acquired methemoglobinemia'.)

VASECTOMY PROCEDURE — The patient is reexamined just prior to the procedure to confirm the absence of unusual anatomy or other contraindication to the procedure. (See 'Contraindications' above.)

Ideally, the procedure room should be warmed to 70 to 80 degrees Fahrenheit (20 to 25 degrees Celsius) which helps prevent contraction of the cremasteric and dartos muscles, facilitating isolation of the vas deferens.

Materials — Equipment needed to perform a vasectomy include:

- Povidone iodine or chlorhexidine
- Sterile drapes, sterile gloves, sterile gauze
- Electrocautery equipment or disposable thermal cautery
- Suture (4-0 absorbable [chromic or polyglactin 910] preferably on a non-cutting needle)
- 10 mL syringe with a 1.5 inch 25 or 27 gauge needle for administering local anesthetic
- 1 percent or 2 percent lidocaine without epinephrine (maximum dose 4.5 mg/kg [2 mg/pound])
- Surgical instruments: vas fixation clamp and sharp dissecting forceps, straight scissors, needle holder

Positioning — The patient is asked to lie supine on the procedure table. It is helpful to position and secure the penis onto the lower abdomen (eg, with surgical drape, adhesive tape, or umbilical tape). The scrotum is then prepared with an antiseptic solution. Sterile towels are used to drape the area surrounding the scrotum, and sterile technique is employed for the remainder of the procedure.

Anesthesia — The vas deferens is isolated and positioned to lie as superficially as possible beneath the median raphe of the scrotal skin anteriorly, midway between the top of the testes and the base of the penis. This is usually accomplished using the non-dominant hand and a "three finger technique" to manipulate the vas within the scrotum (picture 1).

Local anesthetic without epinephrine (0.5 to 1 mL) is injected into the skin to create a wheal over the vas. A large wheal is avoided because it will interfere with isolating the vas.

Next, a vasal nerve block to anesthetize the deeper tissues can be performed in the following manner [14]. With tension on the vas, the needle is advanced through the anesthetized scrotal skin approximately 2 to 3 cm along the sheath of the vas (but not into the vas) toward the inguinal ring, and 2 to 5 mL of anesthetic (depending on concentration) injected into the tissue surrounding the vas; there should not be
any resistance [14]. Some operators then anesthetize the contralateral vas to allow ample time for the anesthetic to take effect.

An alternate anesthetic method involves a no-needle jet injection technique that uses a high pressure spray to deliver local anesthetic through the scrotal skin and into the tissue surrounding the vas [15,16]. The major drawback seems to be the initial cost of the device.

Exposing the vas — The vas is positioned under the skin wheal as superficial to the skin as possible and a vas fixation clamp is used to gently entrap the vas and a minimal amount of overlying tightly stretched skin.

In the conventional technique, a small incision is made and carried through the skin and subcutaneous tissue to expose the vas (picture 2).

For the no-scalpel technique, a sharp mosquito hemostat is used to puncture through the scrotal skin with care not to go through the vas. An opening approximately twice the width of the vas is made by gently spreading with both tips of the hemostat.

If a vas fixing clamp is in place, it can be left alone or repositioned as needed. If the vas has not been fixed in a clamp, it should now be grasped. The vas is elevated through the incision or opening with an Allis clamp, towel clamp or dissecting forceps (picture 3). The perivasal tissue is incised an separated (picture 4); then, approximately two centimeters of the vas is brought up as a loop gently and grasped with a second vas fixating clamp, towel clip or ring forceps (picture 5).

The loop of vas is cleaned of residual tissue with care to avoid trauma to the associated blood vessels. The tip of a hemostat or tips of the dissecting forceps are inserted into the window of the vas deferens loop and gently spreading to completely isolate the vas.

Dividing the vas — The vas is divided. The minimum length, if any, of vas that should be removed to prevent recanalization is controversial [17,18]. Rates of recanalization more likely reflect the technique used to manage the vasal ends than the actual length of the segment removed. We favor excision of a segment 10 to 15 mm in length. (See 'Managing the vasal ends' below.)

If a segment is removed, it can be sent for pathologic confirmation. Although this practice has little clinical benefit, histologic documentation that full thickness vas was excised can be helpful in the event of vasectomy failure. (See 'Vasectomy failure' below.)

Irrigation of the prostatic end does not have any documented benefit. Three randomized trials failed to demonstrate any acceleration of sperm clearance by irrigation of the prostatic end during vasectomy [19-21].

Managing the vasal ends — The optimal method of managing the testicular vasal end is debatable [22-26]. Intraluminal fulguration of 1.5 cm of the prostatic end of the vas with fascial interposition between the prostatic and testicular vasal ends appears to be the most effective method for managing the vasal ends [3,22-24,27-29]. (See 'Vasectomy failure' below.)

Fulguration using a battery powered hand held cautery (red-hot wire) appears to scar and occlude the vas lumen more effectively than electrocautery (picture 6) [27]. Fascial interposition creates a tissue barrier between the vasal ends. Absorbable suture or a clip is used to tack a layer of the vas sheath between the two cut vasal ends (picture 6 and figure 2) [28,29].

The efficacy of the combined approach (fulguration and fascial interposition) was illustrated in a study of the outcome of 6248 vasectomies performed using fascial interposition in conjunction with thermal cautery of both ends (figure 3A-B) [30]. No failures (ie, pregnancies) occurred and there was a low rate of complications (congestive epididymitis in 4.8 percent, sperm granuloma in 1.4 percent). Of note, the
surgeons did not remove a vas segment or apply ligatures or clips to the open vasal ends.

The application of surgical clips to the vasal ends (cut and clip vasectomy) also has a low failure rate: 0 percent when two clips were applied to each end; higher failure rates have been reported with use of the application of single clips to each end [31,32]. Use of clips adds to the cost of the procedure (picture 7).

Ligation alone of the vasal ends should be avoided. A review of six studies that assessed this method (ie, "cut and tie vasectomy") reported failure rates of 1 to 6 percent [33]. Failure may have be due to ischemic sloughing of the vasal ends, which increases the potential for spontaneous recanalization.

Conventional wisdom suggests that both vasal ends should be occluded by fulguration, ligation, or clips; however, some advocate leaving the testicular end untreated (open-ended vasectomy) [32,34-36]. The rationale for leaving one end open is that sperm leakage from the testicular cut end prevents inspissation, increased epididymal pressure, and epididymal rupture and allows a small sperm granuloma to form [32].

The value of this approach is supported by a study of 4330 open-ended and 3867 standard vasectomies (segment excised, cautery of both cut surfaces, ligation of both ends, fascial interposition) that found lower rates of complications with the open ended approach: congestive epididymitis (1.2 versus 2.7 percent), painful sperm granuloma (1.5 versus 3.2 percent) [34]. There were no significant differences between techniques in the rates of spontaneous recanalization (0.02 versus 0.08 percent).

The open-ended technique can be offered to the patient. However, in our experience, most men choose to have both ends occluded. (See 'Sperm granuloma' below.)

Closure — The perivasal tissues are carefully inspected for bleeding and gently returned to the scrotum. If the incisional approach is used, one to two absorbable sutures are placed in the scrotal skin. In the no-scalpel technique, skin closure is not necessary. [5].

Once the procedure is completed, we dress the wound with antibiotic ointment and a bandage. A fluff dressing is placed and the patient assisted in putting on a scrotal support or alternately, tight-fitting underwear.

POSTOPERATIVE CARE — The dressing and scrotal support are maintained for at least 48 hours after surgery. An ice pack intermittently applied to the scrotum for 48 hours also helps decrease discomfort and swelling.

Significant post-procedure pain is common occurring in up to 30 percent of patients but is usually self limited. Acetaminophen or ibuprofen usually provides sufficient analgesia, although occasionally narcotic analgesics are necessary.

Postoperative instructions should be reviewed with the patient. Mild pain, swelling, and bruising are normal for the first two to three days and blood in the ejaculate is common and will typically clear after three to four days. The patient should call for increasing pain, bleeding from the incision site, fever, or significant scrotal swelling.

Bed rest or quiet activity is recommended for the first 24 hours following a vasectomy. The patient may return to light work in two to three days, but should refrain from heavy work, sports, or lifting for one week.

Sexual activity is avoided for one week. The patient and his partner should be reminded to use an alternate method of contraception until semen analysis has confirmed absence of sperm (azoospermia) in the ejaculate. Since sperm are stored along the entire vas deferens and in the seminal vesicle, interruption of the vas does not result in immediate sterility and several ejaculations are required to evacuate all of the sperm.
COMPICATIONS — Complications following vasectomy include hematoma, infection, sperm granuloma, and persistent post vasectomy pain. The most important determinant of postoperative complications is operator experience. In one study, surgeons performing more than 50 vasectomies during the year studied had one-third the complication rate of those performing fewer than 10 procedures [37].

Hematoma — Bleeding and/or hematoma formation is the most common complication associated with vasectomy. In rare cases, bleeding may be severe enough to require reoperation for scrotal exploration, hematoma evacuation, and control of bleeding. The most common site of bleeding is the pampiniform plexus of veins.

Hematoma rates are lower for no-scalpel procedures, where tissue dissection is minimized [28,38]. Hematoma formation occurs in 0.1 to 2.1 percent of men undergoing no-scalpel procedures compared with 0.3 to 10.7 percent for incisional technique [39].

Infection — Randomized trials comparing no-scalpel and conventional incisional techniques also demonstrate lower wound infection rates for no-scalpel procedures [28,38]. Infections rates reported for the no-scalpel and incisional techniques are 0.2 to 0.9 and 1.3 to 4 percent, respectively [39].

Sperm granuloma — Sperm are highly antigenic and stimulate a significant inflammatory reaction. A sperm granuloma may form when sperm leaks from the testicular side of an open-ended vas following vasectomy. Less commonly, they may form with extravasation from a cauterized or fulgurated vas.

These granulomas are rarely symptomatic and may be protective to the testis and epididymis. The granuloma is rich in epithelial-lined channels that may vent leaking sperm away from the epididymis and protect against increased intraepididymal pressure.

Most granulomas are asymptomatic and over time will ultimately resorb. Granulomas, however, have been implicated in increased rates of post-vasectomy pain and in vas recanalization related to the inflammatory response induced by the antigenic reaction to sperm [40].

Post-vasectomy pain syndrome — The post-vasectomy pain syndrome is distinct from post-procedure pain, however, there is some controversy regarding its definition, and therefore prevalence. Rates for the post-vasectomy pain syndrome have been reported as 0.1 to 0.25 percent [41,42]. However, surveys have found that "troublesome" post-vasectomy pain is reported by as many as 15 percent of men, with pain severe enough to impact quality of life in 2 percent; survey respondents, however, may not have been representative of all post-vasectomy men [43,44].

The cause of most post-vasectomy pain syndromes is a chronic congestive epididymitis [43]. Testicular fluid and sperm production remain constant following vasectomy. The majority of this fluid accumulates in the epididymis, which then swells. While asymptomatic in most men, some will develop a chronic dull ache in the testes, which is made worse by ejaculation. Other causes or contributors to pain syndromes include the formation of sperm granuloma, or nerve entrapment at the vasectomy site.

First-line therapy for postvasectomy pain is the administration of nonsteroidal antiinflammatory medications and warm baths. If unsuccessful, local nerve blocks or steroid injections may be performed by a pain specialist. If the post-vasectomy patient's discomfort is localized to a tender, palpable granuloma, this may be excised, followed by fulguration of the leaking end of the vas [45].

Refractory cases may require surgery, including either vasectomy reversal (vasovasostomy) or complete epididymectomy. Vasovasostomy successfully relieves pain in up to 70 percent of patients [46]. These patients, however, will almost always require the use of another form of contraception as a result. (See "Overview of vasectomy", section on 'Vasectomy reversal'.)

Complete epididymal resection is reserved for the most severe cases. Injury to the testicular blood
supply, a known complication of this procedure, causes testicular atrophy. Thirty to ninety percent of patients undergoing epididymectomy for post-vasectomy orchialgia will have residual scrotal pain [47].

Vasectomy failure — Vasectomy failure can be due to technical errors, recanalization, or unprotected intercourse before azoospermia is documented.

The varying techniques employed in vasectomy to fulgurate, ligate and manage the vasa ends are associated with different failure rates. (See 'Vasectomy procedure' above.) Representative failure rates are listed below [48]:

- Intraluminal needle cauter y (vas not transected, no segment removed): Less than 1 percent
- Cautery both ends and fascial interruption: 1.2 percent or less
- Cautery (prostatic end) only and fascial interruption (clip): 0.02 to 2.4 percent
- Cautery of both ends and excision of a segment: 4.8 percent or less
- Ligation and fascial interruption: 16.7 percent or less
- Ligation and excision of segment: 1.5 to 29 percent

Recanalization is rare, occurring in about 0.2 percent of patients [40]. It is defined as the presence of any spermatozoa after one or more previously azoospermic samples were properly collected and documented [49]. It can occur at any time following vasectomy.

FOLLOW UP TO CONFIRM STERILITY — A systematic review found that approximately 80 percent of patients are azoospermic after three months and 20 ejaculations and suggest that a single sample is sufficient to confirm sterility [50]. The time to achieve azoospermia declines with increasing number of ejaculations following vasectomy and increasing patient age.

We suggest obtaining a semen analysis three months postoperatively; the patient should have had at least 20 ejaculates since the time of vasectomy [51,52]. Azoospermia in a semen sample is definitive evidence of infertility [50]. The laboratory performing the analysis should examine a fresh specimen using direct microscopy; if sperm are not seen on the initial prepared slide, a centrifuged specimen should be evaluated. A systematic review including 56 studies reported the time to achieve azoospermia was variable, but more than 80 percent of men were azoospermic after three months and 20 ejaculations [50].

If there are motile sperm at the three month check-up, a follow-up test is performed one to two months later [53]. Vasectomy is considered a failure if motile sperm are confirmed on the follow up examination, there have been a sufficient number of ejaculations (>20) and >3 months have elapsed since the procedure. The patient should be advised to use alternative contraception and potentially undergo a second procedure. (See 'Vasectomy failure' above.)

Azoospermia is the ideal end point of vasectomy. A small proportion of patients, however, do not achieve azoospermia but consistently have nonmotile sperm. Nonmotility is a less definitive sign of infertility than azoospermia since it may reflect death of recently motile sperm due to a prolonged delay between ejaculation and laboratory analysis. The accuracy of determining whether sperm have normal motility is dependent on the timely examination of the semen specimen, ideally less than four hours from the time collected by the patient [51]. When rare, non-motile sperm are observed, a repeat test in another one to two months may show azoospermia or continued presence of rare, non-motile sperm.

The continued presence of rare, non-motile sperm is probably clinically insignificant, and these men can be given cautious assurance of success. Guidelines from the British Andrology Society recommend that patients be given "special clearance" to discontinue other contraception, following appropriate counseling, provided they have: a low sperm count (<10,000/mL), all sperm are immotile, seven months have elapsed from vasectomy and there have been a minimum of 24 ejaculations [51].

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, “The
Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on “patient info” and the keyword(s) of interest.)

- Basics topics (see "Patient information: Vasectomy (The Basics)"
- Beyond the Basics topics (see "Patient information: Vasectomy")

**SUMMARY AND RECOMMENDATIONS**

- Vasectomy, a safe and reliable outpatient procedure, is the most common method for permanent male contraception. Patients should be thoroughly counseled about the permanence of the procedure, potential risks and benefits, failure rates, and alternatives. (See 'Patient counseling' above.)
- Methods of vasal occlusion (microsurgical vasal plug, polymer injection) seek to provide a reversible mode of contraception for men. These methods are still largely investigational.
- Congenital or acquired anatomic abnormalities (eg, large varicocele, cryptorchidism), infection, and bleeding diathesis represent some contraindications to vasectomy. (See 'Contraindications' above.)
- To perform vasectomy, the vas is isolated and brought up through a scrotal skin incision (conventional) or puncture site (no-scalpel technique). The vas is transected, a segment removed, and the prostatic end fulgurated then clipped or tied. The testicular end is handled variably. A fascial interposition is created to isolate the vasal ends from each other. (See 'Vasectomy procedure' above.)
- We suggest a no-scalpel approach over conventional vasectomy because of lower bleeding and infection rates (Grade 2B). (See 'Vasectomy procedure' above.)
- We suggest fulguration and fascial interruption to manage the prostatic vasal end (Grade 2B). (See 'Vasectomy procedure' above.)
- Postoperative care includes scrotal support, intermittent ice application, and rest. Sexual activity should be avoided for at least one week and contraception advised until azoospermia confirmed. (See 'Postoperative care' above.)
- Hematoma is the most common complication of vasectomy. Patients are advised to be seen if they experience significant swelling, bleeding from the vasectomy site, or pain not responding to analgesics. (See 'Complications' above.)
- Semen analysis is performed three months after the procedure. Azoospermia is indicative of a successful procedure. (See 'Follow up to confirm sterility' above.)

Use of UpToDate is subject to the Subscription and License Agreement.

**REFERENCES**

Vasectomy and other vasal occlusion techniques for male contraception

http://46.4.230.144/web/UpToDate.v19.2/contents/f38/7/39155.htm?abs...