

# Male Reproduction

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## MALE ANATOMY

The reproductive tract of the male or tom cat consists of the penis, testes, scrotum, prostate and bulbourethral glands, and the ductus deferens (also called the vas deferens) (Figure 39-1). The fetal testes are inside the abdomen; they descend through the inguinal ring into the scrotum at birth or shortly afterward. By 6 to 8 weeks of age, testes should be palpable in the scrotum. The hair-covered scrotum is divided by a thin wall into two cavities; each cavity contains a testis, epididymis, and the end of the spermatic cord. The testes may not stay in the scrotum permanently until 4 to 6 months of age. The structure of the feline testis is similar to most domestic animals.<sup>9</sup> There are three major cell types in the testes:

1. Interstitial (Leydig) cells: secrete testosterone in response to luteinizing hormone (LH)
2. Sertoli cells: line the seminiferous tubules and secrete estrogen and inhibin to support the developing spermatozoa in response to follicle-stimulating hormone (FSH)
3. Germ cells: spermatozoa in various stages of development present within the seminiferous tubules

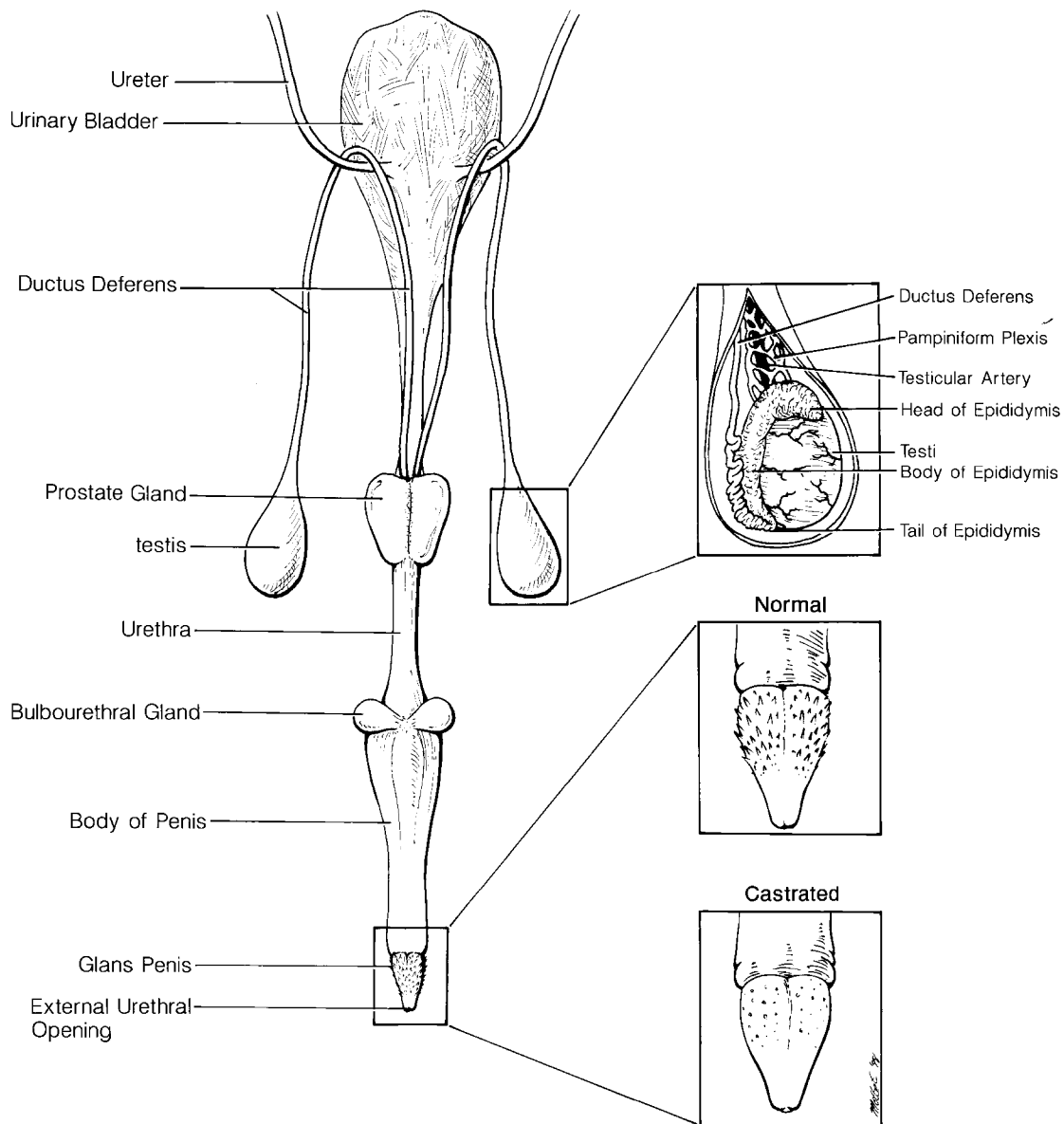
Production of spermatozoa occurs in seminiferous tubules; spermatozoa are then transported into the epididymis, where maturation and storage takes place. The seminiferous tubules are closely packed and convoluted and are surrounded by interstitial cells. The tail of the epididymis becomes the ductus deferens, which carries sperm to the penis after passing through the inguinal canal with the rest of the spermatic cord. The spermatic

cord consists of the ductus deferens, the testicular artery and vein, lymphatics, and nerve plexus.

The prostate of the cat is approximately 1 cm in length and covers the urethra near the neck of the urinary bladder. The prostate is androgen-dependent and atrophies after castration. Prostatic disease is very rare in the cat, with only a few cases reports of tumors published.<sup>38,39</sup> The bulbourethral glands are two small pea-shaped structures near the bulb of the penis. During ejaculation, spermatozoa from the epididymis are mixed with secretions from the prostate and bulbourethral glands. It is normal for a small proportion of spermatozoa to travel retrograde through the urethra into the bladder (Figure 39-2). The urethra in the male cat is very narrow and shorter than in the dog.

The penis of the cat contains a vestigial os penis (5 mm in length). When not erect, the penis is completely enclosed within the prepuce. The glans of the penis of a mature tom cat is covered with 120 to 150 penile spines that are directed caudally. The spines are testosterone-dependent and start to appear at about 12 weeks of age, are fully developed at puberty, and are absent in neutered males, disappearing by about 6 weeks after castration (Figure 39-3).

In addition to testosterone, important hormones in the male cat include LH and FSH, both produced in the anterior pituitary gland in response to gonadotropin-releasing hormone (GnRH), produced by the hypothalamus. Resting plasma testosterone levels vary widely, because secretion is episodic. Testosterone is not only essential for development of secondary sexual characteristics (e.g., heavy jowls, thick skin) and breeding behavior but also for production of spermatozoa.



**FIGURE 39-1** Anatomy of the reproductive tract of the male cat. (From Johnston S, Root Kustritz M, Olson P: *Sexual differentiation and normal anatomy of the tom cat*. In Johnston S, Root Kustritz M, Olson P, editors: *Canine and feline theriogenology*, Philadelphia, 2001, Saunders.)

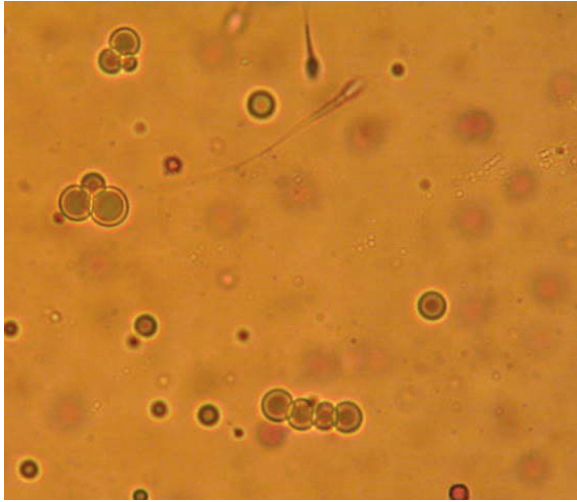
Castration causes an immediate drop in blood testosterone, but viable sperm may still be present for up to 7 weeks after surgery.

## MATING BEHAVIOR

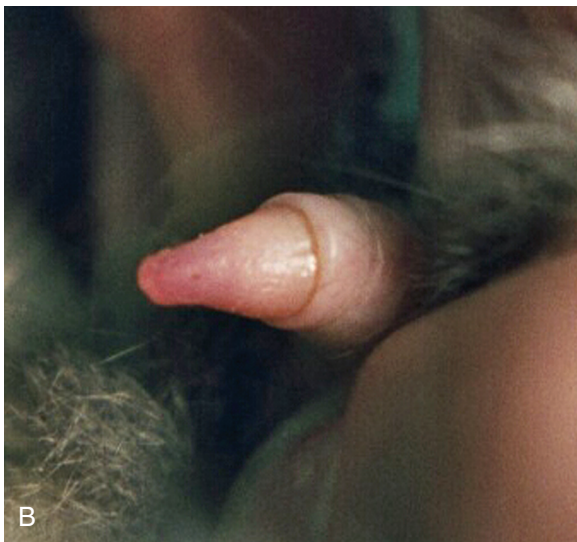
Spermatozoa are present in the testes by the age of 5 to 9 months, and full maturity of spermatogenesis occurs at 8 to 10 months of age.<sup>37</sup> However, the actual age at which mating begins varies with physical condition, body size, and season. The onset of puberty is typically at 8 to 10 months of age and at a body weight of 2.5 kg or more. However, significant variation among breeds is seen with longhair breeds, such as the Persian, maturing

more slowly than shorthair breeds, such as the Siamese. Tom cats probably have a normal breeding lifespan of 10 years or more.

Tom cats are attracted to estrous queens by vocalizing, odors, and behavior. A tom cat will approach a queen in estrus, touch noses, and then investigate her perineum. A flehmen reaction may be exhibited, that is, sampling of the queen's pheromones by the vomeronasal organ. The tom cat grasps the skin on the back of the queen's neck and attempts to mount her. The tom cat then treads on his back feet and slides down over the back of the queen, attempting to position for intromission. The tom cat starts a series of pelvic thrusts, and ejaculation follows within 20 to 30 seconds. Semen is deposited in the posterior vagina. The tom cat then



**FIGURE 39-2** Because a degree of retrograde ejaculation is normal in the tom cat, collection of a urine sample after ejaculation allows for detection of sperm.



**FIGURE 39-3** A, Glans of the penis of an intact tom cat with penile spines. B, Glans of the penis of a castrated cat without penile spines.

quickly jumps away to avoid being swatted by the queen. Once the queen's postcoital behavior settles down (typically in 10 to 60 minutes), the tom cat will often try to grasp and mount again. A pair may breed several times until the tom cat is exhausted. Breeding usually occurs at night under natural circumstances.

After castration, mating behavior typically ceases, but may persist for years in some mature and experienced tom cats. The behavior may include mounting of other cats or kittens, the owner's legs, or soft inanimate objects. It is important to ensure the cat is not cryptorchid (see below). A rare cause of breeding behaviors in castrated male cats is a testosterone-secreting adrenal tumor.<sup>25</sup> The behavior may be attention seeking or because of a stimulus-poor environment. Ensuring adequate environmental enrichment and interactive time with the owner is often helpful. The behavior should not be rewarded, even inadvertently, by attempts at punishment. Interruption and distraction with another activity is likely to be more effective. Urine spraying may also persist after castration, although typically it resolves in 80% or more of cats. There is one report in the literature on the use of cyproheptadine (2 mg/cat, PO, every 12 hours) for the successful treatment of masturbation and urine spraying in a cryptorchid cat.<sup>32</sup> For more on urine spraying, see Chapter 13.

## CONTROL OF REPRODUCTION

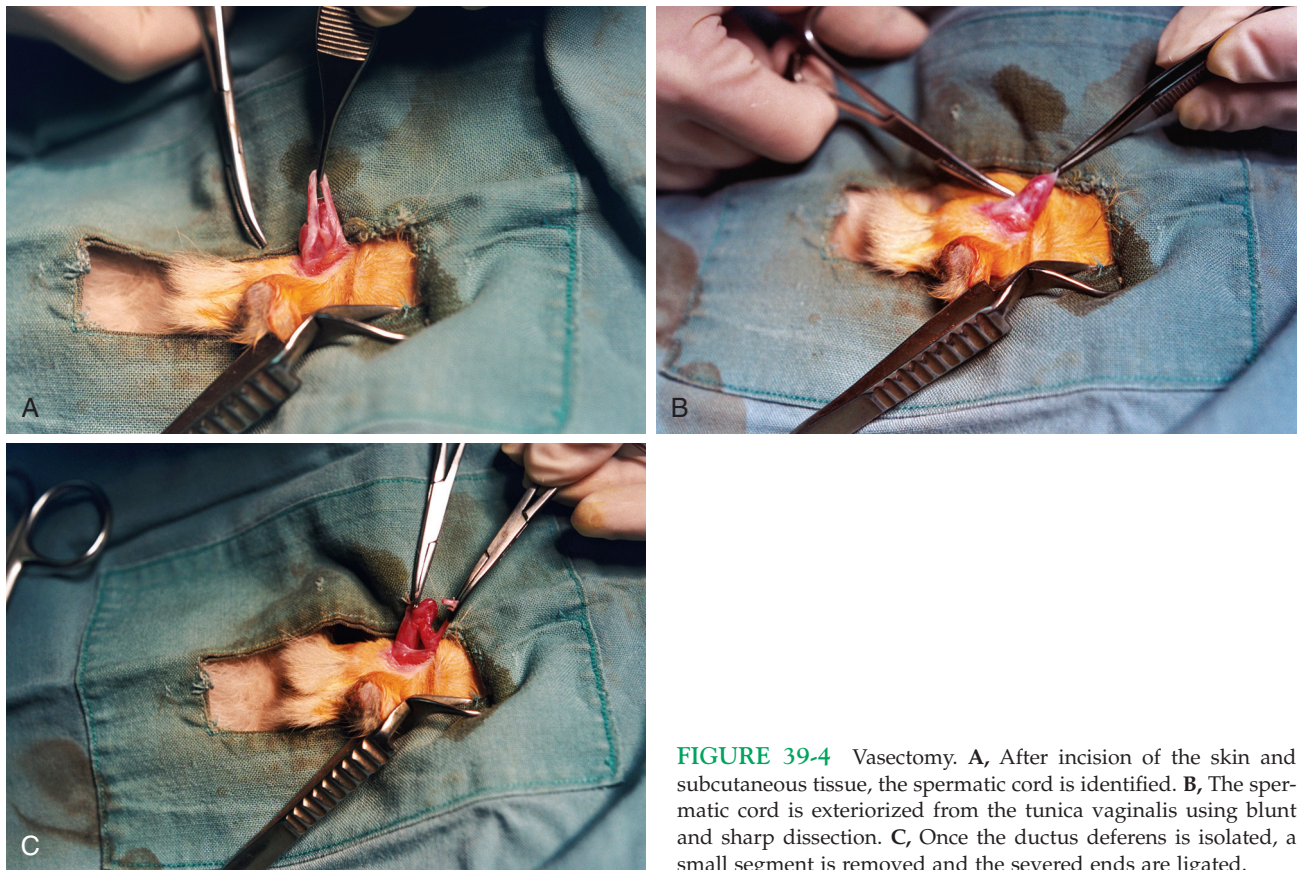
### Surgical Castration

Castration is the most common procedure used to control fertility in male cats. The surgery is easy to perform, requires simple equipment, is effective and irreversible, and eliminates most of the undesirable traits of an intact male (e.g., aggression, roaming, urine marking).<sup>12</sup> Cats may be castrated using either an open or closed approach. The spermatic cord may be ligated with suture material or the cord may be knotted on itself. Castration may be performed as early as 6 weeks of age (see Chapter 41). Prepubertal castration is more effective at preventing unwanted sexual behaviors than castration after sexual maturity.<sup>13</sup> Complications associated with castration in the tom cat are few but include scrotal swelling, hemorrhage, bruising, and infection.

### Vasectomy

Vasectomy involves the bilateral removal or occlusion of a portion of the ductus deferens, causing infertility by preventing ejaculation of sperm during copulation. Vasectomy does not remove or prevent undesirable sexual behaviors, because testosterone is still produced. Therefore it is infrequently used for control of reproduction in male cats. However, "teaser tom cats" (infertile





**FIGURE 39-4** Vasectomy. **A**, After incision of the skin and subcutaneous tissue, the spermatic cord is identified. **B**, The spermatic cord is exteriorized from the tunica vaginalis using blunt and sharp dissection. **C**, Once the ductus deferens is isolated, a small segment is removed and the severed ends are ligated.

males with good libido) may be used in catteries to bring queens out of heat when pregnancy is not desired. Mating with a teaser tom cat induces a pseudopregnancy in the queen and delays return to estrus. Vasectomy does not alter libido or mating ability in adult tom cats. Live sperm may be present for up to 7 weeks after surgery, however.<sup>30</sup>

Vasectomy is a relatively simple surgical procedure performed through a 1- to 2-cm incision cranial to the scrotum (Figure 39-4).<sup>14</sup> After incision of the skin and subcutaneous tissue, the spermatic cords are identified and exteriorized from the tunica vaginalis using blunt and sharp dissection. Gentle manipulation of the testicle is helpful for identification of the spermatic cord. Once the ductus deferens is isolated, a small segment is removed and the severed ends are ligated. The subcutaneous tissue and skin are closely routinely.

### Chemical Castration

An injectable sterilant, zinc gluconate neutralized by arginine (Neutersol, Addison Biological Laboratory, Fayette, Mo.), was licensed for use in puppies (3 to 10 months of age) in the United States from 2003 to 2005 and is currently not available in that country. The product was licensed in Mexico in 2008 (EsterilSol, Ark Sciences, Baltimore, Md.) for use in dogs. A product with the same

active ingredient, but at a different concentration and with dimethylsulfoxide (DMSO) as a carrier, was licensed in Brazil in 2009 (Infertile; Rhobifarma, Hortolândia, Brazil), also for use in dogs. The intratesticular injection causes sclerosis of the testes and permanent sterility. In one study comparing intratesticular injection of zinc gluconate with surgical castration in dogs, the product was judged to be valuable for large-scale use, particularly in remote locations or where facilities and expertise for surgical castration are not available.<sup>21</sup> Necrotizing injection site reactions were reported in 4 of 103 treated dogs. Neutersol is reported to be effective in cats, but has not yet been licensed in this species.<sup>19</sup> In one study, 115 cats were injected with EsterilSol (0.3 to 0.4 mL/testis, under sedation) at 6 months of age.<sup>20</sup> Cats were monitored for 12 months, and testicular atrophy, reduced testosterone levels, and absence of sperm were documented.

### DISEASES AND CONDITIONS OF THE PENIS

Few problems affect the penis of cats; conditions found more commonly in other species, such as hypospadias and persistent penile frenulum, are rare in the cat. One case report of hypospadias in a 1-year-old Himalayan cat was associated with chronic cystitis.<sup>17</sup> The

hypospadias was surgically corrected and the cat recovered fully. A 1-year-old Persian cat presented for infertility was found to have dorsal deviation of the penis resulting from a persistent frenulum.<sup>1</sup>

A small number of cases of phimosis have been reported in the cat.<sup>4,10,22</sup> Phimosis is due to constriction of the preputial opening that prevents protrusion of the penis. Phimosis may be congenital or acquired secondary to trauma, inflammation, or neoplasia. The most common clinical signs are stranguria, pollakiuria, and vocalizing during urination<sup>22</sup>; other clinical signs include dribbling urine, urinating outside the litter box, and inability to mate. The severity of clinical signs varies with the degree of narrowing. Diagnosis is made on physical examination. In many cases, surgical correction of the defect is necessary.

The records of 10 cats diagnosed with phimosis at Michigan State University Veterinary Teaching Hospital have been reviewed.<sup>22</sup> The mean age at presentation was 18.6 weeks (range, 8 weeks to 2.4 years). Two of the cats had other congenital defects (cryptorchidism, penile hypoplasia). Eight of the 10 cats underwent surgical correction of the condition by a full thickness incision in the ventral aspect of the prepuce, with or without resection of a wedge of prepuce. A satisfactory outcome was achieved in seven cats, where long-term follow-up was available. Congenital phimosis has been reported in an 8-week-old domestic shorthair cat presented for hematuria, pollakiuria, and polydipsia.<sup>4</sup> Urine culture was positive for *E. coli*. Surgical correction of the phimosis was accomplished by resection of a small wedge of the dorsal prepuce, and along with antibiotic treatment, led to resolution of clinical signs.

Priapism is persistent abnormal erection of the penis in the absence of sexual stimulation, and may be caused by a variety of factors, such as spinal cord injury, trauma, neoplasia, and inflammation. It is rarely reported in the cat. Priapism may be confused with paraphimosis; however, paraphimosis is associated with a narrow preputial orifice or other preputial abnormalities. Without intervention, the penis may become dry and edematous, and even necrotic. Most cases in the cat require surgical management. In a series of seven cases of priapism, six cases were in Siamese cats.<sup>11</sup> In four of the cases, priapism developed after unsuccessful attempts at mating, despite the fact that three of the cats were castrated. Five of the cats were successfully treated with perineal urethrostomy, and histologic examination revealed thrombosis of the corpus cavernosum.

Priapism was reported in a 1.5-year-old domestic shorthair cat after routine castration.<sup>36</sup> Two days after surgery, the cat developed pollakiuria and stranguria, as well as protrusion of the penis. The cat was successfully treated with perineal urethrostomy. Histology of the resected tissue revealed severe congestion of the corpus cavernosum, with organized thrombi and areas of

necrosis. Another case of priapism was reported in a 2-year-old castrated cat with feline infectious peritonitis (FIP).<sup>31a</sup> At necropsy histologic examination of the penis revealed severe pyogranulomatous inflammation and fibrinoid necrosis of the corpus cavernosum.

## DISEASES AND CONDITIONS OF THE TESTES

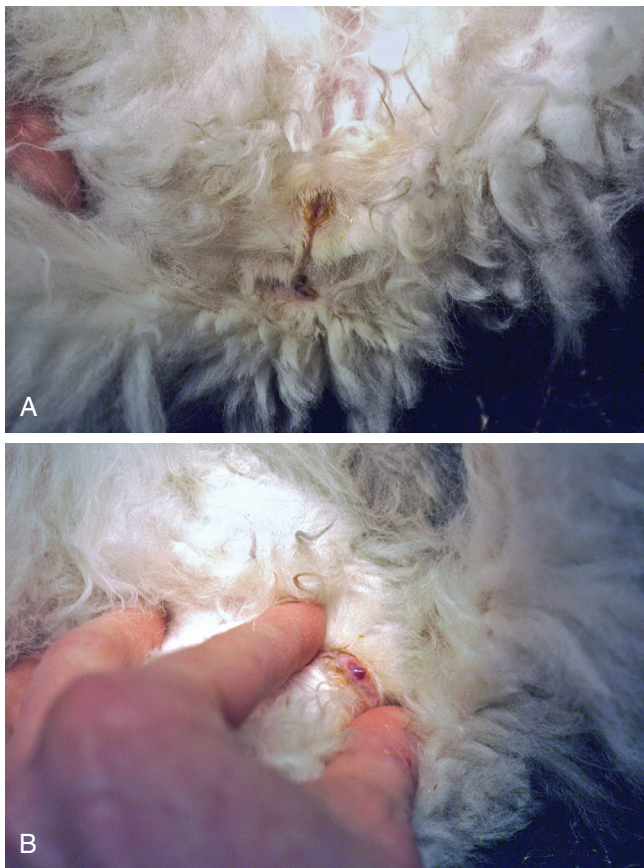
Few conditions of the testes of the cat come to the attention of clinicians, with the exception of cryptorchidism. Other problems that are occasionally encountered include orchitis, neoplasia, and abnormalities of gonadal sex or chromosomal sex.

Orchitis is rare in the cat, although occasionally bacterial orchitis has been reported. Clinical signs include scrotal swelling, pain, and redness. Bacterial orchitis is treated with a broad-spectrum antibiotic for 2 to 3 weeks. Orchitis has also been reported as an uncommon manifestation of FIP<sup>8</sup>; one case report was a cat concurrently infected with FIV.<sup>34</sup> Scrotal swelling may be the only sign associated with FIP in affected cats, at least initially (see Figure 33-16). The vaginal cavity around each testis is confluent with the peritoneal cavity so that fluid accumulated in the abdomen may also appear in the scrotum. Lesions in the testes are consistent with a chronic necrotic and fibrinous orchitis and fibrinous periorchitis with vasculitis.

Testicular neoplasia is uncommon in the cat. Examples of both Sertoli and interstitial cell tumors have been reported.<sup>2,26,29,38</sup> Neoplasia of testicular origin developing after castration has been reported in five cats.<sup>6</sup> All cases involved interstitial cell tumors within the scrotal skin or the spermatic cord. All cats were castrated at 1 year of age or younger, and the mean age at diagnosis of the neoplasia was 9.6 years. Affected cats demonstrated sexual behaviors associated with intact males, such as urine spraying and aggression. Two cats had penile spines. The study authors suggest that care be taken during castration to avoid incising the tunica albuginea to avoid transplantation of small amounts of testicular tissue, and the subsequent development of tumors.

Testicular hypoplasia and infertility may be seen in male tortoiseshell or calico cats. It has been estimated that about 1 in every 3,000 tortoiseshell or calico cats is male.<sup>15</sup> A survey of over 4,500 male cats in the United Kingdom determined that 0.43% were tortoiseshell.<sup>18</sup> Orange is a sex-limited coat color in cats, controlled by a single gene on the X chromosome. Black and orange color may occur together in the female, but normally would not occur together in the male. Males exhibiting black and orange coat color may have various chromosomal abnormalities, such as 39/XXY, mosaicism (two populations of cells with different genotypes from one fertilized egg), or chimerism (two or more populations





**FIGURE 39-5** A, External genitalia of an intersex cat presented for ovariectomy that was subsequently found to have one testis next to the vulva. B, A small penis-like structure was present in the vulva, and one testis was found subcutaneously near the vulva.

of cells from the fusion of different embryos). Mosaics or chimeras are often fertile.

Both true hermaphroditism and pseudohermaphroditism are very uncommon in the cat. Many cases are unreported, because karyotyping is not widely available for cats. Affected individuals may be discovered at the time of surgical sterilization. For example, the author has examined a blue tabby intersex cat (Figure 39-5). The cat was presented as a female and was spayed without incident. Several months later, the owners complained of a strong smell to the urine, and on examination, a small penis-like structure was present in the vulva and one testis was found subcutaneously near the vulva. The cat's specific condition was not determined, because karyotyping and gonadal histopathology was not performed.

Cryptorchidism

The testes are normally descended into the scrotum by birth or shortly afterward. However, testes may move freely up and down in the inguinal canal prior to puberty. Cryptorchidism is failure of one or both testes to descend

**TABLE 39-1** Data from 4,140 Cats Presented for Castration during a 10-Year Period in Ottawa, Canada

	No. Presented for Castration	No. Cryptorchid (%)
ALL CATS	4,140	72 (1.7)
BREEDS WITH AT LEAST 10 CATS		
Abyssinian/Somali	15	1 (6.7)
Balinese	10	0
British Shorthair	19	0
Burmese	19	2 (10.5)
Maine Coon	16	2 (12.5)
Persian/Himalayan	135	14 (10.4)
Ragdoll	16	3 (18.75)
Siamese	158	4 (2.5)

into the scrotum and remain there by 7 to 8 months of age. It is the most common congenital defect of the feline urogenital system. The term “monorchid” refers to total absence of one testis. Unilateral testicular agenesis has been reported, with the finding of a rudimentary spermatic cord and no associated testis.<sup>31</sup> The term “anorchid” refers to total absence of both testes (an exceedingly rare event). It is uncertain if cryptorchidism is linked with other congenital defects in cats.

The prevalence of cryptorchidism in cats has been reported as 1.3% to 3.8%.<sup>28,31,42</sup> In one study of more than 100,000 feral cats admitted to trap-neuter-return programs, 1.3% of male cats were cryptorchid.<sup>41</sup> In another study of more than 5,000 free-roaming cats admitted to a trap-neuter-return program, 1.9% of the males were cryptorchid.<sup>33</sup> Persian cats are overrepresented in some studies.<sup>28,31</sup> In the author's practice, records of 4,140 cats presented for castration during a 10-year period were reviewed (Table 39-1). Seventy-two cats (1.7%) were identified as cryptorchid. Three cats were identified as monorchid. Of the cats presented for castration, 10.5% were of a pedigree breed, with a total of 22 breeds represented. Among the pedigree cats, 6.2% were identified as cryptorchid. The highest incidence was in the Ragdoll breed (>18%).

Cryptorchidism is typically unilateral, with left and right sides equally affected. In one study where the location of the retained testis was recorded, 49% were inguinal, 33% were abdominal, and 14% were within the inguinal ring.<sup>31</sup> In the author's practice, 87% of 72 cats had unilateral cryptorchidism, and the most common configuration was the unilateral, inguinal cryptorchid (51.6% of cases) (Table 39-2). Cats with bilateral cryptorchidism are likely to have abdominally retained testes. If one testis is in the scrotum, it may be difficult to determine if it is on the left or right side. Pushing the scrotal

**TABLE 39-2** Location of 124 Testes in 62 Cryptorchid Cats Presented for Castration during a 10-Year Period in Ottawa, Canada

	Abdominal	Inguinal	Inguinal Ring	Scrotal
Right side	11	21	4	26
Left side	11	16	6	29
Totals	22 (17.7%)	37 (29.8%)	10 (8%)	55 (44.3%)

testis dorsally and cranially toward the inguinal canal can help determine its location.<sup>3</sup> It may be difficult to palpate inguinal testes if the cat has large inguinal fat pads, unless the testis is located caudal to the fat pad. The inguinal lymph node and fat pad are commonly confused with inguinal testes on palpation.

Abdominally retained testes have been examined histologically, and typically, no spermatozoa are found. The higher temperature inside the body probably suppresses development of sperm. Cats with retained testes located outside the abdomen, however, may be fertile. Cryptorchid testes produce testosterone; so, affected cats have the typical male phenotype (e.g., thick skin on neck and shoulders, broad face) and behaviors (e.g., libido, aggression, urine marking).

In one study, only 22% of cat owners were aware their pet was cryptorchid.<sup>42</sup> All male cats should be examined for cryptorchidism during initial wellness visits. If a retained testis is suspected, there are two ways to confirm the condition. The simplest is to check for testosterone-dependent penile spines. Gonadotropin stimulation testing has also been used to detect retained testes. Testosterone levels fluctuate in the cat; so, resting samples are not very informative and provocative testing must be used. Various protocols have been described (Box 39-1).

The mode of inheritance for cryptorchidism is suggested to be recessive in cats, as in other species, and cryptorchid males should not be used for breeding.<sup>31</sup> Cryptorchidism is an example of a sex-limited trait. The trait is physically expressed only in the male even though it can be carried by females. Both the sire and dam of an affected cat should be considered to be carriers of the trait. Some full siblings of an affected cat will also be carriers. A reduction in the number of cryptorchid cats in a pedigree breeding program can be achieved by removing affected males and carrier parents from breeding. If the problem is widespread in a family line, full siblings of an affected cat should also be eliminated from the breeding program.

There is no treatment proven to cause a retained testis to descend into the scrotum. Treatment with gonadotropins has not been successful. In other species, surgical removal of the retained testis is routinely recommended, because the retained testis is at risk for neoplasia or torsion. Torsion of the spermatic cord has not been

### BOX 39-1

#### Hormonal Methods for Diagnosis of Cryptorchidism in the Cat

After collection of a baseline serum testosterone sample:

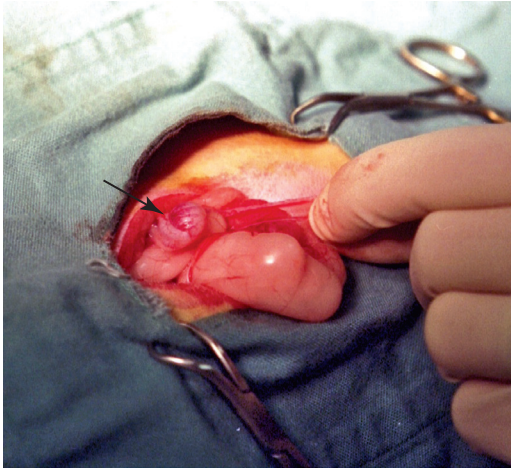
1. Administer 25 µg gonadotropin-releasing hormone (GnRH) (Cystorelin; Merial, Duluth, Ga.), IM; take second serum testosterone sample 1 hour later<sup>15</sup>
2. Administer 250 IU human chorionic gonadotropin (HCG), IM; take second serum testosterone sample 4 hours later<sup>15</sup>
3. Administer 500 IU HCG, IV; take second serum testosterone sample 2 hours later<sup>24</sup>

Resting testosterone levels in intact male cats are usually less than 3.0 ng/mL, although considerable variation occurs. Provocative testing will induce a marked elevation of serum testosterone in the cryptorchid male.

documented in the cat, and only a few case reports of testicular tumors have been published. Cryptorchid cats that have only the scrotal testis removed will display all the normal behaviors of an intact male. Most studies report cryptorchid cats that have had the scrotal testis removed, with unsuccessful attempts to locate the undescended testis. Owners subsequently seek veterinary care because of odoriferous urine and unwanted behaviors (e.g., urine spraying, aggression, seeking females). Therefore it is important that both testes be removed to avoid unwanted behaviors that may provoke abandonment or relinquishment to a shelter.

Testes that are palpable in the inguinal subcutaneous tissue can be removed through a simple incision. In other cases, a caudal midline incision and dissection deep to the inguinal fat pad is required. The external inguinal ring should be examined, but care should be taken not to damage structures in the femoral triangle. For abdominally retained testes, laparotomy through a midline approach is required, although laparoscopic-assisted cryptorchidectomy has also been described.<sup>23,27,40</sup> Advantages of a laparoscopic technique include minimal invasiveness, reduced tissue trauma, and potentially reduced postoperative pain and fewer complications than laparotomy. The principle disadvantage is the need for specialized equipment with the associated costs and expertise required. Initially, the laparoscopic approach may take longer to perform than a traditional laparotomy until the practitioner gains experience with the technique.

Surgical techniques for removal of abdominal testes have been described elsewhere.<sup>3</sup> Use of a spay hook to retrieve the vas deferens is not recommended because of the risk of damage to the ureters.<sup>31</sup> Abdominal testes are often near the bladder (Figure 39-6) but can be located caudal to the kidney, in the internal inguinal ring or in



**FIGURE 39-6** The testes (arrow) in cats with abdominal cryptorchidism are often found near the bladder.

the inguinal canal.<sup>31</sup> The best procedure is to find the vas deferens and follow it caudally to the testis. Applying gentle traction to the vas deferens may facilitate location of the testis by detecting its movement. Although it can be frustrating to locate the retained testis in some cases, it is not appropriate to simply ligate the vas deferens and testicular vessels in the hope the testis will atrophy. It is possible for the blood supply to re-establish and for the testis to remain functional.

## INFERTILITY

Causes of infertility are not well studied in the tom cat, partly because of the difficulty in obtaining semen for analysis compared with other species, such as the dog. Regardless, a systematic approach can be taken when the clinician is presented with a potentially infertile tom cat. A thorough evaluation of the queens involved must also be performed (see Chapter 40). Breeders should be encouraged to keep complete records on each breeding male in a cattery (Box 39-2).

Owners of breeding cats may request administration of antimicrobials to prevent transmission of bacterial infections from the queen to the tom cat and vice versa, especially if cases of infertility have occurred in the cattery. However, both the vagina of the queen and the preputial mucosa of the male have normal resident bacterial populations. In one study, bacterial cultures from the preputial mucosa of 29 tom cats (age range, 0.5 to 2.5 years) were all positive for both aerobic and anaerobic bacterial species.<sup>35</sup> The most common aerobic bacteria were *Pasteurella multocida*, unidentified gram-negative rods, and *E. coli*. The most common anaerobic bacteria were *Bacteroides* spp., *Fusobacterium* spp., and *Streptococcus* spp. The type of bacterial populations found in queens differed from that found in the tom cats,

### BOX 39-2

#### Reproductive Data Collection for Breeding Tom Cats

1. Age at puberty
2. Details about libido: interest in estrous queens, willingness to breed
3. Details for each mating
  - a. Dates of breeding
  - b. Number of copulations
  - c. Problems during breeding, for instance, prolonged thrusting, failure to elicit postcoital reaction in queen
  - d. Age and parity of each queen bred
  - e. Outcome of breeding: pregnancy or date of queen's return to estrus
4. Details of each litter: date born, litter size, sexes, birth weights, stillbirths, congenital defects (if present), illnesses, necropsy findings, and so forth

### BOX 39-3

#### Causes of Breeding Problems in Tom Cats

1. Inexperience or immaturity
2. Nervousness or anxiety
3. New environment or changes to existing environment
4. Inadequate housing
5. Improper breeding management
6. Malpositioning during copulation
7. Medical conditions, both reproductive and nonreproductive
8. Hair rings around the shaft of penis preventing intromission
9. Poor libido
10. Stressors (e.g., showing, travel, social conflicts)

suggesting that mating does not lead to a permanent transfer of bacteria. These bacterial populations may play a role in host defense against pathogenic bacteria. Therefore treatment of normal queens or tom cats with antimicrobials may affect the protective bacterial flora and actually increase the risk of infection with pathogenic bacteria.

Successful breeding tom cats must be physically, socially, and sexually mature. Ideally, a young inexperienced tom cat should be paired with a calm, mature, and experienced queen. Tom cats are very territorial, and breeding is most successful if the tom cat is in his home environment and the queen is brought to him. Breeding problems in the tom cat are associated with a wide variety of factors (Box 39-3).



**BOX 39-4****Investigation of Infertility in the Tom Cat****1. Normal libido?****If Yes**

Investigate breeding management  
Investigate queen's fertility  
If possible, perform semen evaluation

**If No**

Ensure queen is in estrus  
Investigate behavior problems in tom cat (e.g., shyness, nervousness)  
Evaluate general health of tom cat for reproductive and nonreproductive problems  
Consider effect of age on libido

**2. Normal mating ability?****If Yes**

Same as above

**If No**

Investigate orthopedic or neurologic problems  
Check penis for hair ring or other abnormalities that prevent intromission

The first step in investigation of infertility in the tom cat is collection of the reproductive history and a thorough physical examination. Various reproductive disorders causing infertility have been described in the tom cat, such as testicular hypoplasia and persistent penile frenulum.<sup>1</sup> Nonreproductive disease, such as oral cavity disease or degenerative joint disease, may influence willingness or ability to mate. Chronic illness, such as upper respiratory tract infection or diarrhea, may lead to poor body condition and diminished libido. Particular attention should be paid to examination of the penis (position, size, ability to extrude from the prepuce, presence of spines) and testes (size, symmetry, consistency). Ultrasonography may be a useful tool for investigation of testicular abnormalities, although it is performed less frequently in the tom cat than in the male dog.<sup>5</sup> Collection of a minimum database (complete blood count [CBC], serum chemistries, complete urinalysis, feline leukemia virus [FeLV] and FIV testing) is recommended. Information should also be obtained on the cat's housing, diet (including nutritional supplements), and medications (both prescription and nonprescription).

Whether or not the cat has a normal libido determines the next diagnostic steps (Box 39-4). In late-maturing breeds, libido cannot be assessed properly until about 3 years of age. Poor libido is often caused by management problems or underlying medical conditions. The tom cat's environment is very important for breeding success.

In pedigreed catteries, tom cats are often housed in cages or enclosures because of urine marking behavior. Tom cats often dislike changes to their territory, even changes in odor, such as when scented cleaners are used. The enclosure for a breeding tom cat must provide enough space to allow for normal exercise. Cats value vertical space; so, provision of areas to climb or shelving is very important. It also provides a way for the tom cat to retreat from the postcoital reaction of the queen to avoid being swatted. Inadequate housing may inhibit the breeding behavior of normal tom cats. For more on breeding management, see Chapter 40. Measurement of baseline testosterone in tom cats with poor libido is not informative; provocative testing must be used, as discussed above in diagnosis of cryptorchidism. Administration of supplemental testosterone in an attempt to correct poor libido is ineffective and inappropriate. Exogenous testosterone may suppress release of GnRH and LH, thereby interrupting testosterone synthesis by the interstitial cells of the testes.

If the male has normal libido, the breeder should attempt to witness matings (either in person or by video camera/web camera) to ensure that normal events are taking place. For example, if no postcoital reaction is seen from the queen, intromission was likely unsuccessful. If prolonged pelvic thrusting occurs in long-haired cats, the base of the penis should be checked for a ring of hair. Observing the breeding pair will also help determine if the tom cat is shy or inhibited, especially by an aggressive queen.

Semen evaluation may be a valuable diagnostic tool for tom cats with normal libido, where other causes of infertility have been ruled out. Semen collection can be performed either by electroejaculation under general anesthesia or by training the tom cat to an artificial vagina; both techniques were first reported in the 1970s and are well described in the literature.<sup>43</sup> Electroejaculation requires specialized equipment that is not widely available, as well as expertise in the technique. Training a tom cat to an artificial vagina is time consuming, requires a "teaser" queen, and will not be successful in all cases. In addition, few clinicians have experience examining semen in cats. These barriers make semen evaluation in the tom cat an uncommon procedure in general clinical practice.

Recently, a novel technique for semen collection in the cat that may be useful in clinical practice has been described.<sup>7,44</sup> In this technique, the tom cat is sedated with medetomidine alone (130 to 140 µg/kg, IM) or medetomidine (100 µg/kg IM) plus ketamine (5 mg/kg, IM). Alpha<sub>2</sub>-adrenergic agonists are known to stimulate erection and ejaculation in other species. A 3-Fr tom cat catheter is modified by cutting off about 1 cm of the tip with a scalpel blade. The catheter is inserted into the urethra once, to a distance of approximately 9 cm (to the level of the prostatic urethra), and is then

withdrawn to collect released semen. It is important to avoid entering the bladder with the catheter so that inadvertent collection of urine does not occur. After collection, the semen is placed in a warmed Eppendorf tube and diluted with semen extender or in vitro fertilization (IVF) medium.

Collected semen should be evaluated macroscopically (appearance, volume) and microscopically (motility, morphology, concentration, viability). Eosin-nigrosin stain can be used to differentiate live and dead spermatozoa. Characteristics of normal cat semen collected by the various techniques have been reported.<sup>7,16,43,44</sup> The volume of semen collected ranges from approximately 30 to 100  $\mu\text{L}$  (collection through artificial vagina) to 200 to 300  $\mu\text{L}$  (collection by electroejaculation). Semen samples collected by urethra catheterization after administration of medetomidine are too small in volume (about 10  $\mu\text{L}$ ) and too concentrated to allow evaluation of sperm motility and morphology as is, and so the sample must be diluted before analysis.<sup>44</sup> A variety of morphologic defects have been described for cat sperm. Normal cat semen has less than 30% morphologically abnormal sperm.<sup>43</sup> Teratospermia is characterized by greater than 60% abnormal sperm forms and is associated with decreased genetic variation and low circulating testosterone concentrations.<sup>43</sup> The small volumes of semen collected from cats are challenging to handle and analyze, especially if the clinician performs the procedure infrequently.

When it is not possible to collect a semen sample, vaginal lavage with 1 mL sterile saline of a queen immediately after breeding may allow determination of whether sperm are present. Because a degree of retrograde ejaculation is normal in the tom cat, collection of a urine sample after ejaculation also allows for detection of sperm (see Figure 39-2). Sperm motility and morphology cannot be examined in samples collected from the bladder or by vaginal flush.

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