Summary
Early-age neutering of puppies and kittens (as early as 6-7 weeks of age) is increasing in popularity in the United States. This increase likely results from accumulating information on the safety of the procedure and lack of long-term adverse side effects. As veterinarians become comfortable and familiar with the procedure, they are likely to encourage more clients to consider early-age neutering. Puppies and kittens neutered at early ages have shorter recovery times than those neutered at more traditional ages; mortality and morbidity rates have also been reported as lower. Early-age neutering is also one tool used to combat pet overpopulation, a problem whereby millions of healthy dogs and cats are euthanized each year in the U.S. because they are unwanted. Thus, the prepuberal gonadectomy may be good for individual animals and for controlling birth rates in populations of dogs and cats.

Introduction
Prepuberal gonadectomy is not a new procedure. Veterinarians in the U.S. have often recommended that female dogs and cats be neutered prior to the first estrus (i.e., prepuberal) to reduce the risk of mammary neoplasia and eliminate the possibility of unwanted pregnancy. What is new, however, is the age of the prepuberal animal that many veterinarians are now neutering. Traditionally, female dogs and cats not intended for breeding were neutered at approximately 6 months of age and male dogs and cats were neutered at approximately 6 to 9 months of age. However, in an attempt to reduce the number of unwanted pets in the U.S., veterinarians began to question whether it was also safe to neuter puppies and kittens at an even younger age [1]. Although animal shelters often request neuter contracts be signed at the time of adopting a pet, many new owners fail to comply with the contract. This compliance failure occurs even when financial reimbursement is available for the neuter surgery. In a survey published by the Massachusetts Society for the Prevention of Cruelty to Animals (MSPCA) and conducted by the Dorr Research Corporation of Boston, 73% and 87% of 500 households with dogs and cats, respectively, stated that their pets were neutered, but nearly 20% of the neutered animals had produced at least one litter of offspring prior to being sterilized [2]. Prepuberal gonadectomy performed prior to adoption, on puppies and kittens, could offer a tool for animal shelters that desire to adopt only neutered animals to control pet overpopulation.

Concerns by Veterinary Profession - Risks vs. Benefits
Although the anesthetic and surgical procedures for prepuberal gonadectomy have been reported as safe, veterinarians have also been concerned about long-term health risks. Veterinarians questioned whether the immune system of puppies and kittens would be adversely affected by the stress of anesthesia and surgery at early ages, and at a time when animals are being immunized against potentially fatal infectious diseases. Veterinarians also were concerned about the risk of urinary-tract obstruction in male cats and the risk of
urinary incontinence in female dogs neutered at early ages. Based on clinical experience, some practitioners were also concerned that neutered animals might have a propensity for obesity or have abnormal growth patterns. Until the 1990's, few studies had been published that critically evaluated these concerns among dogs and cats neutered at different ages prior to, and following, puberty.

**Propensity to Disease**
In studies conducted at animal shelters, puppies and kittens neutered at early ages had no higher risk to infectious diseases than older animals. One study involved dogs and cats from 2 animal shelters undergoing neuter surgeries in association with the fourth-year student surgical teaching program of an university teaching hospital [3]. Twelve of 1988 (0.6%) animals died or were euthanized because of severe infections of the respiratory tract or as the result of parvovirus infection during the 7-day postoperative period. All of the deaths were in animals from the shelter with the shortest animal holding period. Animals neutered at > 24 weeks of age had a significantly higher (P<0.004) minor complication rate than animals neutered at <12 weeks of age, but did not differ from animals neutered at 12 to 23 weeks of age. Minor complications during or after gonadectomy included complications such as incisional swelling or suture reactions, scrotal swelling, cardiac rate and rhythm abnormalities, and mild gastrointestinal upsets. Differences in major complications were not detected among the groups. Overall, younger patients did relatively better than older animals, even when immunity to infectious diseases may not have been possible due to their young ages, or when veterinary students were performing delicate pediatric surgeries.

**Growth**
Many veterinarians once held the belief that puppies and kittens neutered at early ages might be stunted in growth. Several research studies have now refuted these once-held beliefs. In a 15-month study conducted at the University of Florida, the effects of prepubertal gonadectomy on skeletal growth, weight gain, food intake, body fat, and secondary sex characteristics were investigated in 32 mixed-breed dogs [4]. Growth rates were unaffected (P>0.05) by gonadectomy, but the growth period in final radial/ulnar length was extended in all neutered male dogs (neutered at 7 weeks or 7 months) and in bitches neutered at 7 weeks of age. Thus, animals were not stunted in growth but were actually slightly (as determined by radiographs) taller. In a similar study at the same university [5], thirty-one cats were neutered at 7 weeks or 7 months or left intact. No differences (P>0.05) were detected between neutered cats, regardless of when they were neutered, for mature radius length or time of distal radial physeal closure. Distal radial physeal closure was delayed (P<0.05) in neutered cats when compared to intact cats. Similar findings in cats were reported by work from the University of Minnesota [6]. In males and females, distal radial physeal closure was delayed (P<0.01) in both groups of neutered cats (neutered at 7 weeks or 7 months of age) compared to intact animals. In female cats, proximal radial physeal closure was also significantly delayed (P=0.02) in cats neutered at 7 weeks of age.

**Obesity**
Although obesity can occur in both neutered and intact animals, and is influenced by a number of factors such as diet and activity level, there are data to suggest that neutered cats may gain significantly more than those remaining intact. The information on whether dogs are more likely to experience weight gain following neutering is conflicted in the literature.

When comparing neutered cats to sexually intact cats, intact cats were found to weigh less (P<0.05) that cats neutered at 7 months, but there was no difference between intact cats and those neutered at 7 weeks. Root [6, 7] assessed obesity by body mass index at 24 months of age in 34 cats. Body condition scopes and body mass index values were higher (P<0.01) in animals gonadectomized at 7 weeks or 7 months than in intact animals, indicating that animals gonadectomized at either age were more likely to be obese than intact cats. Heat coefficient, a measure of resting metabolic rate, was higher in intact cats than in gonadectomized cats. Based on these data, the author suggested that neutered male cats require an intake of 28% fewer calories than intact cats and neutered female cats require an intake of 33% fewer calories than intact female cats [7]. Information on over 8,000 dogs was gathered from 11 veterinary practices in the United Kingdom during a six month survey [8]. In this retrospective study, spayed female dogs were about twice as likely to be obese as intact female dogs. Salmeri et al.[4], however, found no differences in food intake, weight gains, or back-fat depth among neutered and intact animals during a 15-month prospective study.
Urinary Tract Health

Concerns over urinary obstruction in cats has long been used as an argument against early-age neutering. Gonadectomy appears to have little effect on urethral function in dogs or cats as determined by urethral pressure profilometry [4, 9]. Urethral diameters as determined by contrast retrograde urethrogram are similar among neutered cats (neutered at 7 weeks to 7 months of age) and those remaining intact [9]. The incidence of urethral obstruction in 263 cats adopted from shelters and neutered at ≤ 24 weeks of age or ≥ 24 weeks of age did not differ [10]. Of 70 male cats neutered ≤ 24 weeks of age, none had obstructive episodes, while two of 38 male cats neutered at ≥ 24 weeks of age had obstructive episodes. The incidence of estrogen-responsive urinary incontinence is increased among neutered female dogs, and there was concern that neutering puppies at an earlier age might further increase the risk for spayed bitches. Urinary incontinence in dogs neutered at traditional ages can develop within days of the surgery or not until several years later. Estrogen-responsive urinary incontinence was reported in 34 of 791 (4%) bitches neutered at conventional ages, and seven of 2,434 (0.3%) sexually intact bitches[11]. Howe et al., [12] evaluated 269 dogs adopted from shelters and neutered at ≤ 24 weeks of age or ≥ 24 weeks of age and found only three cases where owners reported urinary incontinence. One dog was neutered at ≤ 24 weeks of age and two dogs were neutered at ≥ 24 weeks of age. Thus, there is little information to date to suggest that the incidence of urinary incontinence is higher in bitches spayed at earlier ages over conventional ages.

Adrenal Tumors

There was some early concern that dogs and cats neutered at early ages might be at risk for developing adrenal gland tumors. Such concern seemed to arise from reports that functional adrenocortical tumors in ferrets were often found in neutered animals. In support of this suggestion, some studies have shown that gonadectomy within the first few days of life may lead to adrenal tumors in some strains of mice [13]. To date, there has been no documentation of sex steroid-producing adrenal tumors in dogs or cats associated with prepuberal gonadectomy.

Inflammation of the Penis, Prepuce, Vulva

The penis, prepuce and os penis appear infantile in puppies who are neutered at six to eight weeks of age when compared to puppies neutered at conventional ages or those remaining intact. To date, the infantile secondary sex characteristics have not been associated with an increased risk of balanoposthitis. Complete penile extrusion was possible in 100% of intact cats, 60% of of cats neutered at 7 months of age, and no cats neutered at conventional ages [14]. The clinical significance of failure to extrude the penis is unknown, although it could increase the difficulty of catheterizing animals who require such a procedure. The vulvas of puppies neutered prior to puberty appear smaller when compared to intact bitches. Vulvar size may also appear smaller in intact bitches during anestrus or in some bitches spayed later in life. Perivulvar dermatitis can result in bitches with recessed or small vulvas, especially if the bitch has excessive skin and adipose tissues partially cover the vulva. Although perivulvar dermatitis has been associated with weight gains and recessed vulvas following ovariohysterectomy, there is no information to suggest that the occurrence is higher in bitches spayed at early ages over those neutered at conventional ages.

Surgical and Anesthetic Considerations

Anesthetic and surgical considerations for the pediatric patient include the potential for hypoglycemia, hypothermia, a relatively small blood volume, and the delicate nature of the pediatric tissues. Since hepatic glycogen stores are minimal in neonates, prolonged fasting may result in hypoglycemia. Food should be withheld no longer than 8 hours, with 3-4 hours recommended for the youngest patients (6-8 weeks) [15, 16]. Additionally, animals may be fed a small meal within 1-2 hours after recovery from anesthesia [15, 16]. Hypothermia can be lessened by using warm water blankets and by the use of warm intravenous fluids (if used). Minimizing operative time will also help lessen the severity of hypothermia. Excessive wetting of the pediatric patient during preparation of the surgical site should be avoided, and the use of warmed scrub solution (chlorhexidine) and avoidance of alcohol will be beneficial in helping preserve body heat [15, 16]. Pediatric tissues are very friable and should be handled carefully. The relatively small blood volume of pediatric patients makes meticulous hemostasis very important. Fortunately, the small size of blood vessels and the presence of minimal abdominal and ovarian bursal fat allow for excellent visualization of the vasculature, and makes precise hemostasis simple to achieve.
Pediatric ovariohysteretcomies may be performed similarly to adult ovariohysterectomy with some slight modifications [3, 15, 17]. Puppy incisions are started relatively more caudal to the umbilicus than adult dogs. Generally, the uterus is more easily exposed in puppies if the incision is started at least 2-3 cm caudal to the umbilicus (resulting in an incision placed nearer the middle third of the distance from the umbilicus to the cranial brim of the pelvis, similar to a feline incision). In kittens, the incision is placed in a similar location as adult cat incisions. Upon entrance into the abdomen, it is common to encounter substantial amounts of serous fluid in both puppies and kittens. It may be necessary to remove some of the fluid using gauze sponges to improve visualization. In contrast to adult dogs and cats, it is recommended that the use of a Snook ovariohysterectomy hook be avoided in pediatric patients due to the delicate nature of the tissues. Because of incision location in both puppies and kittens, the uterus is easy to locate by looking between the urinary bladder and colon. Uterine tissue is extremely friable in young puppies and kittens, therefore care must be taken to avoid excess traction. After the uterus has been located, the suspensory ligament may be carefully broken down to improve visualization, and a window made through the broad ligament adjacent to the ovarian vasculature. A clamp is then placed just proximal (medial) to the ovary across the vessels using a mosquito hemostat on kittens and small puppies and Kelly, Crile, or Carmalt forceps on larger puppies. The ovarian vessels are double ligated using 3-0 to 4-0 absorbable suture material or stainless-steel hemostatic clips. A single ligature may be sufficient to prevent hemorrhaging in very small pedicles. After ligation of the ovarian vessels on both sides, the remaining broad ligament should be broken down and the uterine pedicle ligated at the junction of the uterine body and cervix with two fully encompassing uterine body ligatures or hemostatic clips. After the reproductive tract has been removed, it should be examined to ensure complete removal (of ovaries and uterine body), and the abdomen should be examined for evidence of hemorrhage. When closing, it is important to carefully identify the ventral fascia (external rectus sheath) and differentiate it from the overlying subcutaneous tissue since they can occasionally be difficult to tell apart (particularly in some puppies). The ventral fascia can be closed using either a simple continuous or simple interrupted suture pattern using 3-0 (or possibly 2-0 on large puppies) absorbable (polydioxanone, polyglyconate, or polyglactin 910) or monofilament nonabsorbable (polypropylene, polybutester, or nylon). The subcuticular layer may be closed with an absorbable suture material (3-0 to 4-0) in a continuous intradermal pattern to avoid the use of skin sutures. Alternatively, skin sutures may be loosely placed following closure of the subcutaneous tissues. Pediatric puppy castration is also performed with modifications to the techniques used in adult dogs [3, 15]. As with adult canine castrations, it is important to ascertain that both testes have descended prior to commencing surgery. Because of the small size and mobility of puppy testes, the entire scrotal area may be clipped and surgically prepped to permit the entire scrotum to be included in the sterile field. This will greatly facilitate testis localization and manipulation, and does not cause scrotal irritation as in adult dogs, since the scrotal sac is not well developed. Puppies may be castrated through a single midline prescrotal or scrotal incision. Alternatively, two scrotal incisions may be used similar to a feline castration. After exposing testicles and spermatic cord in closed fashion (testes remain encased in the parietal vaginal tunic during castration), the spermatic cords should be double ligated with 3-0 absorbable suture material or stainless-steel hemostatic clips. Incisions may be closed using 1-2 buried interrupted sutures in the subcuticular layer, or incisions may be left open to heal by second intention healing. Closure of incisions prevents postoperative contamination with urine or feces, and prevents fat from extruding from the incision. Kitten castration is performed using identical techniques as in the adult cat [3, 17]. Care should be used when exteriorizing testes to prevent tearing of the spermatic cord due to its small size. As with adult cats, incisions are left open to heal by second intention.

References


All rights reserved. This document is available on-line at www.ivis.org. Document No. A1201.0400.