

Long-term outcome of gonadectomy performed at an early age or traditional age in dogs

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Objective—To determine long-term results and complications of gonadectomy performed at an early age (prepubertal) or at the traditional age in dogs.

Design—Cohort study.

Animals—269 dogs from animal shelters.

Procedure—Dogs that underwent gonadectomy were allotted to 2 groups on the basis of estimated age at surgery (traditional age, ≥ 24 weeks old; prepubertal, < 24 weeks old). Adoptive owner information was obtained from shelter records, and telephone interviews were conducted with owners to determine physical or behavioral problems observed in the dogs since adoption. Follow-up information was obtained from attending veterinarians for dogs with complex problems or when owners were uncertain regarding the exact nature of their dog's problem.

Results—Prepubertal gonadectomy did not result in an increased incidence of behavioral problems or problems associated with any body system, compared with traditional-age gonadectomy, during a median follow-up period of 48 months after gonadectomy. Rate of retention in the original adoptive household was the same for dogs that underwent prepubertal gonadectomy as those that underwent traditional-age gonadectomy. Infectious diseases, however, were more common in dogs that underwent prepubertal gonadectomy.

Conclusions and Clinical Implications—With the exception of infectious diseases, prepubertal gonadectomy may be safely performed in dogs without concern for increased incidence of physical or behavioral problems during at least a 4-year period after gonadectomy. (*J Am Vet Med Assoc* 2001;218:217–221)

Millions of dogs and cats are euthanatized annually in US animal shelters.¹ Many animal adoption agencies now require mandatory neutering of all companion animals after adoption; however, owner compliance with these programs is estimated to be $< 60\%$.^{2,3} As a method of increasing population control effectiveness, many of these groups, as well as many veterinarians, have promoted prepubertal gonadectomy, which is neutering well before the onset of puberty and prior to adoption.^{4–11} In 1993, the AVMA House of Delegates approved Resolution 6, which supported the concept of prepubertal gonadectomy in an effort to stem the

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overpopulation problem in dogs and cats.¹² Despite the passage of this resolution, acceptance of prepubertal gonadectomy by veterinarians has been slow, in part because of concerns about anesthesia, potential post-operative behavioral abnormalities, musculoskeletal disorders (including hip dysplasia), urinary incontinence in female dogs, and obesity.^{13–18} On a short-term basis (7 days), prepubertal gonadectomy has been shown to be safe and did not result in increased morbidity or mortality in dogs, compared with traditional-age gonadectomy.⁴ Results of other studies also support the belief that increased morbidity or mortality are not associated with the early age procedure on a short-term basis^{6–10}; however, to the authors' knowledge, no long-term studies with large numbers of animals and reference (or control) populations have been reported.

Objectives of the study reported here were to determine long-term results and complications of gonadectomy performed at an early age (prepubertal) or at the traditional age in dogs.

Materials and Methods

Dogs and surgical technique—All dogs were from 2 humane organizations and underwent ovariectomy or castration in association with the fourth-year surgical teaching program at Texas A&M University. These dogs constituted the study group in a previous report in which dog care before and after surgery was described.⁴ Shelter 1 accepted only owner-surrendered animals, had a long holding period, and did not euthanize animals after they entered the shelter. Shelter 2 performed animal control in the region, had a short holding period, and euthanized animals that were not adopted within a stated period. Dogs were placed in 2 groups on the basis of age, which was estimated on the basis of dentition,¹⁹ size, breed, weight, or date of birth (when available). Group-1 (traditional-age) dogs were ≥ 24 weeks of age, and group-2 (prepubertal) dogs were < 24 weeks of age.

Ovariectomies and castrations were performed on group-1 dogs by use of accepted techniques, using a single or triple-clamp method (depending on preference of student or clinician). Ovariectomies in group-2 dogs were performed in similar fashion to those in group-1 dogs (using a single-clamp method) with the exception of incision location. Incision location in group-2 dogs was nearer the middle third of the distance from the umbilicus to the cranial brim of the pelvis. In male puppies, the entire scrotal and prescrotal areas were prepared for surgery, and the puppies were castrated through a single midline scrotal or prescrotal incision, using the closed castration technique. Castration incisions were closed in an intradermal pattern by use of 1 or 2 simple interrupted sutures in which knots were buried.

Study design—Client information was recorded from the humane organization records for each dog that was adopted. Adoptive owners were contacted by telephone no earlier than 41 months (range, 41 to 64 months) after surgery and asked questions from a standardized questionnaire² to

evaluate rates of infectious diseases and retention in the original adoptive household, physical status of all body systems, and behavioral status of the dog. If an owner gave a specific name and description (including treatment) for a medical condition for which their dog had been treated by a veterinarian, which was consistent with the clinical signs the dog had at that time, the dog's veterinarian was not contacted. Attending veterinarians were contacted to clarify complex problems or those not adequately described by the owner. Internet resources were used to attempt to locate telephone numbers and addresses for those individuals who had moved since adopting their pet.

Problems were classified by severity (major or minor) and type (eg, trauma-induced). Major problems were those that resulted in mortality, prolonged (≥ 2 weeks) morbidity, surgery, or prolonged (≥ 2 weeks) or recurrent medical treatment. Additionally, behavioral problems that resulted in, or could potentially result in, alterations to the dog's environmental status (ie, removal of dog from the household or from inside the house) were considered major problems. Examples of major problems included parvoviral enteritis, chronic skin disorders, and behavioral problems that resulted in removal from the household or to the outdoors. Minor problems were those that did not result in surgery or death, including single episodes that resolved with short-term (< 2 weeks) treatment. Examples of minor problems included mild lameness that resolved without treatment, single episodes of upper respiratory tract infection, and behavioral problems that did not jeopardize the dog's standing in the household. Trauma-induced problems included vehicular accidents, dog fights, snake bites, gunshot wounds, and poisonings. Dogs that died, ran away, were returned to the shelter, or were placed in a new home within 1 month of adoption were not included in the subsequent analysis except to list problems that led to death or removal from the household.

Statistical programs^{b,c} were used for all analyses. Frequencies of responses to all objectives were summarized by use of proportions and 95% confidence intervals. Summaries for each body system and frequencies of the most commonly cited problems were described similarly. Mantel-Haenszel χ^2 analysis was used to compare frequencies of problems between group-2 and group-1 dogs, stratified by shelter. When differences were detected between shelters for a certain variable, the 2-tailed Fisher exact test was used to determine significance. Follow-up times were examined by use of the unpaired Student *t*-test and Mann-Whitney test. Differences were considered significant at $P \leq 0.05$.

Results

Follow-up information was obtained on 269 of 635 (42%) dogs that underwent gonadectomy and were adopted during the study period. The remaining dogs were lost to follow-up and were not included in the study. An additional 580 dogs underwent gonadectomy during the study period, but these dogs were not adopted or shelter records for them could not be located, so they were not included in the study. Owner contact was attempted at least 3 times during a period of several days.

There were 154 (57%) dogs with follow-up data from shelter 1 and 115 (43%) dogs from shelter 2. Shelter 1 had 52 group-1 dogs and 102 group-2 dogs; 89 (58%) dogs were female and 65 (42%) dogs were male. Shelter 2 had 42 group-1 dogs and 73 group-2 dogs; 64 (56%) dogs were female and 51 (44%) dogs were male. When shelters were combined, there were 94 dogs in group 1 and 175 dogs in group 2; 153 dogs

were female and 116 dogs were male. A difference was not detected between shelters for distribution of age groups or sex among groups.

Group-1 dogs were significantly older than group-2 dogs at the time of gonadectomy surgery (group 1, 70.8 ± 59.3 weeks [median, 52 weeks; range, 24 to 280 weeks]; group 2, 11.2 ± 4.2 weeks [median, 10 weeks; range, 6 to 22 weeks]; $P = 0.0001$).

Mean and median follow-up times (length of time from gonadectomy to owner contact, or death or loss of dog) did not differ between shelters (shelter 1, 39.6 ± 19.6 months [median, 48 months; range, < 1 to 63 months]; shelter 2, 37.2 ± 20.7 months [median, 47 months; range, < 1 to 64 months]). Follow-up times did not differ between age groups (group 1, 40.4 ± 20.5 months [median, 50 months; range, < 1 to 63 months]; group 2, 37.6 ± 19.8 months [median, 47 months; range, < 1 to 64 months]).

Difference was not detected between age groups for incidence of dogs being returned to a shelter or placed in another home or in the number of dogs alive or dead at time of owner contact. Overall, 35 (13%) dogs were returned to a shelter and 16 dogs (6.0%) had been given to a new owner. Of the 51 dogs returned to the shelter or placed in new homes, 27 were relocated because of animal-associated problems (destructive, aggressive, or miscellaneous behavioral or medical problems), and 24 were relocated because of owner-associated problems. The majority of dogs ($n = 174$; [65%]) were still alive at follow-up, although several dogs had died (31 [11%]) or run away (13 [5%]). Approximately equal numbers of dogs in both age groups died from traumatic incidents (vehicular, gun, or miscellaneous trauma) or medical causes (parvoviral enteritis, behavioral, or miscellaneous medical problems), and there was no difference between age groups in incidence of traumatic or medical deaths.

Owners reported that 197 (73%) dogs (group 1, $n = 73$ [78%]; group 2, 124 [71%]) developed a problem after adoption. When classified by severity and type, 107 (40%) dogs (group 1, $n = 43$ [46%]; group 2, 64 [37%]) had a major medical or surgical problem, 69 (26%) dogs (group 1, 24 [26%]; group 2, 45 [26%]) had a minor problem, and 21 (8%) dogs (group 1, 6 [6%]; group 2, 15 [9%]) had ≥ 1 traumatic incident. More dogs had 1 problem (group 1, $n = 40$ [43%]; group 2, 66 [38%]) than 2 to 3 problems (group 1, 30 [32%]; group 2, 55 [31%]) or ≥ 4 problems (group 1, 3 [3%]; group 2, 3 [2%]). Significant differences in overall incidence of problems, problem severity, or number of problems were not detected between age groups.

Infectious diseases affected 23 (9%) dogs; parvoviral enteritis was reported in 14 (5%) dogs and infections of the upper portion of the respiratory tract were reported in 9 (4%) dogs. Group-2 dogs had higher incidence of infectious diseases, compared with group-1 dogs ($P = 0.04$), which was attributable to the greater incidence of parvoviral enteritis seen in that group ($P = 0.01$). Shelter 1 had significantly ($P = 0.008$) higher incidence of parvoviral enteritis in group-2 dogs, compared with group-1 dogs. A difference between age groups was not reported for incidence of infections of the upper portion of the respiratory tract.

The most common problems reported in dogs of both groups were behavioral in nature. Overall, 92 (34%) dogs (group 1, $n = 36$ [38%]; group 2, 56 [32%]) had at least 1 behavioral problem; aggressive (20 [7%]) and destructive behaviors (8 [3%]) were most common. Inappropriate elimination, including submissive urination ($n = 5$ [2%]) and housebreaking problems (3 [1%]), was observed infrequently. Miscellaneous behavioral problems ($n = 65$ [24%]) included excessive barking and digging, separation anxiety, jumping, and inability to get along with other animals. A difference between age groups was not detected in incidence of overall or specific behavioral problems.

Integumentary problems were reported in 80 (30%) dogs; nonspecific skin allergies and dermatitis were most common ($n = 39$ [15%]). Other integumentary problems included ear problems ($n = 29$ [11%]), masses (8 [3%]), mange (5 [2%]), and miscellaneous skin problems (9 [3%]). A difference between age groups was not reported for overall incidence or incidence of specific integumentary system problems.

Musculoskeletal problems were seen in 21 (8%) dogs. Mild hip dysplasia that did not require surgical management or prolonged medical management was reported in 6 dogs, whereas 1 dog had more severe hip dysplasia that required long-term intermittent medical management. Other musculoskeletal problems included undiagnosed lameness ($n = 6$ [2%]) and miscellaneous disorders (8 [3%]). A difference between age groups was not reported for overall incidence of musculoskeletal system problems or incidence of hip dysplasia.

Twelve (5%) dogs had gastrointestinal tract problems. Most problems were minor and consisted of intermittent vomiting, diarrhea, or both. One dog had dental disease, diarrhea of parasitic origin, and salivary mucocele. Intermittent vomiting or diarrhea generally developed long after adoption and thus were not likely associated with shelter-related infectious disease outbreaks. Group-1 dogs had more gastrointestinal tract problems than did group-2 dogs ($P = 0.001$); this finding was attributed to a high incidence of gastrointestinal tract problems in group-1 dogs from shelter 1 ($P = 0.001$).

Urinary problems were identified in 6 (2%) dogs. Three dogs developed urinary incontinence; 2 of these dogs were in group 1, and 1 was in group 2. Of the 2 group-1 dogs, 1 dog presumably had estrogen-responsive urinary incontinence, whereas the other dog developed long-term incontinence after anesthesia and a dental cleaning procedure (urinary tract infection could not be identified). The group-2 dog developed incontinence after ovariohysterectomy. This dog was mildly incontinent for 2 months, did not require medical treatment, and has not had a recurrence of this problem. Two dogs had single episodes of cystitis, whereas 1 dog had a single episode of azotemia of unknown cause. A difference was not detected between age groups for incidence of problems associated with the urinary system.

Neurologic, cardiopulmonary, and reproductive

problems also were identified. Significant differences were not detected between age groups for problems that involved any of these body systems. Neurologic problems were reported in 7 (3%) dogs, including seizures ($n = 4$ [2%]) and intervertebral disc problems (3 [1%]). Five (2%) dogs had heartworm disease. Reproductive problems were reported in 3 (1%) dogs, including 2 dogs (1 dog from each group) with single episodes of vaginitis and 1 dog with mammary neoplasia.

Miscellaneous problems (often traumatic in nature) were reported in 43 (16%) dogs, including vehicular accidents ($n = 7$ [3%]), lacerations (4 [2%]), poisonous snake bites (7 [3%]), bite wounds (4 [2%]), gunshot injuries (2 [1%]), and others. A difference was not detected between age groups for incidence of miscellaneous problems.

A difference was not detected between age groups for owner perception of their dog's body weight. Most (82%) owners judged their dog's body weight to be ideal, whereas 18% felt their dogs were overweight.

Discussion

Little scientific data exists to support recommendations regarding timing of gonadectomy in dogs. However, many veterinarians remain resistant to prepubertal gonadectomy because of concerns about short- and long-term outcomes.¹³⁻¹⁸ Many of these concerns have proven unfounded in short-term studies,^{4,6-9} but controlled long-term studies have been lacking.

This study examined dogs from a shelter environment that underwent either early or traditional age gonadectomy approximately 4 years after surgery. Problems that may occur later in a dog's life, such as neoplasia or degenerative joint disease, were beyond the scope of this study; however, problems in this shelter population related to retention rates in households, behavioral characteristics, and non-age-related problems associated with numerous body systems were evaluated.

Prepubertal gonadectomy was not associated with higher return rate or increased rate of placement in another home after adoption, compared with traditional-age gonadectomy. Behavioral problems and unpreparedness for pet ownership by adoptive owners were the most common reasons cited for return of dogs to shelters or placement in new homes.

Although most (73%) dogs developed a problem after adoption, dogs that underwent prepubertal gonadectomy had similar outcome to dogs that underwent traditional-age gonadectomy, except for infectious diseases. More dogs had major problems than had minor or traumatic problems. Most dogs had 1 to 3 problems, whereas few dogs had ≥ 4 problems.

Parvoviral enteritis was the most commonly reported infectious disease and was reported exclusively in dogs that underwent prepubertal gonadectomy. Parvoviral enteritis is common in puppies from shelter environments, but uncommon in older dogs. The potential influence of anesthesia and surgery on the incidence of parvoviral enteritis in puppies that underwent gonadectomy could not be determined in our study, because comparisons with puppies that did not undergo gonadectomy were not performed.

Interestingly, most puppies that developed parvoviral enteritis were adopted from the shelter with long holding periods, rather than from the shelter with short holding periods. This may reflect the euthanasia policy of each shelter; the shelter with the long holding periods attempted treatment of animals with infectious diseases, which may have caused increased risk of exposure for other puppies in the shelter. This is in contrast to the other shelter, which euthanizes dogs of a certain age group (and doesn't permit adoption of that age group) during infectious disease outbreaks.

Concerns that prepubertal gonadectomy would result in increased incidence of musculoskeletal disorders or hip dysplasia^{2,6} were not supported by results of the study reported here. It has been speculated that the increased length of time that growth plates remain open and the subsequent increased long bone growth (and decreased muscle mass, in absence of testosterone) seen in dogs neutered at an early age might predispose these dogs to hip dysplasia or angular limb deformities.^{2,6} Hip dysplasia was diagnosed infrequently in dogs in our study, and of those that were affected, most dogs did not require medical or surgical treatment. No difference was seen between age groups in the incidence of hip dysplasia. Angular limb deformities were not observed in dogs in our study.

Gastrointestinal tract problems were reported more commonly in dogs that had undergone traditional-age gonadectomy. Most problems were minor and consisted of mild vomiting, diarrhea, or both. Cause of this increased incidence was undetermined, but may reflect unidentified dietary or environmental differences between age groups and shelters.

It has been suggested that prepubertal gonadectomy may result in increased incidence of urinary incontinence in female dogs, because of the lack of estrogenic influence on the urinary tract.^{2,15,18} Results of our study indicate that female dogs that undergo prepubertal gonadectomy are not more likely to develop urinary incontinence than are dogs that undergo traditional age-gonadectomy, during the first 4 years after gonadectomy. Only 3 dogs in our study developed incontinence. Interestingly, only 1 dog (traditional-age gonadectomy) had a history consistent with estrogen-responsive urinary incontinence.

Prepubertal gonadectomy was not associated with problems associated with integumentary, neurologic, cardiopulmonary, or reproductive systems. Dermatitis and ear problems were the most common integumentary problems, reflecting common types of skin problems encountered in routine veterinary practice. Neurologic problems seen in our study also reflected commonly encountered neurologic problems and included seizures and intervertebral disc disease. All dogs with cardiopulmonary disorders had heartworm disease. Not surprisingly, problems associated with the reproductive system were uncommon. Although concern has been expressed that prepubertal gonadectomy would result in increased incidence of vaginitis,^{14,15} results of our study do not support such a concern, because only 1 dog in each age group was affected. In

both of these dogs, vaginitis responded to short-term antimicrobial treatment and did not recur.

Miscellaneous problems were often traumatic in nature. Prepubertal gonadectomy was not associated with incidence of miscellaneous problems. The high incidence of injuries in free-roaming dogs emphasizes the health benefits of maintaining dogs in confined environments.

Most owners assessed their dog's body weight as ideal. Prepubertal gonadectomy was not associated with obesity as perceived by the owner; however, owner perception of a pet's body weight may often be suspect.

Prepubertal gonadectomy can be safely performed without any increased risk of problems or complications during anesthesia, surgery, and the first week after surgery.⁴ Results of the study reported here indicate that prepubertal gonadectomy is not associated with increased problems associated with behavior or any body system, compared with traditional-age gonadectomy, during the first 4 years after surgery. Dogs that underwent prepubertal gonadectomy in our study were more likely to develop infectious diseases, particularly parvoviral enteritis. We did not determine whether prepubertal gonadectomy was associated with increased incidence of infectious diseases, compared with that observed in shelter puppies that did not undergo gonadectomy. Rate of retention in the original adoptive household in dogs that underwent prepubertal gonadectomy was similar to that of dogs that underwent traditional-age gonadectomy. Lastly, after adoption, no difference was observed in outcome related to physical or behavioral problems between a shelter with long holding periods and one with short holding periods.

^aAvailable from first author upon request.

^bBMDP, Version 7.0, BMDP Statistical Software Inc, Los Angeles, Calif.

^cStatistix, Version 4.1, Analytical Software, Tallahassee, Fla.

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Correction: Long-term outcome of gonadectomy performed at an early age or at traditional age in cats

In “Long-term outcome of gonadectomy performed at an early age or at traditional age in cats” (*JAVMA*, Vol 217, pp 1661-1665), the first sentence in the seventh complete paragraph on page 1664 should read, “Most behavioral problems were minor in nature; however, several cats were judged to have major behavioral problems, including destructive behavior (damaging furniture, carpet, or walls) and inappropriate elimination (spraying or other inappropriate urination).”