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

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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 cats.

Design—Cohort study.

Animals—263 cats from animal shelters.

Procedure—Cats 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 cats after adoption. Follow-up information was obtained from attending veterinarians for cats with complex problems or when owners were uncertain regarding the exact nature of their cat's problem.

Results—Compared with traditional-age gonadectomy, prepubertal gonadectomy did not result in an increased incidence of infectious disease, behavioral problems, or problems associated with any body system during a median follow-up period of 37 months. Additionally, the rate of retention in the original adoptive household was the same for cats that underwent prepubertal gonadectomy as those that underwent traditional-age gonadectomy.

Conclusions and Clinical Relevance—Prepubertal gonadectomy may be performed safely in cats without concern for increased incidence of physical or behavioral problems for at least a 3-year period after gonadectomy. (*J Am Vet Med Assoc* 2000;217: 1661–1665)

Pet overpopulation continues to be a serious problem in the United States. In 1990 it was estimated that approximately 11 to 19 million animals were euthanized in US animal shelters.[1] Additionally, many unwanted animals die from exposure, starvation, or trauma each year.[2] Although many humane organizations now require mandatory neutering of all companion animals after adoption, owner compliance with these programs is estimated to be < 60%.[3,4] To increase the effectiveness of population control measures, many humane organizations and veterinarians have promoted prepubertal gonadectomy (neutering well before the onset of puberty and prior to adoption).[5-12] Prepubertal gonadectomy of humane shelter animals may result in nearly 100% neutering compliance rates, fewer returned animals, and improved staff morale.[3]

In 1993, the AVMA House of Delegates approved Resolution 6, which stated: "Resolved, that AVMA supports the concept of early (8 to 16 weeks of age) ovariohysterectomies/gonadectomies in dogs and cats in an effort to stem the overpopulation problem in these species."[13] Despite the passage of this resolution, acceptance of prepubertal gonadectomy by veterinarians has been slow, in part, because of concerns about anesthesia, urethral obstruction in male cats, potential behavioral abnormalities, and obesity.[14-20] Short-term results (7 days) and complications of prepubertal gonadectomy in nearly 2,000 cats and dogs have been reported.[5] In that study, animals were allocated into 3 groups on the basis of estimated age: < 12 weeks old (prepubertal), 12 to 23 weeks old (prepubertal), and ≥ 24 weeks old (traditional age). Prepubertal gonadectomy did not result in increased short-term morbidity or mortality in cats, compared with traditional-age gonadectomy. Prepubertal gonadectomy in cats was concluded to be safe. Results of other clinical and experimental studies also do not indicate that increased morbidity or mortality is associated with prepubertal gonadectomy on a short-term basis[6-8,10,12]; however, to the authors' knowledge, long-term studies with large numbers of animals and reference (or control) populations have not been reported.

Objectives of the long-term study of animal shelter cats reported here were to compare effects of prepubertal and traditional-age gonadectomy on incidence of infectious diseases, retention in the original adoptive household, and long-term differences in physical, behavioral, and health-related problems. Findings were also compared between cats in a limited-admission shelter and those in a shelter with a short holding period.

Materials and Methods

Cats—Cats included in the study were from 2 humane organizations and underwent ovariohysterectomy and castration in association with the fourth-year surgical teaching program at Texas A&M University during the first 28 months (July 1994 through October 1996) that a prepubertal gonadectomy program was in operation. Shelter 1 accepted only owner-surrendered animals, had a long holding period, and did not euthanatize animals after they had entered the shelter. Shelter 2 performed animal control in the region, had a short holding period, and euthanatized animals that were not adopted within a stated period of time. These

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cats formed the study group in a previous report.[5] Cats were allocated into 2 groups on the basis of age, which was estimated by evaluation of dentition,[21] size, body weight, and date of birth (when available). Group-1 (traditional-age) cats were ≥ 24 weeks of age, and group-2 (prepubertal) cats were < 24 weeks of age.

Study design—Client information was recorded from the humane organization records for each cat that was adopted. Owners were contacted by telephone no earlier than 30 months after surgery (range, 30 to 58 months). At least 5 attempts were made at various times during the day, evening, and weekends to contact owners for which addresses or phone numbers could be located. Owners were asked questions from a standardized questionnaire[a] to evaluate cats for incidence of infectious diseases, retention in the original adoptive household, physical status of all body systems, and behavioral status. If an owner gave a specific name and description (including treatment) of a medical condition for which their cat had been treated by a veterinarian that were consistent with the clinical signs the cat had at that time, the cat's veterinarian was not contacted. The attending veterinarian was 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 cat's physical or environmental status (eg, onychectomy or removal from the household or to the outdoors, respectively) were considered major problems. Examples of major problems included destructive behavior resulting in onychectomy, inappropriate elimination resulting in return to the shelter or placement of the cat outdoors or in another home, and liver problems. If urinary tract disease was identified as contributing to inappropriate urination (ie, cats ceased inappropriate urination when the urinary tract disease was treated), the problem was classified as a urinary system problem rather than a behavioral problem. 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 shyness, skin allergies, single episodes of infection of the upper portions of the respiratory tract or cystitis, and behavioral problems that did not jeopardize the cat's standing in the household. Cats with signs of urinary tract infection were treated with antimicrobials (in addition to dietary modifications) without urinalysis or bacteriologic culture of urine. Because bacterial infection could not be confirmed, all urinary tract infections reported by owners and veterinarians were listed as cystitis to reflect the fact that cystitis may be aseptic. Traumatic problems resulted from traumatic incidents or poisoning and included vehicular accidents and injuries from fighting, being struck by an automobile engine fan, and gunshot. Cats that died, did not return home, or were returned to the shelter within 1 month of adoption were not included in the subsequent analysis other than to list the problems that led to death or removal from the household.

Statistical analyses—Statistical programs were used for all analyses.[b,c] Distribution of responses to survey questions were described by use of proportions and 95% confidence intervals. Summaries for each body system and incidence of the most commonly cited health problems were described similarly. Mantel-Haenszel χ^2 analysis was used to compare incidence of health problems between prepubertal and traditional age groups stratified by shelter. When differences were detected between shelters for a certain variable, the 2-tailed Fisher exact test was used to determine significance. Differences were considered significant at $P \leq 0.05$.

Results

Follow-up information was obtained for 263 of 693 (38%) cats that underwent gonadectomy and were adopted during the study period. The remainder of these cats were lost to follow-up and were not included in the study. An additional 214 cats underwent gonadectomy during the study period but were not adopted and were not included in the study. Internet resources were useful in locating 7 (3%) individuals who had moved since adopting their cat. Five owners declined to participate in the study.

There were 75 cats in group 1 and 188 cats in group 2. Mean ± SD age of cats at the time of gonadectomy was greater ($P < 0.001$) for group-1 cats than for group-2 cats (group 1, 56.8 ± 53.1 weeks [median, 51 weeks; range, 24 to 390 weeks]; group 2, 10.5 ± 3.7 weeks [median, 9 weeks; range, 6 to 22 weeks]).

There were 155 (59%) cats with follow-up data from shelter 1 and 108 (41%) cats from shelter 2. Shelter 1 had 31 group-1 and 124 group-2 cats; 85 (55%) cats were female and 70 (45%) were male. Shelter 2 had 44 group-1 cats and 64 group-2 cats; 70 (65%) cats were female, and 38 (35%) were male. When shelters were combined, 75 cats were in group 1, and 188 cats were in group 2; 155 cats were female, and 108 were male. Distribution of sexes between groups was not different between shelters.

Mean and median follow-up times (length of time from gonadectomy to owner contact or death or loss of cat) did not differ between shelters (shelter 1, 38 ± 8.6 months [median, 38 months]; shelter 2, 36.8 ± 8.9 months [median, 37 months]). Mean and median follow-up times did not differ between groups when shelter data were combined (group 1, 38.3 ± 10.2 months [median, 39 months]; group 2, 37.1 ± 8.0 months [median, 36 months]).

Differences were not detected between age groups for incidence of cats being returned to a shelter; overall, 7 (3%) cats were returned to a shelter. Two cats were returned to a shelter because of owner allergies, 2 because of inappropriate elimination, 1 because of aggression, 1 because of FeLV infection, and 1 because

of fleas. Most cats (n = 228; 87%) were still alive at follow-up, although several cats had died or been euthanatized (20; 7%) or failed to return home (8; 3%). Of the cats that were no longer alive, 5 were involved in vehicular accidents, 3 died from infectious diseases, 2 from poisonings, 5 from miscellaneous traumatic incidents, 1 from pulmonary mycosis, and 4 from unidentified causes. A difference was not detected between age groups in the number of cats alive or dead at time of owner contact. More cats in both age groups died from traumatic incidents than from medical causes, and a difference in incidence of traumatic or medical deaths was not detected between age groups.

Overall, owners assessed 181 (69%) cats as having experienced a problem since adoption (group 1, n = 58 [77%]; group 2, 123 [65%]). When classified by severity and type, 71 (27%) cats (group 1, 27 [36%]; group 2, 44 [23%]) had a major medical or surgical problem, 74 (28%) cats (group 1, 23 [31%]; group 2, 51 [27%]) had a minor problem, and 36 (14%) cats (group 1, 8 [11%]; group 2, 28 cats [15%]) had a traumatic incident or failed to return home. Most cats had only 1 problem (group 1, n = 35 [47%]; group 2, 81 [43%]). Several cats from both groups had 2 or 3 problems (group 1, n = 21 [28%]; group 2, 41 [22%]), whereas few cats had 4 or more problems (group 1, 2 [3%]; group 2, 1 [0.5%]). A difference was not detected in overall incidence of problems between age groups. A difference was not detected between age groups for problem severity or type or number of problems.

Infectious diseases affected 21 (8.0%) cats; infections of the upper portions of the respiratory tract were seen in 12 (5%) cats. Miscellaneous infectious diseases also were reported in 3% of cats and included feline leukemia (n = 3), feline immunodeficiency virus infection (1), viral enteritis (3), feline infectious peritonitis (1), and diarrhea caused by spirochetes (1). Differences between age groups were not detected for incidence of infectious diseases, infections of the upper portions of the respiratory tract, or miscellaneous infectious diseases.

The most common problems reported in cats of both groups were behavioral in nature. Overall, 75 (29%) cats (group 1, n = 26 [35%]; group 2, 49 [26%]) had at least 1 behavioral problem, with the most common major problems being destructive behavior (23) and inappropriate elimination (17). Miscellaneous behavioral problems were also reported, including aggression toward people (n = 9), shyness (19), psychogenic alopecia (4), fighting (3), fear of outdoors or people (3), nervousness (3), pica (1), and psychotic behavior (1). Differences between age groups were not detected in the incidence of overall behavioral problems, destructive behavior, inappropriate elimination, or other miscellaneous behavioral problems.

Problems associated with the urinary system were reported in 17 (7%) cats, with cystitis being most common (n = 11 [4%]). Overall (combined shelter data), group-1 cats had more urinary system problems than group-2 cats ($P = 0.004$). Older cats at shelter 2 had more urinary problems overall ($P = 0.003$) and cystitis ($P = 0.041$) than did younger cats. Similar age differences for these variables were not detected in cats at shelter 1. Cystitis was reported commonly in cats of both sexes. Group 1 had 4 female and 3 male cats with cystitis, and group 2 had 2 cats of each sex with cystitis. Differences between age groups were not detected for the incidence of obstruction or other miscellaneous urinary tract problems. Only 2 of 38 (5%) male cats in group 1 had obstructive episodes, whereas 0 of 70 (0%) group-2 cats had an obstructive episode. One obstructive episode was reported in a cat neutered at 1 year of age, whereas 3 episodes were reported in a cat neutered at 6 months of age. Miscellaneous urinary tract problems included urinary calculi (n = 3) and renal failure (1).

Problems were also identified in the integumentary, gastrointestinal, musculoskeletal, and cardiopulmonary systems. Differences between age groups were not detected in any of these body systems. Skin problems were reported in 42 (16%) cats but were usually minor and included ear mite infections (n = 20), ear infections from causes other than ear mites (4), aural hematoma (1), minor skin allergies (10), anal sac impaction (2), abscess (1), *Cuterebra* sp infection (1), benign skin tumor (1), localized ringworm infection (1), and minor hair loss (1). Gastrointestinal tract problems were reported in 21 (8%) cats, whereas 8 (3%) cats had musculoskeletal problems, and 8 (3%) cats had cardiopulmonary problems. Gastrointestinal tract problems included diarrhea (n = 5), vomiting (4), regurgitation (3), liver problems (4), dental calculus (3), gingivitis (1), and megaesophagus (1). Most gastrointestinal tract problems were minor in nature; however, liver problems (n = 4), chronic vomiting (1), chronic regurgitation (1), megaesophagus (1), and recurrent dental calculus (1) were considered major. Musculoskeletal problems were generally minor and consisted of transient lameness (n = 5) for which a diagnosis was not achieved. Major musculoskeletal problems included fractures (n = 2), and recurrent patellar luxation (1). Cardiopulmonary problems included heartworm disease (n = 2), asthma (2), and others (4). Neither neurologic nor reproductive problems were reported.

Other miscellaneous problems were reported in 57 (22%) cats, and many were caused by traumatic incidents (n = 43), poisonings (3), or miscellaneous medical problems (11). Miscellaneous traumatic incidents included vehicular accidents (n = 9), injuries from fights with other animals (11), corneal scratches (3), gunshot injuries (2), injuries from automobile engine fans (2), traumatic tail amputation (2), cranial trauma after falling through the slats in a fence (1), and others (13). Other miscellaneous medical problems were reported, including parasite infestations (n = 3), facial twitch (1), vaccine reaction (1), systemic mycosis (1), infection associated with neutering (1), diabetes mellitus (1), and others (3).

A difference between age groups was not detected in owner perception of their cat's body weight. Most owners (84%) judged their cat's body weight to be ideal, whereas 14% believed their cats were overweight, and 2% believed their cats were underweight.

Discussion

Pet overpopulation continues to be a substantial problem in the United States. Because all methods of pet birth control involve veterinarians, they play a crit-

ical role in battling pet overpopulation. Although many methods of pet birth control have been examined, gonadectomy remains the mainstay.

Although there are few scientific reports to support recommendations regarding the ideal time to neuter cats, many veterinarians remain resistant to prepubertal gonadectomy in companion animals. Concerns include potential for surgical and anesthetic complications, stunted growth, vaginitis, perivulvar dermatitis, urethral obstruction in male cats, urinary incontinence, impaired immunocompetence, obesity, and dermatologic, endocrine, cardiac, and behavioral abnormalities.[14-20] Many of these concerns have been proven unfounded by results of short-term studies, but controlled long-term studies have been lacking.

Our study was designed to provide long-term information regarding all body systems and behavioral characteristics in shelter cats that underwent prepubertal gonadectomy, compared with shelter cats that underwent gonadectomy at a traditional age. Although 3 years (follow-up time for cats in our study) certainly does not reflect the typical lifespan of a cat, it does permit evaluation of a substantial portion of a cat's life. Certain problems that may develop later in a cat's life, such as neoplasia, were beyond the scope of this study; however, problems related to infectious diseases, retention rates in households, behavioral characteristics, and non–age-related problems associated with numerous body systems, including the urinary system, were evaluated.

Follow-up was obtained in a moderate number (38%) of cats that underwent surgery during the study period. Although a higher follow-up rate was desirable, many adoptive owners could not be located or contacted.

Prepubertal gonadectomy did not affect retention rate in the original adoptive household or result in an increased rate of return to a shelter after adoption, compared with traditional-age gonadectomy. Of the 7 cats returned to a shelter, 4 were returned because of animal-associated problems, and 3 were returned because of owner-associated problems. Inappropriate elimination (n = 2) and owner allergies (2) were the most common reasons cited for returning cats to shelters.

In our study, both gonadectomy groups had similar rates, type, and severity of problems. Although most (69%) cats developed a problem after adoption, outcome for cats that underwent prepubertal gonadectomy was similar to that of cats that underwent gonadectomy at a traditional age.

Infections that involved the upper portions of the respiratory tract were the most commonly reported infectious disease; however, prepubertal gonadectomy did not result in an increased incidence of infectious diseases after adoption, compared with traditional-age gonadectomy. Infections of the upper portions of the respiratory tract in cats from shelters are common and may result in return of the cat to the shelter or owner dissatisfaction. Most adoptive cat owners in our study whose pets developed infectious diseases kept their cat and obtained veterinary care.

Most behavioral problems were minor in nature; however, 5 cats were judged to have major behavioral problems, including destructive behavior (damaging furniture, carpet, or walls) and inappropriate elimination (spraying or other inappropriate urination). Many of these behavioral problems resulted in onychectomy, or change to an outdoor environment, which probably put cats at further risk for injury or illness. Prepubertal gonadectomy did not result in increased behavioral problems, compared with those observed after traditional-age gonadectomy.

Concerns that prepubertal gonadectomy would result in increased incidence of feline **idiopathic lower urinary tract disease (ILUD)** and potential urethral obstruction in male cats were not supported by results of our study. Cats that were neutered at the traditional age appeared to be at increased risk for urinary tract problems (including cystitis), as indicated by a highly significant difference between age groups in shelter-2 cats. Reasons for this increased risk of urinary tract problems were not determined; however, unidentified differences in environments or diets may have played a role. Results of experimental and clinical studies implicate calicivirus, feline syncytia-forming virus, and a gamma herpesvirus (bovine herpesvirus 4) as potential causes of ILUD in some cats.[22] If a virus is involved in ILUD, removal of reproductive hormones via gonadectomy before puberty could possibly affect viral manifestation in some way and account for differences between age groups in incidence of urinary problems. Finally, gonadectomy at an early age may result in some other unidentified protective effect on the urinary tract. Although the increased incidence of urinary tract problems in cats that were neutered at the traditional age remains unexplained, concerns regarding increased incidence of urethral obstruction in male cats that were neutered before puberty are unfounded within 3 years of surgery. Only 2 male cats developed urethral obstruction, and both cats were in the traditional-age gonadectomy group. None of the 70 males that underwent prepubertal neutering had obstructive episodes. Because ILUD is most commonly recognized in young to middle-aged adult cats,[23] studies of longer duration are unlikely to yield different results.

Prepubertal gonadectomy did not affect problems associated with integumentary, gastrointestinal, musculoskeletal, or cardiopulmonary systems. Ear problems accounted for most integumentary problems; ear mite infestation was most common. Most musculoskeletal disorders involved mild lameness that was self-limiting and of undetermined cause. Miscellaneous cardiopulmonary disorders were seen, including 2 cats with heartworm disease.

Miscellaneous problems were often traumatic in nature. Prepubertal gonadectomy had no effect on the incidence of miscellaneous problems. The high incidence of injuries received by cats while outdoors emphasizes the health benefits of maintaining cats in completely indoor environments.

Most cat owners assessed their cat's body weight as ideal. Prepuberal gonadectomy had no effect on obesity (as perceived by the owner); however, owner perception of a pet's body weight may often be suspect. Additionally, perception of body weight gives no information regarding attaining or exceeding genetic size or weight potential.

Prepubertal gonadectomy can be safely performed

without increased risk of problems or complications during anesthesia, surgery, and the first week after surgery.[5] Results of our study indicate that prepubertal gonadectomy does not result in increased problems associated with behavior or any body system, compared with traditional-age gonadectomy, for as long as 3 years after surgery. Results of our study also suggest that prepubertal gonadectomy may result in some unidentified protective effect on the urinary tract, compared with traditional-age gonadectomy in some cats. Furthermore, increased incidence of infectious diseases or a difference in the rate of retention in the original adoptive household in cats that underwent prepubertal gonadectomy was not detected. Finally, differences between cats obtained from shelters with long holding periods, and cats obtained from shelters with short holding periods are not expected for outcomes related to physical or behavioral problems of cats that undergo prepubertal gonadectomy.

[a]Survey available on request from authors.
[b]BMDP, version 7.0, BMDP Statistical Software Inc, Los Angeles, Calif.
[c]Statistix, version 4.1, Analytical Software, Tallahassee, Fla.

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