



For Active Dogs!

Brought to you by Canine Sports Productions

Coaching dog enthusiasts to embrace the unique needs of active dogs through teaching, mentoring and educational media

Spay-Neuter Considerations in Light of Recent Evidence: One Veterinarian's Opinion

© 2016 Chris Zink DVM, PhD, DACVP, DACVSMR, CCRT, CVSMT, CVA

Canine Sports Productions - www.caninesports.com



Those of us with responsibility for the health of dogs need to continually read and evaluate new scientific studies to ensure that we are taking the most appropriate care of our canine companions. This article reviews scientific evidence that, taken together, suggests that veterinarians and dog owners should revisit the current common recommendation that all dogs that are not intended for breeding have their gonads removed at or before 6 months of age. The results of a number of studies on the effects of removal of the ovary or testicles (gonadectomy) on orthopedics, cancer, behavior, and other health issues are briefly summarized.

Orthopedic Considerations

- Bitches spayed at 7 weeks had significantly **delayed closure of growth plates** as compared to those spayed at 7 months, and those spayed at 7 months had significantly delayed closure of growth plates as compared to those left intact.(1)
- In a study of 1444 Golden Retrievers, bitches and dogs spayed or neutered at less than a year of age were **significantly taller** than those spayed or neutered after a year of age.(2)
- In a study of 203 agility dogs, the author demonstrated that the **tibia and the radius & ulna were significantly longer** than the femur and humerus, respectively, in dogs that were spayed or neutered at or prior to 8 months of age as compared to intact dogs.(C. Zink, unpublished data)
- Several studies have shown that spayed and neutered dogs have a significantly higher prevalence of **CCL rupture** (3–6), even when controlling for body size.(3)
- In a study of 759 male and female Golden Retrievers neutered or spayed before 6 months of age, the incidences of **CCL rupture** were 5 and 8 percent respectively, compared to no CCL rupture diagnosed in intact males and females.(7)
- Dogs that were neutered at least 6 months prior to a diagnosis of **hip dysplasia** were 1.5 times more likely to develop hip dysplasia than sexually intact dogs.(8)
- Spayed/neutered dogs had 3.1 times higher incidence of **patellar luxation**.(9)
- In Labrador Retrievers and Golden Retrievers, neutering before 6 months of age increased the incidence of one or more **joint disorders** by 2x and 4 to 5x, respectively.(10)
- In a study of 1170 German Shepherd Dogs, followed through 8 years of age, 21% of neutered males and 16% of spayed females were diagnosed with one or more **joint disorders** compared with 7% of intact males and 5% of intact females (11).

Discussion: Dogs that have been spayed or neutered at or before puberty can often be identified by their longer limbs, lighter bone structure, narrower chests and narrower skulls than intact dogs of the same breed. This differential growth frequently results in significant alterations in body proportions and particularly the lengths (and therefore weights) of certain bones relative to others. For example, if the femur has achieved its genetically determined normal length at 8 months, prior to a dog being spayed or neutered, but the tibia (which normally stops growing at 12 to 14 months of age) continues to elongate for several months after that point because of the removal of the sex hormones (which contribute to growth plate closure), then the relationship between the femur and tibia will be different than what was genetically determined. This may result in an abnormal angle at the stifle

and a longer (and therefore heavier) tibia placing increased stress on the cranial cruciate ligament (of the knee or stifle joint). It is well known that spayed and neutered dogs are more likely to be overweight or obese than sexually intact dogs (12), and this can be an additional contributing factor to orthopedic diseases. Thus, keeping spayed/neutered dogs lean can help mitigate the increased risk of orthopedic conditions.

Cancer Considerations

- Spayed females had more than 5 times greater risk than intact bitches of developing **cardiac hemangiosarcoma** and neutered males had 1.6 times higher risk than intact males had of developing cardiac hemangiosarcoma.(13)
- Spayed females had 2.2 times increased risk for developing **splenic hemangiosarcoma**.(14)
- Male and female Rottweilers that were neutered or spayed before a year of age had 3.8 and 3.1 times greater risk, respectively, of developing **bone cancer** than intact dogs.(15) In a second study, spayed/neutered dogs had a 2.2 times higher risk of developing bone cancer than intact dogs.(16)
- Neutered dogs had a 2.8 times greater risk for developing **prostate cancer** than intact dogs.(17) Neutered dogs had a 4.3 times higher risk of developing prostate carcinoma.(18, 19)
- Neutered dogs had a 3.6 higher risk for developing **transitional cell carcinoma** of the bladder than intact dogs, and a 3 times greater risk of developing any **bladder tumor**.(17) Spayed/neutered dogs had more than 4 times greater risk for developing transitional cell carcinoma of the bladder than intact dogs.(20)
- Early neutered male Golden Retrievers were 3x more likely to be diagnosed with **lymphosarcoma** than intact males, and late-spayed females were significantly more likely to develop **hemangiosarcoma** and **mast cell tumor** than intact females.(7)
- In a survey of 2505 Vizslas, dogs spayed or neutered dogs at any age were found to have a significantly higher risk of **mast cell cancer**, **hemangiosarcoma**, **lymphoma** and **all cancers** together than intact dogs.(21)
- Female Labrador Retrievers spayed between 2 and 8 years of age were shown to have a significantly increased prevalence of **mast cell cancer**, **hemangiosarcoma**, and **lymphoma**.(10)

Discussion: One study indicated a slightly increased risk of mammary cancer in female dogs after one heat cycle (8% increase), greater risk with two heats (26% increase) and increased risk with each subsequent heat.(22) However, a recent systematic review of the publications that advocate neutering to reduce the risk of mammary tumors in dogs indicated that 9 of 13 reports had a high risk of bias and the remaining 4 had a moderate risk of bias. (23) This study concluded that the evidence that neutering reduces the risk of mammary cancer is weak and do not constitute a sound basis for firm recommendations. Additionally, at the time when several of these studies were conducted (late 1960s), incidence rates for all malignant neoplasms were 453.4/100,000 female dogs. Mammary tumors accounted for half of these tumors, or 198.8/100,000. Thus, the actual overall risk at that time of any bitch getting a mammary tumor was only 0.2%.(24) In any case, the figures for increased risk of mammary cancer must be compared with the 200 to 400% increased risk of other cancers in spayed females. While about 30% of mammary cancers are malignant (25), as in humans, when caught and surgically removed early, the prognosis is very good.(26) This is in comparison to the other cancers listed, such as hemangiosarcoma, lymphosarcoma and bladder cancer, which are usually fatal. Given the balance of cancer risks listed above, owners of bitches should strongly consider having a hysterectomy (ovary-sparing spay) performed rather than an ovariectomy, thus providing while retaining the benefits of the female hormones. In addition, the veterinary field should be developing programs for regular examinations including imaging to facilitate early diagnosis of mammary cancer in all intact female dogs, as has been performed in women for decades.

Behavior Considerations

- Early age gonadectomy was associated with an increased incidence of **noise phobias and undesirable sexual behaviors**, such as mounting.(27)
- Significantly more behavioral problems in spayed and neutered bitches and dogs, with fearful behavior being most common in spayed bitches and **aggression** in neutered dogs.(28, 29)
- In a prospective study, German Shepherd Dogs spayed between 5-10 months of age had significantly increased **reactivity**.(30)

Discussion: A number of the early studies claiming to show positive behavioral effects of spay/neuter were significantly flawed. For example, one of the most often quoted publications to support improvements in behavior, particularly aggression, after gonadectomy does not actually provide any statistical analysis. Additionally, 88% of owners of dogs in this study stated that their reason for castrating the dog was to attempt to resolve an existing behavior problem. Owners were also surveyed regarding the dog's behavior a mean of 27 months post-castration. These factors likely introduced a significant amount of bias.(31) Another performed statistical analysis but showed that the age when the dog was neutered was not correlated with the degree of improvement.(32) Most critically,

neither of these two studies included a control group of intact dogs. One of the more important undesirable behavioral effects of spay/neuter for canine athletes was a finding of a significantly lowered energy level. This was shown in a study that was well controlled and examined over 3500 dogs.(29)

Other Health Considerations

- *Female, and sometimes male, dogs that are spayed/neutered before puberty have an increased risk of urinary incontinence and it is more severe in bitches spayed earlier.(33-36)*
- *Spayed female dogs displayed a significantly higher risk of hypothyroidism when compared to intact females.(37) A health survey of several thousand Golden Retrievers showed that spayed or neutered dogs were more likely to develop hypothyroidism.(2) Neutered male and spayed female dogs had higher relative risks of developing hypothyroidism than intact females.(38)*
- *Neutered females had a 22 times increased risk of developing fatal acute pancreatitis as compared to intact females.(39)*
- *Risk of adverse reactions to vaccines is 27 to 38% greater in neutered dogs as compared to intact.(40)*
- *In a study of female Rottweilers there was a strong positive association between retention of the ovaries and longevity.(41)*

Summary

I have gathered these studies to show that the veterinary practice of recommending that every dog not meant for breeding have its gonads removed at or before the age of 6 months is not a black-and-white issue. Clearly more studies need to be undertaken to evaluate the effects of spaying and neutering, and in particular to investigate non-gonadectomy alternatives to prevent procreation such as vasectomy and hysterectomy. After examining the risks and benefits, I have significant concerns with removal of the gonads in both males and females. It is clear that the gonads are not just important for reproduction, but play a critical role in growth, development and long-term health. One study showed that spayed bitches had 30x higher levels of luteinizing hormone than intact bitches (42), and given that this hormone has receptors on diverse tissues throughout the body (43), it is possible that the lack of a feedback loop for this hormone might contribute to some of the negative effects of gonadectomy, at least in females.

Preventing Procreation

If we leave the gonads intact, how can we prevent the production of unwanted dogs? For **males**, it is relatively easy to perform a vasectomy. One possible disadvantage is that vasectomy does not prevent some unwanted behaviors associated with males such as marking and humping. On the other hand, females and neutered males frequently participate in these behaviors too. Training is the most effective solution to these behaviors. Another potential issue is finding a veterinarian who can perform the procedure. Veterinary schools do not currently teach students how to perform vasectomies. However, the methodology has been described and any veterinary surgeon can learn the technique.

In **females**, the issues are more complex, because having a bitch in heat is inconvenient and leaving the uterus intact substantially increases the risk of pyometra (a serious, potentially fatal uterine infection). One solution is to perform a hysterectomy (removal of the uterus), leaving the ovaries intact. Unfortunately, the effects of this technique on female dogs have never been carefully studied. There is some suggestion that these dogs might continue to ovulate and perhaps show behavioral changes, vulvar swelling and in some cases a minor discharge. Further, dogs that have this surgery will have intact ovaries, so veterinarians would need to establish an effective monitoring system for early detection of mammary cancer in intact bitches, as is available for women. In addition, there is the possibility of the dog developing stump pyometra if small amounts of uterine tissue are left behind during the hysterectomy. It is to be hoped that the effects of this technique will be appropriately studied to answer some of these questions.

For **males with retained testicles**, there is a logical solution, based on fact. A large prospective study showed that the incidence of testicular cancer in cryptorchid dogs was 12.7/1000 dog-years at risk.(44) In other words, if 100 dogs with retained testicles live to be 10 years old, approximately 13 of them will develop cancer in the retained testicle. The average age at which tumors develop in an undescended testes is 8.7 years.(45) These tumors are commonly benign, though they can grow quite large. Based on this study, I recommend that dogs with retained testicles undergo ultrasound examination every two years to determine whether a tumor is developing in the retained testicle(s). If a tumor is detected, which will happen in a minority of dogs, it can be removed at that time. In addition, dogs with one retained testicle should undergo a vasectomy on the remaining spermatic cord. This solution allows the dog to have the benefit of its sex hormones, but prevents passing this likely genetic condition on to offspring.

Most of all, it is important that we assess each dog and its living situation individually, weighing the risks and

benefits of removal of the gonads. *There is no single solution that fits every dog.*



Acknowledgment: The author is grateful for excellent in-depth discussions with Samra Zelman on the literature regarding spaying and neutering and for her careful review of this article.

References

1. Salmeri KR, Bloomberg MS, Scruggs SL, Shille V. Gonadectomy in immature dogs: effects on skeletal, physical, and behavioral development. *JAVMA* 1991;198:1193-1203.
2. Glickman L, Glickman N, Thorpe R. The Golden Retriever Club of America National Health Survey 1998-1999. <http://www.grca.org/healthsurvey.pdf>
3. Slauterbeck JR, Pankratz K, Xu KT, Bozeman SC, Hardy DM. Canine ovariohysterectomy and orchiectomy increases the prevalence of ACL injury. *Clin Orthop Relat Res.* 2004;(429):301-5.
4. Whitehair JG, Vasseur PB, Willits NH. Epidemiology of cranial cruciate ligament rupture in dogs. *JAVMA* 1993;203:1016-1019.
5. Duerr FM, Duncan CG, Savicky RS, Park RD, Egger EL, Palmer RH. Risk factors for excessive tibial plateau angle in large-breed dogs with cranial cruciate ligament disease. *JAVMA* 2007;231:1688-91.
6. Duval JM, Budsberg SC, Flo GL, Sammarco JL. Breed, sex, and body weight as risk factors for rupture of the cranial cruciate ligament in young dogs. *JAVMA* 1999;215:811-814.
7. Torres de la Riva G, Hart BL, Farver TB, Oberbauer AM, Messam LL, McC, Willits N, Hart LA. Neutering Dogs: Effects on Joint Disorders and Cancers in Golden Retrievers. *PLoS ONE* 2013;8:e55937
8. van Hagen MA, Ducro BJ, van den Broek J, Knol BW. Incidence, risk factors, and heritability estimates of hind limb lameness caused by hip dysplasia in a birth cohort of boxers. *Am J Vet Res* 2005;66:3071-2.
9. Vidoni B, Sommerfeld-Stur I, Eisenmenger E. Diagnostic and genetic aspects of patellar luxation in small and miniature breed dogs in Austria. *EJCAP* 2005;16:149-58.
10. Hart BL, Hart LA, Thigpen AP, Willits NH. Long-term health Effects of Neutering Dogs: Comparison of Labrador Retrievers with Golden Retrievers. *PLoS ONE.* 2014;9:e102241
11. Hart BL, Hart LA, Thigpen AP, Willits NH. Neutering of German Shepherd Dogs: associated joint disorders, cancers and urinary incontinence. *Veterinary Medicine and Science* 2016;2:191-199.
12. Lund, E. M., Armstrong, P. J., Kirk, C. A., Klausner, J. S. Prevalence and risk factors for obesity in adult dogs from private US veterinary practices. *Intern J Appl Res Vet med* 2006;2:177-86.
13. Ware WA, Hopper DL. Cardiac tumors in dogs: 1982-1995. *J Vet Intern Med* 1999 13(2):95-103.
14. Prymak C, McKee LJ, Goldschmidt MH, Glickman LT. Epidemiologic, clinical, pathologic, and prognostic characteristics of splenic hemangiosarcoma and splenic hematoma in dogs: 217 cases (1985). *JAVMA* 1988;193:706-12.
15. Cooley DM, Beranek BC, Schlittler DL, Glickman NW, Glickman LT, Waters D. Endogenous gonadal hormone exposure and bone sarcoma risk. *Cancer Epidemiol Biomarkers Prev.* 2002 11(11):1434-40.
16. Ru G, Terracini B, Glickman LT. Host related risk factors for canine osteosarcoma. *Vet J.* 1998 156(1):31-9.
17. Bryan JN, Keeler MR, Henry CJ, Bryan ME, Hahn AW, Caldwell CW. A population study of neutering status as a risk factor for canine prostate cancer. *Prostate* 2007;67:1174-81.
18. Teske E, Naan EC, van Dijk EM, Van Garderen E, Schalken JA. Canine prostate carcinoma: epidemiological evidence of an increased risk in castrated dogs. *Mol Cell Endocrinol* 2002;197:251-5.
19. Sorenmo KU, Goldschmidt M, Shofer F, Ferrocone J. Immunohistochemical characterization of canine prostatic carcinoma and correlation with castration status and castration time. *Vet Comparative Oncology.* 2003 Mar; 1 (1): 48.
20. Knapp DW, Glickman NW, Denicola DB, Bonney PL, Lin TL, Glickman LT. Naturally-occurring canine transitional cell carcinoma of the urinary bladder A relevant model of human invasive bladder cancer. *Urol Oncol* 2000;5:47-59.
21. Zink MC, Farhooody P, Elser SE, Ruffini LD, Gibbons TA, Rieger RH. Evaluation of the risk and age of onset of cancer and behavioral disorders in gonadectomized Vizslas *JAVMA* 2014;244:309-319.
22. Schneider R, Dorn CR, Taylor DO. Factors influencing canine mammary cancer development and postsurgical survival. *J Natl Cancer Inst* 1969;43:1249-61.
23. Beauvais W, Cardwell JM, Brodbelt DC. The effect of neutering on the risk of mammary tumours in dogs – a systematic review. *J Small Anim Pract* 2012;53:314-322.
24. Dorn CR, Taylor DO, Schneider R, Hibbard HH, Klauber MR. Survey of animal neoplasms in Alameda and Contra Costa Counties, California. II. Cancer morbidity in dogs and cats from Alameda County. *J Natl Cancer Inst.* 1968 Feb;40:307-18.
25. Misdorp W. Tumors of the Mammary Gland. In: Meuten DJ. *Tumors in Domestic Animals.* 4th Edn. Iowa State Press, Blackwell Publishing Company, Ames, Iowa, p. 575.
26. Lena L, De Andres PJ, Clemente M, Cuesta P, Perez-Alenza MD. Prognostic value of histological grading in noninflammatory canine mammary carcinomas in a prospective study with two-year follow-up: Relationship with clinical and histological characteristics. *Vet Pathol* 2012; June 11. [Epub ahead of print.]

27. Spain CV, Scarlett JM, Houpt KA. Long-term risks and benefits of early-age gonadectomy in dogs. *JAVMA* 2004;224:380-387.
28. Serpell JA. Measuring behavior and temperament in dogs. American Kennel Club Canine Health Foundation Biennial National Parent Club Canine Health Conference. 2005. St. Louis, MO. p. 46-8.
29. Duffy DL, Serpell JA. Non-reproductive effects of spaying and neutering on behavior in dogs. Proceedings of the Third International Symposium on Non-surgical Contraceptive Methods for Pet Population Control. 2006. <http://www.acc-d.org/2006%20Symposium%20Docs/Session%20I.pdf>
30. Kim HH, Yeon SC, Houpt KA, Lee HC, Chang HH, Lee HJ. Effects of ovariohysterectomy on reactivity in German Shepherd dogs. *Vet J* 2006;172:154-9.
31. Hopkins, S. G., Schubert, T. A., Hart, B. L. Castration of adult male dogs: effects on roaming, aggression, urine marking, and mounting. *JAVMA* 1976;168:1108-10.
32. Neilson JC, Eckstein RA, Hart BL. Effects of castration on problem behaviors in male dogs with 5eferences to age and duration of behaviors. *JAVMA* 1997;211:180-2.
33. Stocklin-Gautschi NM, Hassig M, Reichler IM, Hubler M, Arnold S. The relationship of urinary incontinence to early spaying in bitches. *J. Reprod. Fertil. Suppl.* 57:233-6, 2001.
34. Aaron A, Eggleton K, Power C, Holt PE. Urethral sphincter mechanism incompetence in male dogs: a retrospective analysis of 54 cases. *Vet Rec* 1996;139:542-6.
35. Thursfield MV. Association between urinary incontinence and spaying in bitches. *Vet Rec.* 1985;116:695.
36. Thrusfield MV, Hold PE, Muirhead RH. Acquired urinary incontinence in bitches: its incidence and relationship to neutering practices. *J Small Anim Pract* 1998;39:559-66.
37. Milne KL, Hayes HM Jr. Epidemiologic features of canine hypothyroidism. *Cornell Vet.* 1981;71:3-14.
38. Panciera DL. Hypothyroidism in dogs: 66 cases (1987-1992). *JAVMA* 1994;204:761-7.
39. Hess RS, Kass PH, Shofer FS, Can Winkle TJ, Washabau RJ. Evaluation of risk factors for fatal acute pancreatitis in dogs. *JAVMA.* 1999;214:46-51.
40. Moore GE, Guptill LF, Ward MP, Glickman NW, Faunt KK, Lewis HB, Glickman LT. Adverse events diagnosed within three days of vaccine administration in dogs. *JAVMA* 2005;227:1102-8.
41. Waters DJ, Kengeri SS, Clever B, Booth JA, Maras AH, Schlittler DL, Hayek MG. Exploring mechanisms of sex differences in longevity: lifetime ovary exposure and exceptional longevity in dogs. *Aging Cell* 2009;8:752-5.
42. Beijerink NJ, Buijtsels JJ, Okkens AC, Kooistra HS, Dieleman SJ. Basal and GnRH-induced secretion of FSH and LH in anestrus versus ovariectomized bitches. *Theriogenology* 2007;67:1039-45.
43. Zwida K, Kutzler MA. Non-reproductive long-term health complications of gonad removal in dogs as well as possible causal relationships with post-gonadectomy elevated luteinizing hormone (LH) concentrations. *J. etiology An Health* 2016;11-11.
44. Reif JS, Maquire TG, Kenny RM, Brodey RS. A cohort study of canine testicular neoplasia. *JAVMA* 1979;175:719-23.
45. Nieto JM, Pizarro M, Balaguer LM, Romano J. Canine testicular tumors in descended and cryptorchid testes. *Dtsch Tierarztl Wochenschr.* 1989;96:186-9.