

## Spay and Neuter Surgery's Effects on Orthopedic Disease, Behaviour, and General Health in Dogs

2018-10-31 01:10:38 1vpcf

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Twenty-odd years ago when I first started practicing veterinary medicine, if a client asked when they should spay or neuter their dog, my response was "6 or 7 months of age," and then we would move on to the next question. Today, when a client asks when they should spay or neuter their dog, my response is more along the lines of "How much time do you have?" It is no longer a simple question, and it has also morphed into my asking myself whether clients should spay or neuter their pets at all.

Over the last decade, it has become apparent that performing a gonadectomy (spaying or neutering) has unanticipated health implications. Specifically, gonadectomies and the age at which they are performed have been linked to the incidence of many cancers, orthopedic conditions, other medical conditions, and behavioural issues.

The following is an attempt to summarize the majority of this information, but fair warning: There is no simple answer that can be applied to all dogs.

### Orthopedic disease

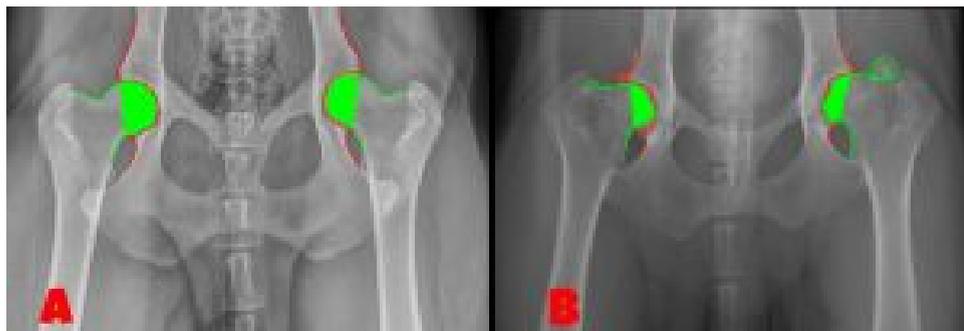
Sex hormones affect the maturation of young dogs; performing a gonadectomy on a juvenile dog delays growth plate closure. This can result in longer leg length, and it can also promote the development of certain orthopedic conditions, specifically hip dysplasia and elbow dysplasia (HD and ED), as well as cruciate ligament disease (CLD).

Multiple retrospective studies have found an increased incidence of HD in gonadectomized dogs, particularly if the surgery was performed prior to 6 months of age. Similarly, ED has also been shown to occur more commonly in gonadectomized dogs. Both of these conditions typically result in secondary osteoarthritis.

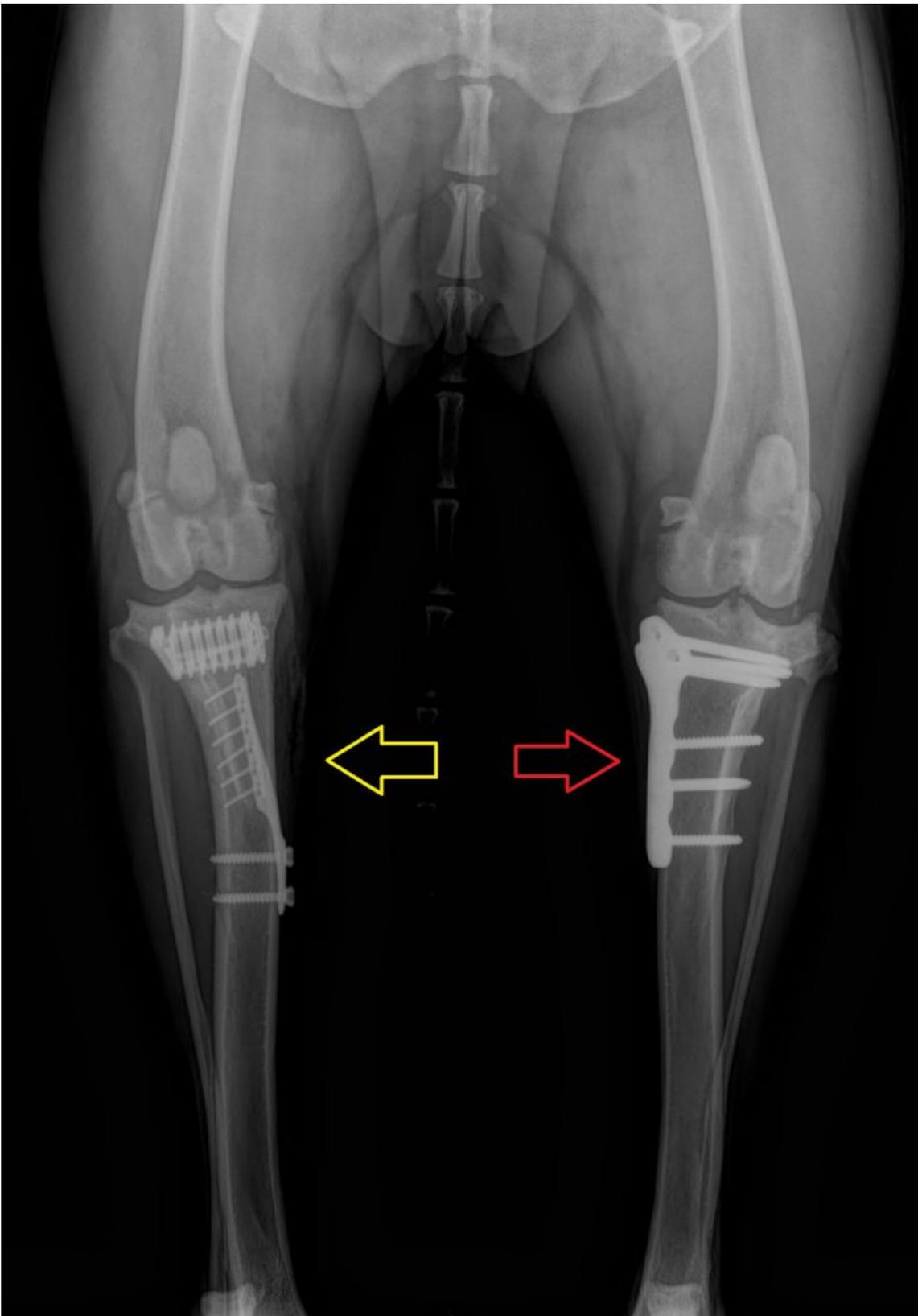
CLD is the single most common surgical orthopedic condition affecting dogs. Multiple studies have determined that gonadectomized dogs are at significantly greater risk for developing CLD. As with both HD and ED, some research has found this correlation to be stronger in dogs that were gonadectomized before 6 months of age.

Unlike human CLD (ACL tear), which is usually the result of trauma, canine CLD is a developmental condition; the knee grew in such a way that, for affected dogs, even normal activity puts abnormally high strain on the cranial cruciate ligament. Although many factors contribute to this condition, the slope of the top of the tibia—called the tibial plateau angle or TPA—has been identified as a major predisposing factor. The steeper the TPA, the greater the strain on the ligament. Delayed closure of a tibial growth plate, which happens in dogs gonadectomized before maturity, results in a steeper TPA and hence a predisposition to CLD.

To complicate this issue, the risk does not appear to be uniform across all breeds. For instance, Torres de la Riva et al. (2013) found that gonadectomizing golden retrievers between 6 and 11 months of age increased the risk of CLD, yet gonadectomizing Labrador retrievers between 6 and 11 months of age did not.



A: Normal Hip Radiographs. This radiograph depicts normal canine hip joints; the femoral head (outlined in green) fits well into the socket (red line). The area of green fill depicts how much of the femoral head is covered by the socket. B: Dysplastic Hip Radiographs. In contrast, these femoral heads fit poorly within the socket, and enjoy little bony support. Secondary arthritic changes and soft tissue mineralization can be seen.



This dog has received cruciate surgery on both knees. The surgery on the left (yellow arrow) is called a TTA, and the surgery on the right (red arrow) is called a TPLO

## Neoplasia

Gonadectomies have been linked to the incidence of a number of neoplastic conditions, preventing some and increasing the risk for others.

Mammary cancer is the most common cancer of intact females, with 20% of predisposed breeds facing a lifetime risk of developing malignant mammary cancer. Early research concluded that spaying before a third heat and before 2.5 years of age greatly reduced the chance of developing mammary cancer, although the statistical strength of this conclusion faced later criticism.

The chance of developing ovarian, uterine, or cervical cancer is essentially nonexistent in spayed females. However, in intact females, such cancers occur infrequently and are rarely malignant.

There is a common misconception that neutering reduces the chance of prostate cancer in dogs, when in fact the reverse is true. Neutering does eliminate the risk of testicular cancer, though. Prostate cancer is considered rare in dogs, but testicular cancer is common.

Perhaps most concerning is the link between gonadectomies and certain malignant sarcomas, including lymphoma, osteosarcoma, and hemangiosarcoma. Mast cell tumours and cardiac tumours are also implicated. Each of these tumours occurs more frequently in gonadectomized versus intact dogs.

As with orthopedic disease, certain breeds face greater risk than others. For instance, spayed female Rottweilers have a three to four times increased risk for developing osteosarcoma, whereas other breeds only have a two times greater risk. Spayed female vizslas are nine times more likely to develop osteosarcomas, whereas spayed golden retrievers face a four times increased risk. Neutered golden retrievers were not at increased risk for hemangiosarcoma, yet neutered vizslas were.

Yet another complicating variable is the age at which spaying occurred. Golden retrievers spayed at an earlier age were less at risk for developing mast cell tumours compared to those spayed at a later age, but were still at greater risk compared to those that remain intact. Conversely, early spaying increased the risk of developing lymphosarcoma relative to late spaying or leaving intact. Late spaying increased the risk of hemangiosarcoma for both golden retrievers and vizslas. Lymphosarcoma was not reported in golden retrievers neutered at a late age, yet those neutered early were at increased risk compared to intact goldens.

## Other conditions

Spayed females are at greater risk for recessed vulvas, vulvar dermatitis, and vaginitis. Vulvar dermatitis is linked to an increased risk of urinary tract infections. Urinary incontinence is quite common in spayed females, but rare in intact females.

Ovarian cysts, a cause of chronic pain that can easily go undiagnosed, is eliminated by spaying. Similarly, spaying eliminates the risk of other uterine diseases, as well as vaginal hyperplasia. Pyometra, a potentially fatal uterine infection that typically requires emergency surgery to resolve, can affect up to 24% of intact females but is prevented by spaying.

Neutering reduces or eliminates the chance of prostate inflammation, non-neoplastic prostate enlargement, perianal adenomas, perianal hernias, testicular torsion, epididymal disorders, and perianal fistulas.

## Behavioural issues

The effects of gonadectomy on behaviour is another complex topic, one made no simpler by the existence of conflicting results in the literature. Here, too, the findings may vary between breeds. For example, neutering improved the trainability of Shetland Sheepdogs and Rottweilers, but did not for any of the remaining breeds examined.

There is broad agreement that neutering has the positive benefit of reducing urine marking, roaming, and inter-male aggression. However, research consistently shows that gonadectomized dogs are more likely to have fear issues related to noise.

Most research shows that inappropriate reproductive behaviours are reduced with gonadectomy, but Spain et al. (2004) found the reverse. Earlier research that looked specifically at male dogs found that neutering reduced aggression, but more recent research examining both sexes found an increase in aggression of gonadectomized dogs. A similar trend can be found with fear behaviours: Recent research found an increase in fear, whereas older papers reported decreased fear in gonadectomized dogs. Wright and Nesselrote (1987) found that gonadectomy decreased reactivity of male dogs but increased reactivity of females.

Serpell and Hsu (2005) found gonadectomy did not affect trainability in most breeds, but Starling et al. (2013) reported decreased boldness, a trait linked to trainability. Different researchers have concluded that gonadectomy either increases, decreases, or has no effect on separation anxiety.

## Summary

Statistically, gonadectomized dogs live longer than intact dogs. Gonadectomized dogs are also less likely to be relinquished or rehomed. Early gonadectomy of shelter animals, prior to adoption, eliminates the risk of further unwanted puppies.

Gonadectomized dogs are more likely to develop potentially debilitating orthopedic disease, or malignant cancer, but are less likely to develop other debilitating or dangerous medical conditions. The probabilities of some unwanted behaviours are increased by gonadectomy, but others are decreased. Gonadectomized dogs are more likely to die from cancer or immune-mediated disease, but less likely to die from infection, trauma, vascular disease, or degenerative disease. The effect of a gonadectomy on certain conditions varies by breed. Further, even within a given breed, the age at which the procedure is performed can either increase, decrease, or neutralize the risk of certain conditions.

So, what is the best age to gonadectomize your dog? Should you do it at all? To answer that question, information about the breed, family history of disease or behaviour issues, and intended use of the dog all need to be considered. Even once this information is gathered, it then needs to be weighed against the limited and sometimes conflicting research available—no easy task. Table 1 summarizes the major pros and cons of performing a gonadectomy, but it is not an exhaustive list.

As a veterinary sports medicine specialist, I focus on reducing orthopedic disease, and that consideration greatly influences the advice I give. For most dogs I recommend a gonadectomy once the growth plates have closed, at around 17 months of age. If unwanted behaviours known to be linked to sex hormones develop with the onset of puberty, then that plan might change. If there is a known history of a relevant cancer in a family line, then that may be enough for me to advise leaving the dog intact. Conversely, if I am repairing a fracture on a young shelter animal, I will routinely spay or neuter that patient as part of that procedure because for a shelter manager, preventing unwanted puppies is the primary concern. In short, there is no easy answer that can be applied to all dogs, and my advice varies from patient to patient.

**Table 1: The major pros and cons of performing a gonadectomy.**

	Spaying Pros	Spaying Cons	Neutering Pros	Neutering Cons
<b>General</b>	Increased life expectancy		Increased life expectancy	
	Population control		Population control	
<b>Orthopedic</b>		Increased risk of hip and elbow dysplasia, as well as cruciate ligament disease if performed before maturity		Increased risk of hip and elbow dysplasia, as well as cruciate ligament disease if performed before maturity
<b>Neoplasia</b>	Reduced incidence of mammary tumours (most common tumour of intact female dogs; 50% are malignant)	Increased risk of lymphoma, osteosarcoma, hemangiosarcoma, mast cell tumours, and cardiac tumours	Eliminates risk of testicular cancer (common)	Increased risk of prostate cancer (rare condition)
	Eliminates risk of cervical, uterine, and ovarian tumours (uncommon tumours that are rarely malignant)			Increased risk of lymphoma, osteosarcoma, hemangiosarcoma, mast cell tumours, and cardiac tumours
<b>Other medical conditions</b>	Elimination of pyometra (common and potentially fatal condition), other uterine diseases, and vaginal hyperplasia	Increased risk of recessed vulva, perivulvar dermatitis, cystitis, vaginitis, and especially urinary incontinence	Reduces or eliminates the chance of prostate inflammation, non-neoplastic prostate enlargement, perianal adenomas, perianal hernias, testicular torsion, epididymal disorders, and perianal fistulas	
<b>Behavioural issues</b>		Increased fearfulness and reactivity	Reduced urine marking, roaming, and intermale aggression	Increased noise phobias, other fears, or aggression?
			Reduced fear and aggression?	

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**A publication of the International Association of Animal Behavior Consultants, <http://iaabc.org>**