

Companion Animal Gonadectomy

Timing of Gonadectomy and Influences on Well-being

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The consequences of Human gonadectomy are well established. Reports of gonadectomy pre-date modern history. Punishment for prisoners of war often included castration in history B.C. – assuring a dominant line of succession. Aristotle, in 4 B.C., described the physiological consequences of gonadectomy in animals. He noted that stags don't grow horns if castrated prior to growing them. However, they if castrated after they grow horns, they keep growing them. Birds become bigger and more colorful if castrated early. But they don't change their appearance if castrated after maturity. Castrated animals, in general, grow longer.

There are also examples of Human contemporary and geographical peer groups that underwent gonadectomy for various reasons. The consequences are described below.

The Skoptzy

The Skoptzy were a Christian sect, whose male members in order to attain their ideal sanctity, subjected themselves to castration. Their origin was in 18th century Russia / Romania / Bessarabia. They believed that the second coming of Christ would occur only when the number of Skoptzy reached 144,000. The “voluntary” nature of subjecting themselves to castration is questioned – as many were castrated at less than 10 years of age.

Medical studies of the Skoptzy by at least 3 different investigators were performed. Around 1900, Pittard observed the Skoptzy versus their uncastrated peers. In 1907, Tandler and Grosz reported observations of Romanian Skoptzy. During German occupation of Romania, Koch performed a variety of anthropomorphic measurements including radiographs.

Eunuchs of the Chinese Court

The employment of eunuchs as court functionaries in China and other oriental countries predates history. Possession and employment of eunuchs as servants in China was reserved for the imperial family and the 8 hereditary princes. The emperor employed

about 2000 in his service and the princes and princesses each employed 30 and lesser family members 10. Most of those employed were “volunteers”. Often poor parents would “volunteer” (i.e. sell) their children into service to assure they had a good quality of life. There were a considerable number of adults that, after having children, did also volunteer as adults themselves.

Palace eunuchs cared for the garden, courtyards, kitchens, armory... All eunuchs received a stipend as well as room and board. They were often released from service when elderly and spent the rest of their lives in monasteries. The practice continued until the eunuchs were expelled from the Forbidden City in 1923.

Medical studies included anthropomorphic studies by Wagenseil at Tungchi University. In 1960, Wu and Gu performed careful physical examinations.

Eunuchs of the Ottoman Court

The practice of employing eunuchs as palace functionaries in Istanbul began during the Roman Empire and continued through the Ottoman eras. Ownership of eunuchs was not limited to the royal family. Individuals were often children from Ethiopia or Sudan.

Hikmet and Regnault made the first medical observations in Istanbul in 1901. Wagenseil, working for the German Red Cross Hospital, performed anthropological measurements and physical examinations during the first world war.

Reported Medical Consequences of Castration (contemporary and geographical peers)

The studies listed above found nearly the same results.

- Enlargement of the Pituitary – The sella turcica is grossly enlarged – sometimes greatly enlarged. Correlation of earlier castration with size. Klinefelter’s syndrome and pituitary adenomas were more common in early castrates.
- Skeletal Changes – Castrated men were taller due to failure of closure of the epiphyses. Bones of the skull were thinner. Cortices of long bones were thinner. Increased fractures of long bones. Kyphosis and vertebral fractures were common.
- Gynecomastia – Occurred in about 50% of those castrated before puberty. Probable extra-glandular aromatization (creation of estrogen) of adrenal androgens in the face of lack of testosterone was the cause.
- Disappearance of the Prostate – Consistent finding.

- Lifespan – No effect on lifespan. In nearly all societies, women live longer than men. Some theories include the detriment of testicles or the benefit of ovaries on lifespan. Apparently, losing one's testicles is not a factor in lifespan.

Common Day Examples of Gonadectomy

Ovariectomy is less commonly discussed until modern times. The first successful ovariectomy in Humans was reported in 1817 by Ephraim McDowell in Danville, KY. Since then, up to 500,000 procedures are performed per year. The reported risks and adverse effects include premature death, increased cardiovascular disease, early cognitive impairment or dementia, parkinsonism, osteoporosis and bone fractures, and decline in sexual function. Interestingly, hormone replacement therapy does not always reduce the adverse effects.

Orchiectomy in Humans is not typically performed bilaterally. Testicular cancer patients often have just one testicle surgically removed. However, prostate cancer patients sometime have bilateral orchiectomy or undergo chemical "removal". 40,000 men per year start Androgen-Deprivation Therapy. Side-effects include loss of libido, hot flashes, and genital shrinkage. 60% start anti-ADT due to the side effects.

Trans-sexuals (male-to-female, male-to-eunuch) also have similar side-effects. The difference being, 53% of the sex-change procedures were not performed by medical professionals.

Large (Food) Animal Castration

Castration is very common in the food animal business. Selective breeding, behavioral modification and increase in meat fat density are all cited for the procedure. Long-term consequences of gonadectomy in food animal medicine is not well studied as most of the animal are slaughtered before becoming aged. It is well known, however, that goats that are castrated early have underdeveloped, more narrow than usual, ureters and urethras, predisposing them to urinary obstruction.

Companion Animal Gonadectomy

Undoubtedly, the ASPCA has had a profound impact on dog and cat gonadectomy around the World. Henry Bergh, an American diplomate on assignment in Russia, is well-known for stopping a carriage driver from beating his horse. When Bergh arrived back home in

the US, he saw some of the same behavior occurring here. The American Society for the Prevention of Cruelty to Animals was founded in 1866 in New York City. Its goal was to prevent animal cruelty. It began as an ambulance for carriage horses. His ambulance concept was used for injured horses in WW1.

In 1973, the ASPCA Adoptions department began requiring spay/neuter for all adoptions. In 2015, the ASPCA acquired Humane Alliance, a national pioneer in high-quality, high-volume spay/neuter services and training. In the US, 6.5 million dogs/cats enter shelters every year. 67% are stray; 33% are relinquished by their owners. Only 50% are ever adopted – often due to behavioral issues.

Despite the reported benefits, gonadectomy rates remain low in some countries. For example, in a sample of dogs (n = 10,519) owned by German-speaking dog enthusiasts, only 43.1% were gonadectomized, while among dogs attending UK veterinary clinics (n = 148,741), 41.1% were gonadectomized. By contrast, in Australia, 77% of male dogs and 85% of female dogs are gonadectomized, and in the U.S., an estimated about 83% of all dogs are gonadectomized.

Gonadectomy Related Health Issues

Hormones produced by the reproductive organs not only are essential for reproduction, but in the development of homeostasis, body condition, cholesterol levels, energy levels, urinary continence, muscle tone, cognition, behavior, and, perhaps most importantly, they also play a role in the immune system.

Over-population

There are many excellent reasons for gonadectomy that relate to control of numbers in the broader population. Gonadectomy at, or just before, sexual maturity has been common practice for decades, chiefly to avoid unwanted litters. More recently, the merits of very early gonadectomy (at less than 12 weeks) have been emphasized by those focusing on population control only... perhaps to the detriment of our pets' health.

Behavioral Risks

The beneficial effects of gonadectomy are underpinned by the need to reduce the number of unwanted companion animals. Thousands of dogs are euthanized in shelters and pounds annually in many developed countries. However, shelters are inundated by dogs that are most commonly surrendered because they display undesirable behaviors. So, the paradox that castration may reduce the numbers of unwanted dogs... but, may also increase the likelihood of problem behaviors and therefore surrender to shelters... is troubling.

The deleterious behavioral consequences of castration have traditionally been believed to be negligible. However, recent research (C-BARQ) indicates that 8 behaviors related to fearfulness and 7 behaviors related to aggression were inverse in incidence to age at castration and percentage of lifetime exposed to gonadal hormones. The overall difference of incidence was up to 12% in juvenile gonadectomized dogs. A problem behavior that occurs in 1% of intact dogs but occurs in 13% of juvenile castrates would mean a 1200% increase in that unwanted behavior.

On the other hand, castrated males may also wander less in search of mating opportunities, an outcome with the additional benefits of fewer hit-by-cars and unwanted litters.

Mammary Tumors

Overall prevalence of mammary tumors in dogs is 0.25% with 74% being intact females. Spaying is thought to reduce the risk of mammary neoplasia. However, a recent systematic review described evidence for the association of being spayed before first heat cycle and development of mammary tumors as being only “weak”. Studies (ISCFR 2012) looking at intact 10-year-old dogs found an incidence of mammary tumors of 13%. The incidence in a specific breed varied widely at 3 – 73%. Average onset of tumors was 8 years of age. Incidence does seem to be on the rise.

There is no known association of mammary cancer and being intact in cats.

Ovarian Tumors

The incidence of ovarian tumors in dogs is extremely low. The average age at onset is 8 years with a range of 14 months to 16 years.

Pyometra

To determine the true incidence of pyometra, we need to look to other regions of the World that spay much less commonly than we do here in the US. In Great Britain, pyometra is present in approximately 2.2% of all intact female dogs. The average age at onset is 7.7 years. In some breeds, the age at onset was much lower – like the dogue de Bordeaux at 3.3 years of age. Other studies looking at intact 10-year-old dogs found an incidence of pyometra of 19%.

Benign Prostatic Hyperplasia / Prostatic Neoplasia

Androgens are essential for the development and function of the prostate. In man, rats and dogs there are age-related decreases in serum testosterone. Despite the decreases, BPH increases with age. The exact mechanism is not fully understood. Androgen deprivation (surgical or chemical) ameliorates the symptoms. However, mature prostate cells exhibit enormous plasticity. Prostatic cells deprived of androgens often give rise to androgen receptor negative cells that can become neoplastic and not responsive to castration. The incidence of prostatic neoplasia is higher in older male dogs that were castrated late in life versus intact dogs. The incidence of prostatic neoplasia (especially TCC) is 8 times higher in castrated dogs and even higher in juvenile castrates.

Testicle Tumors

Reasons for any putative effects of gonadectomy on longevity differ in males and females. In males, it is known to increase the risk of prostate cancer, but the benefits may include removing the risk of testicular disease and other androgen-dependent diseases, such as perineal hernias, perineal adenomas, prostatitis and benign prostatic hyperplasia. Testicular tumors are much more common in cryptorchid dogs and in the Maltese.

Perineal Hernias

Over 95% of dogs with perineal hernias are intact males. Another few percent were recently castrated. Perineal hernias in female dogs is highly unusual and is not related to being intact. Average age, in the patients we see with perineal hernias, is 8 years.

Bone length and Osteosarcoma

Gonadectomy has also been associated with increased bone length, which may, in-part, explain why studies focused on osteosarcoma found twice the prevalence in gonadectomized dogs than in intact dogs of several breeds (Golden Retrievers, Boxers, Weimaraner ...) and an increase of 3-4 times in Rottweilers castrated before 1 year of age. Osteosarcoma most often occurs adjacent growth plates – in the metaphysis.

Bone Length and Canine Hip Dysplasia

Similarly, studies of Golden Retrievers and German Shepherd dogs have shown that early neutering can significantly increase the prevalence of joint disorders, such as hip dysplasia. A study (Torres de la Riva, et al) on Golden Retrievers found that male dogs who were neutered before 12 months of age had double the risk of hip dysplasia than their intact counterparts. Other research shows that dogs sterilized before the age of six months have a 70% increased risk of developing hip dysplasia. Spain et al proposed that it is possible that the increase in bone length that results from early-age gonadectomy results in changes in joint conformation, which could lead to a diagnosis of hip dysplasia. Van Hagen et al found that of the sample dogs diagnosed with hip dysplasia, those that were neutered six months prior to the diagnosis were nearly twice as likely to develop hip dysplasia. Dannuccia et al found that juvenile ovariectomy in Beagles caused increased remodeling of the pelvic bone, which also suggests an increased risk of hip dysplasia.

Cranial Cruciate Ligament Ruptures

Cranial cruciate ligament ruptures have also been linked to spay/neuter in numerous studies.

The Golden Retriever study found that there were no cases of cruciate tear in the intact dogs. While 5% of males and 8% of females neutered before 12 months did suffer tears.

Whitehair et al found that spayed and neutered dogs of any age were twice as likely to suffer cranial cruciate ligament rupture. Slauterbeck et al also found an increased risk. The theory is the femur achieved its genetically determined normal length at eight months when a dog typically gets spayed or neutered. However, the tibia, which normally stops growing at 12 to 14 months of age continues to grow causing an abnormal tibial plateau angle. In addition, with the extra growth, the lower leg below the stifle likely becomes heavier (because it is longer) and may cause increased stresses on the cranial cruciate ligament.

Additionally, gonadectomy can cause a loss of bone mass (Martin et al), and obesity (Edney et al). Both factors could lead to an increased risk of cranial cruciate ligament ruptures and hip dysplasia.

Patellar Luxation

Spayed/neutered dogs are greater than three times more likely to suffer from patellar luxation (Vidoni et al).

Capital Physeal Fractures in Male Cats

McNicholas et al found that predisposing factors for cats with capital physis fractures included obesity, open physes – both due to being castrated before 6 months of age. Physis closure is androgen mediated. Female cats produce androgens in their adrenal glands. Male cats produce androgen almost exclusively in the Leydig cells of the testicles. Male cats that are castrated before growth plate closure often have growth plates that do not mineralize. Slipped physes in female cats are very rare.

Borak et al found Maine Coon cats castrated at an average of 7.7 months of age had an incidence of capital physeal fractures of 8% versus 0.67% in the general cat population.

Urethral Obstruction in Cats / Perineal Urethrostomy

In the cats that we have seen for urethral obstruction, only one cat was intact at the time of surgery. More than 95% of the cats that needed a P.U. were castrated before 6 months of age. Juvenile castration may prevent full development of the urethra. Cats are small goats?

Mast Cell Tumors, Lymphoma, Hemangiosarcoma – Breed-specific Findings

Incidence of cancer is very breed sensitive. Average across all breeds, gonadectomized dogs face 0.1 times the odds of developing mast cell tumors than intact dogs. The incidence of all cancers in spayed females is 6.5 times higher and in neutered males was 3.6 times higher than intact dogs. The younger the dogs are spayed/neutered, the younger they are when diagnosed with cancer.

The Golden Retriever study looked at cancer rates and found that the incidence of lymphosarcoma was three times higher in males neutered before 12 months of age. Interestingly the percentage of hemangiosarcoma in females spayed after 12 months was four times higher than that of intact and even early-spayed females. Additionally, 6% of females spayed after 12 months were affected with mast cell cancer, while there were zero cases among the intact females.

The more recent Vizsla study (Zink, et al) found that spayed females had significantly higher rates of hemangiosarcoma (nine times higher) than intact females. They also found that spayed/neutered dogs were 3.5% more likely to suffer mast cell cancer and 4.3 times more likely to suffer lymphoma.

Waters et al. found similar results in their study of female Rottweilers. The researchers set out to determine whether retaining the ovaries contributed to longevity. In Rottweilers, the major causes of death are sarcoma and all cancers, which account for 38% and 73% of deaths respectively.

After excluding all cancer deaths, females who kept their ovaries during the first seven years of life were more than nine times more likely to reach exceptional longevity than females with the shortest ovary exposure. Although intact female dogs were more likely than males to achieve exceptional longevity, that advantage was erased when ovariectomized.

Pituitary Tumors / Adrenal Tumors

United States – almost all ferrets are gonadectomized between 4 and 6 weeks of age (i.e. before being sold). Incidence of Adrenal tumors is reported by some practices to be 30-35%. In Holland Ferrets are gonadectomized at an average on 12 months of age. Incidence of Adrenal tumors is reported as 0.55%.

Diabetes Mellitus

The risk of other diseases induced by reproductive hormone production like progestin-induced diabetes type 2 and growth hormone excess like acromegaly are reduced in gonadectomized animals has been shown in multiple studies.

While in other studies, castrated males of many breeds had a higher risk of diabetes mellitus than intact males, whereas spaying was not associated with an increased risk in females.

Epilepsy

Estrogen lowers seizure threshold. Dogs suffering from epilepsy often benefit from ovariectomy. Castration does not benefit male dogs with epilepsy... unless sexual arousal is an inciting factor of the seizures. Onset of epilepsy is often less than 3 years of age but typically after 12 months of age.

Desexing versus Sterilization

Desexing involves traditional ovariectomy/ovariectomy and castration. Sterilization procedures would leave the hormone producing ovaries/testicles intact. Sterilization procedure include tubal ligation and vasectomy. Both procedures are extremely simple to perform. Sterilization would support the effort in population control while maintaining the benefits (and detriments) of having hormone producing glands.

General Thoughts

If the goal of gonadectomy is to optimize the lives of our feline and canine companions, there has to be an optimal time to minimize the negative effects of the procedures. The following tables summarize my review of available data concerning the effects of gonadectomy.

Gonadectomy Sensitive Conditions

Condition	Timing Recommendation	Comments
	Feline	
Capital Physeal Fractures	after skeletal maturity	radiograph hips at 12 months especially in Maine Coons
Urethral Obstruction	after 6 months of age	preferably after skeletal maturity – i.e. full growth
	Canine	
Abnormal Behavior	after 6 months of age	preferably after 1 year and after socialization
Cruciate Ligament Ruptures	after skeletal maturity	
Hip Dysplasia	after skeletal maturity	
Patellar Luxation	after skeletal maturity	
Neoplasia	after skeletal maturity	consider not spaying Golden Retrievers, Rottweilers
Mammary Tumors	before 8 years	
Ovarian Tumors	before 8 years	
Pyometra	before 7 years	
Testicular Tumors	before 8 years	If cryptorchid – at skeletal maturity
Benign Prostatic Hyperplasia	before 8 years	
Perineal Hernias	before 8 years	
Pituitary / Adrenal Tumors	?	

My Recommendations

In general, gonadectomy should not be performed before skeletal maturity (i.e. 13 months). A lateral radiograph of the tibia can confirm the timing. Yes, this means some dogs will have their first heat cycle before they are ovariectomized. I believe the negative effects of early gonadectomy far out-weigh the potential increased risk of mammary cancer. I cannot find any other health benefit of early gonadectomy.

Population control is not an excuse to be used against a competent, responsible dog/cat caregiver. You are not an animal shelter. You are not responsible for population control. You can make medical decisions based on evidence-based medicine.

If the patient is undergoing an anesthetic event for another reason - medically necessary / genetically induced reason (i.e. portosystemic shunt), gonadectomy could be considered after 6 months of age.

Gonadectomy should be performed in all non-breeding animals at skeletal maturity.

Gonadectomy should be performed in all breeding animals before the age of 8 years.