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Scrotal Castration as a Safe and Effective Means of Male Canine Sterilization

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For years, a prescrotal technique has been the only accepted method of male dog sterilization, as dogs are considered to be "scrotal conscious." The prevailing thought has been that a scrotal incision will cause more complications including swelling and induction of self-trauma. There is, however, little in the scientific literature that confirms or contradicts this thinking.

In this study 437 apparently healthy male dogs over the age of 6 months were randomly allocated into 2 treatment groups and castrated by either a prescrotal (n=206) or scrotal incision (N=231). Complications were recorded up to 72 hours following the procedure. The focus of this study is to evaluate the hypothesis that there are no differences between the prescrotal and scrotal technique. The method of castration was not found to be significantly associated with hemorrhage, pain or swelling. A reduced incidence in self trauma was associated with scrotal castrations.

Key Words: prescrotal, scrotal, castration, canine, complications

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CHAPTER I

INTRODUCTION

According to the Humane Society of the United States, approximately five to seven million cats, dogs, kittens and puppies enter US animal shelters each year[1]. Three to four million of them are euthanized due to lack of space, lack of resources to care for them and lack of adopting homes. Pet overpopulation is an economic, public health, emotional, and ethical problem. Without significant intervention there will likely never be sufficient resources to care for this landslide of domestic animals in our society.

Animal shelters and humane associations are unable to keep pace with the burgeoning population of dogs and puppies[1]. Unaltered pets, feral, stray and roaming animals produce unwanted offspring at an enormous rate. Spay/neuter programs provide an important means for reducing pet overpopulation in that they can ensure that any pet adopted from a shelter has been sterilized prior to placement and that owned animals are sterilized before reproducing. Even the most well-meaning owner may inadvertently allow mating to occur and thus add to the problem. These unfortunate matings can be avoided and unintended litters will be prevented if animals are sterilized while in the shelter.

Animals that have been spayed or neutered may be considered more adoptable than those that have not[2]. Potential behavior problems (aggression, desire to roam, urine marking, etc.) are associated especially with intact male dogs[3]. Such dogs may

have a greater desire to wander and may thus be more difficult to contain. Health benefits of castration include decreased risk of cancer and prostatic diseases[4, 5]. For these and other reasons, owners may choose to adopt an animal that has already been sterilized.

Spay/neuter programs often have limited resources and an enormous number of animals to treat. Minimizing surgical time without sacrificing animal welfare can be of tremendous benefit within a program. Many programs already operate at high efficiency as far as surgical preparation and animal rotation. Procedures that reduce anesthetic time and expedite the surgical procedure by even a few minutes can have a substantial impact in a high volume program.

While other methods of contraception have been attempted in the canine male, the accepted and most reliable method has been that of surgical castration with the traditional surgical approach being that of a prescrotal incision[6]. For many years, the prescrotal technique has been taught as the only accepted method of canine castration. Veterinarians have been taught that an incision in the scrotal tissue increases the likelihood of patient self-trauma. However, scrotal castration may offer the advantage of reduced surgical time while not increasing complication rates over the traditional prescrotal approach. Additionally, the scrotal approach may offer other advantages, such as decreased anesthetic time and fewer complications, especially when animals are recovering in the shelter environment. This study was conducted to compare complication rates and surgical efficiency between scrotal and prescrotal techniques.

CHAPTER II

LITERATURE REVIEW

Population Control

Population control is one of the most widely recognized benefits of sterilization. In fact, the American Veterinary Medical Association recognizes dog and cat population control as a "primary welfare concern of American society"[7]. Sterilization is the only method to completely ensure the prevention of unwanted litters of puppies and kittens, many of which likely would become free roaming, feral dogs and cats or be surrendered to animal shelters. Millions of animals are euthanized annually due to lack of shelter space and lack of homes[8]. One survey study found that 56% of 154 canine litters were unplanned[9].

Intact male dogs contribute to the animal shelter population. A 1996 study published in the Journal of the American Veterinary Medical Association (JAVMA) found that sexually intact male dogs represented a disproportionately large portion of the relinquishments[10]. Unwanted behavior, aggression and inclination to roam may be contributing factors. Castration has been shown to effectively decrease such unwanted behaviors as urine marking, mounting, and roaming[11, 12]. Despite incentives to have recently adopted pets neutered after leaving the shelter, as many as 40-60% of animals do not return for this needed procedure, even though the surgical procedure is often pre-paid and many municipalities mandate surgical sterilization of pets[7]

Many humane groups and sheltering organizations spend countless hours and considerable funds on campaigns to increase public awareness and compliance with spay/neuter recommendations[13]. Despite ongoing campaigns to increase awareness of the importance of spay/neuter efforts, reports of owners that are actually compliant with this is typically only about 60%.

Many humane organizations spend additional funds to have animals in their care spayed or neutered before adoption. As a result, high quality/high volume spay/neuter clinics are becoming increasingly common. Surgeons at these clinics are usually trained in highly effective, safe techniques for both orchiectomy (castration) and ovariohysterectomy (spay)[14]. Considering the failure of other neutering programs, having a pet surgically altered prior to adoption may be the best approach to population control. In order for such high quality/high volume programs to be successful, the most efficient procedures, as well as the ones with fewest complications, must be utilized

Health Concerns and Benefits of Sterilization

Surgical sterilization is widely promoted as an accepted means to control cat and dog population[1]. Additionally, animals that undergo castration have been shown to be at a decreased risk of diseases (e.g. testicular neoplasia and prostate disease) and decreased undesirable sexual behaviors[15, 16]. Potential health concerns associated with surgical castration include anesthetic and surgical complications (e.g. dehiscence, infection, hemorrhage), increased risk of some types of neoplasia[17], musculoskeletal disorders[18-21] and obesity[12].

While the primary driving force behind spay/neuter programs is usually that of population control (in the population at large) and curbing undesirable behaviors (in

individual pets), castration of the male dog is associated with a variety of positive health benefits[22, 23].

The most common disease of the canine prostate is benign prostatic hyperplasia (BPH) [22]. The incidence of BPH increases with age and may lead to prostatitis, a serious but non-life-threatening disease. Castration has been shown to prevent BPH. However, the incidence of canine prostatic carcinoma is increased in castrated dogs when compared with intact males. In one study comparing 404 dogs with prostate carcinoma, 128 were intact, while 276 were castrated[5]. The cause for the association is unclear although age and the level of health care may be significant confounding factors[22]. Additionally, testicular tumors, the second most common type of tumor in the intact male canine, are prevented by castration[23].

In a retrospective study, White, et al. examined the possible association of reproductive status with the occurrence of grade 2 and grade 3 cutaneous mast cell tumors (MCT) [24]. Spayed females were found to have four times the risk of MCT occurrence compared with intact females. A slightly increased incidence in MCT in neutered males (vs. intact males) was not, however, statistically significant. The significance of hormone receptors in cutaneous MCTs and the potential protective role of sex hormones require further investigation.

Behavior

In addition to population control another benefit of surgical sterilization is a decrease in undesirable behaviors. Intact male dogs often mount other animals (including people), urine mark, display aggressive tendencies, have increased inter-male aggression

and have a higher drive to roam[25]. Some studies suggest that neutered male dogs display higher trainability than intact males[12].

In a 1997 report, behavioral issues were found to be the most common reason owners cited for having their dog castrated[11]. Behavioral issues included objectionable sexual behavior, aggression towards people and other dogs, roaming and inappropriate urination or marking. In this study it was reported that within at least 6 months up to 57% of the behavioral problems decreased following castration, with most reductions occurring in those animals that had displayed roaming behaviors, inter-male aggression and inappropriate urination.

Techniques for Castration

Castration Techniques in large Animals

In the United States castration is a routine husbandry procedure in farm animals and large companion animals such as horses and cattle. In many species, the procedure is performed at an early age in order to reduce aggressiveness and undesirable behavior, improve handling, preserve meat quality, and prevent unwanted pregnancies[26]. Non-surgical (elastic band or a Burdizzo emasculatome) are among common techniques utilized in production animals; however, surgical approaches are also described[26, 27]. A minimally invasive spermatic cord ligation technique for calves has also been described[28]. The technique was effective in inducing permanent ischemia and rendering the animals incapable of reproduction while causing less tissue trauma (and presumably less pain and fewer post-operative complications) than the more commonly utilized techniques[28].

In the horse, castration is routinely performed to facilitate handling and domestication as well as to prevent unwanted reproduction. Other indications include the prevention of testicular neoplasia, testicular trauma, inguinal hernias, torsion of the spermatic cord, hydrocele and varicocele[29]. There is considerable variation in accepted surgical techniques, with the primary differences being in the 3 different venues, standing surgery "in the field", surgery under general anesthesia "in the field", and general anesthesia performed at a veterinary clinic[30]. Currently accepted techniques include open, half-closed and closed approaches followed by use of an emasculator to crush the spermatic cord. The described procedures are all performed via a scrotal incision[29]. Most scrotal incisions are allowed to heal by second intention although primary closure has been described. Primary closure of the castration site may help to minimize post-operative complications such as infection in the equine species.

In situ castration techniques have been described in calves. In these cases, ischemic necrosis of the testicles is induced by transection, ligation, torsion or crushing of the spermatic cord, rendering the testicles non-functional. A prescrotal or inguinal incision, or a laparoscopic approach, have also been used[28, 29]. Additionally, a pinhole technique, in which the spermatic cord is ligated percutaneously, has been utilized in the castration of calves and rams[26].

Canine and Feline Surgical Castration

Surgical sterilization has remained the primary approach to castration in the male dog and cat. Removal of the testicles renders an animal permanently incapable of reproduction, eliminates the possibility of testicular neoplasia and many hormonally-induced diseases and decreases the incidence of testosterone-driven undesirable

behaviors[31]. Bilateral orchiectomy or castration, defined as removal of the testicles, is one of the most common procedures performed on male companion animals in the United States[32].

Despite the fact that several surgical techniques have been described for the surgical sterilization of the male cat, there are few scientific studies that support one technique over another. A 2010 study by Oliveira *et al* compared three methods of surgical ligation of the spermatic cord in the cat[33]. All methods utilized scrotal incision as the approach. There is no literature outlining a prescrotal approach to cats. Complication rates for the three procedures which included ligating the spermatic cord with suture and two different techniques of tying the cord on itself were similar. All three techniques achieved adequate hemostasis, and were associated with an absence of major complications.

Historically, the prescrotal approach has been considered the only acceptable method of sterilization of the male dog[6]. Both open and closed castration techniques have been described. Open castration involves incising the parietal tunic[6, 34, 35]. It has been suggested that open castration provides a more secure ligation with better access to the pampiniform plexus. The disadvantage of the open technique is open access to the peritoneal cavity and potentially a greater risk of peritonitis. Conversely, the closed castration, performing the surgery with the tunic intact, reportedly decreases the incidence of scrotal hematoma[6, 35]. According to the Spay/Neuter Guidelines, published by the American Association of Shelter Veterinarians, the decision to perform open or closed castration is based on surgeon's preference[36].

In the traditional canine castration, using either the closed or open technique, the testis is moved cranially out of the scrotum and exposed through a midline, prescrotal skin incision[37]. The ductus deferens and pampiniform plexus are ligated using 2-0 or 3-0 absorbable suture. The spermatic cord is transected distal to the ligature and the subcutaneous tissue and skin are sutured closed.

A perineal castration was described in 1976, indicated to avoid repositioning when the patient is placed in a perineal position for another procedure, such as perineal hernia repair. In this technique, the animal was placed in sternal recumbency in order to perform the hernia repair. A midline skin incision is made dorsal to the scrotum but ventral to the anus. The testicle is exteriorized and ligated as described for a prescrotal technique[6]. While the paper describes the technique, no complications were recorded[38].

Orchiectomy, like all surgeries, carries risks of complication. While there is a perception that scrotal castration in adult dogs is more prone to complications than prescrotal, limited data are available comparing complication rates of scrotal and prescrotal canine castrations. Data is difficult to obtain due to the fact that complications may vary from practice to practice, furthermore, definitions of complications and degree of detail of records vary by practitioner[34, 39]. Additionally, some minor complications occur at home and may go unnoticed or unreported by the owner. Complication rates following prescrotal castration have been reported to range from 0-32%, with incidence of complications often considered to be lower in younger animals[25, 34, 35].

Complications of both prescrotal and scrotal techniques may include dehiscence, scrotal swelling, hemorrhage, subcutaneous bruising, scrotal hematoma and self-trauma

to the surgical site. Dogs with minor complications may need no intervention, while others may require veterinary care. In one study of 218 animals, 7 dogs and 2 cats developed scrotal hematoma following a prescrotal castration[14, 35]. For instance, dogs with severe scrotal hematoma may experience necrosis of the scrotal skin, necessitating a scrotal ablation[35]. Animals with evidence of abdominal hemorrhage may require an exploratory laparotomy to locate and ligate the bleeding pedicle.

The scrotal technique is described as an accepted method for pediatric canine castrations[6], but is becoming accepted for adult canine castrations by veterinary surgeons in high volume spay / neuter clinics[14].

In the past, scrotal castrations have been discouraged because male dogs are considered to be "scrotal conscious"[37]. The accepted thought has been that disturbing the scrotal skin will cause excessive self-mutilation by the patient, most likely due to irritation caused by skin sutures[14]. For this reason, several studies have discouraged clipping or prepping the scrotum at all, and have recommended draping the scrotum out of the surgical field[37]. The potential for self-mutilation has been given as the reason to avoid performing scrotal castrations in spite of the fact that there is, at present, no reported scientific evidence supporting this conclusion[14].

The scrotal castration technique has recently been described as a more efficient approach, offering a smaller incision and less incidence of scrotal hematoma formation[14]. For this procedure the patient is placed in dorsal recumbency. An incision is made over the median raphe, through the fascia to expose the testicle. The testicles are delivered through the incision and ligated with a Miller's knot or surgeon knot. Skin sutures should be avoided.

Recently, advances have been made in surgical and diagnostic procedures, especially in human medicine, toward less invasive techniques. These advances have led to reduced morbidity, and wound contamination, as well as less pain and shorter patient recovery periods[40]. While this practice is developing at a slower rate in veterinary medicine, there are ongoing efforts to make common procedures less invasive. The scrotal technique, although not well documented, is considered by many high quality/high volume spay/neuter veterinarians to be quicker and less invasive than the traditional prescrotal approach[14]. Additionally, the emergence of high quality/high volume surgery clinics has created a need to identify alternative, safe, but more efficient techniques. Spay/neuter programs often have limited resources and an enormous number of animals to sterilize. Minimizing surgical time without sacrificing animal welfare can be a tremendous benefit in such a program. Procedures that reduce anesthetic time and expedite the surgical procedure by even a few minutes can have impact on a high volume program.

Scrotal castration, though contrary to traditional teaching, has gained popularity in recent years as a safe alternative to the prescrotal technique. Although there are numerous clinics that utilize this technique, there is no published research documenting complication rates or comparing complications between the scrotal and prescrotal techniques.

Several articles published in more recent years outline the technique for incorporating the scrotum as a transposition flap for closure of wounds in the perineum or caudal aspect of the thigh[41, 42]. Successful results were reported with no mention of self-trauma induced by the dogs.

Non-surgical Castration Techniques

Chemical sterilization has not been widely implemented as a means of castrating the male dog. Chemical agents injected into the testes, epididymis or vas deferens cause infertility by disrupting spermatogenesis[43]. Various chemicals such as lactic acid, zinc gluconate and calcium chloride have been used as an intratesticular injection to dogs and other species. Sangeeta *et al* (2006) found that the injections successfully sterilized the animals but were associated with increased pain and healing times were found to be longer in the chemically castrated animals[44]. Healing times for chemical castrations were approximately twice the healing times for surgical castration. Other authors report no or minimal signs of discomfort following injection[43]. In a study for Food and Drug Administration (FDA) approval, post-injection complications included scrotal ulceration and dermatitis, scrotal self-mutilation, preputial swelling, vomiting, diarrhea, anorexia, lethargy and leukocytosis though the manufacturer reported that incidence of all side effects was low with 6.3% of dogs having minor reactions involving testicular swelling, preputial swelling, infection, bruising and self-trauma[45]. In this same study, 1.1% of dogs experienced systemic reactions following surgery including vomiting, anorexia, neutrophilia and diarrhea severe enough that medical treatment was required.

Depending on the treatment method, dogs may remain fertile up to 60 days post-injection due to residual sperm in the epididymis. Furthermore, chemical sterilization does not eliminate gonadal sources of testosterone as only spermatogenesis is affected[43, 46]. In 2012, Oliveira, *et al.* evaluated an intratesticular injection of a zinc gluconate-based solution and its ability to suppress spermatogenesis in adult dogs. Eighty percent (8 of the 10) of the pubertal dogs, ranging in age from 8 months to 4 years, had

ejaculates without sperm. The other 2 dogs had significantly reduced sperm content in ejaculate[47]. In a 2000 study, an intratesticular injection of a 70% glycerol solution did not produce azoospermia nor result in sterility in dogs[48].

Immunocastration has been demonstrated as a successful alternative to surgical castration in the male dog[43, 46-48]. Immunization against gonadotropin-releasing hormone (GnRH) using a CDV p35-conjugated GnRH disrupts the normal hypothalamic control of reproduction. Since GnRH is an extremely small protein, it must be coupled with carrier materials in order to stimulate an adequate immunological response[49]. Additionally, adjuvanted substances must be utilized to break the normal "self tolerance" and facilitate an autoimmune response to self-generated hormones such as GnRH[50]. In the future, it may be feasible to generate autoantibodies against other reproductive proteins though GnRH remains the most likely target. Hormones such as the sex steroids, while seemingly a reasonable target, share common precusors with other important hormones that are vital for normal physiology. Similarly, a vaccination against FSH and LH would have problematic implications as TSH would be affected as well (through a shared alpha subunit)[50]. Immunologic castration using CDV p35-conjugated GnRH proved an effective and safe method for sterilizing the male and canine, resulting in regression of spermatogenesis for a period of 18 weeks post-vaccination[49]. Advances have been made in recent years in the area of immunocastration or contraceptive vaccines, though none that have been sufficiently studied and developed for practical application[50]. While proven effective in research settings, contraceptive vaccinations have been associated with many shortcomings that make them impractical in a clinical setting[50]. Contraceptive vaccinations may not render the animal permanently sterile

and thus booster vaccinations may be needed. Individual animals may respond differently to the vaccination and degree and longevity of sperm suppression is variable. Additionally, adjuvants in vaccinations can cause undesirable side effects, most often pain and inflammation[48, 50].

Vasectomies and vasal occlusion are less invasive surgical techniques than total orchiectomy[48]. However, these procedures are associated with similar anesthetic risks as with surgical castration and post-surgical complications can develop.

Statement of Purpose

The growing number of high quality/high volume spay/neuter clinics has led to a demand to identify the most efficient and safest castration and spay procedures in companion animals. For this reason, there is a need to more closely examine the scrotal castration method and the associated incidence of complications. This study was designed to evaluate the hypothesis that there are no differences in efficiency or complication rates between scrotal and prescrotal procedures.

CHAPTER III

MATERIALS AND METHODS

Dogs for this study were selected from five shelters serviced by the Mississippi State University (MSU) mobile surgical unit and from all animals presented for castration to the Humane Alliance (HA) Clinic in North Carolina.

All dogs were apparently healthy adult males over 6 months of age. Dogs with signs of disease, illness or cryptorchidism were excluded from the study. Animals were randomly allocated into 2 treatment groups, scrotal and prescrotal. All protocols and procedures were performed in accordance with MSU IACUC approval # 11-043 and all owners and shelter managers were required to sign a client consent form (appendix A).

Presurgical and surgical protocols were consistent among each site. Each participating veterinarian was required to view a video depicting standardized surgical methods and follow a prescribed surgical technique for the two approaches to the canine castration.

Prior to anesthesia, food was withheld for a maximum of 12 hours. Water was not withheld. Dogs were anesthetized with butorphenol[a] (0.35 mg/kg of body weight), ketamine[b] (3.5 mg/kg of body weight) and dexmeditomidine[c] (17.5 mcg/kg of body weight) given as a mixture intravenously (IV). Each dog was given subcutaneous

[a] Butorphanol,
[b] Ketaset, Ft. Dodge Laboratories, Fort Dodge, Iowa
[c] Dexdomitor, Pfizer Animal Health, Exton, PA

carprofen[d] (4.4 mg/kg of body weight) for pain control. The surgical area, including the scrotum and prescrotal area, was clipped and prepped using chlorhexidine[e] scrub and the surgical area was covered with a clean, chlorhexidine soaked surgical sponge. The dog was then moved to the surgical suite and placed in dorsal recumbency. The clean surgical sponge was removed and the surgical site was aseptically draped. There were no differences in surgical prep between the two procedures.

In the event that additional anesthesia was needed during the procedure, an additional half dose of the anesthetic mixture was administered intramuscularly. Vital signs, including capillary refill time, heart rate and respiratory rate were monitored throughout surgeries and any outside of normal parameters were noted.

For those dogs undergoing a prescrotal incision technique, a #15 scalpel blade on a Bard-Parker handle was used to incise the prescrotal skin. The incision was begun just cranial to the scrotum and continued cranially 2 to 5 cm, depending on the size of the animal, until the incision was of sufficient length to allow the testicles to be exteriorized. The first testicle was delivered through the prescrotal incision; fascia was stripped from the spermatic cord to allow the testicle and cord to be fully exteriorized for a closed castration technique. Two curved mosquito hemostats were used to crush the tissues of the spermatic cord proximal to the testicle. The spermatic cord was transected distal to the second hemostat using a #15 scalpel blade. The most proximal hemostat was removed and ligature of 2-0 polygalactin 910[f] was secured with a Miller's knot in the area previously crushed by the hemostat. The remaining hemostat was subsequently

[d] Rimadyl®, Pfizer Animal Health, Exton, PA
[e] Nolvasan, Fort Dodge Animal Health, Fort Dodge, Iowa
[f] Vicryl, Ethicon, Inc., Somerville, NJ

removed and the remainder of the spermatic cord was placed back into the incision after checking for hemorrhage. The procedure was repeated for the second testicle. The incision was closed with 2-0 polygalactin 910[f] in a simple interrupted, subcuticular pattern.

For the scrotal technique, a #15 scalpel blade on a Bard-Parker handle was used to make a 2-5 cm incision in the scrotum. The first testicle was delivered through the scrotal incision along the median raphae and a closed castration was performed as described for the prescrotal technique. The procedure was repeated on the second testicle. A single subcutaneous suture was placed in the scrotum using 2-0 polygalactin 910[f.]

Dogs were placed in a cage or run in the treatment area and monitored during recovery. Dogs were ultimately returned within a 2 hour frame to the shelter environment. Privately owned dogs were returned to their owners approximately 24 hours following surgery.

Cases at MSU were monitored by shelter employees, while cases at HA were monitored by the individual owners. Whenever possible, the same individual assessed multiple cases. All observers were given verbal and written instructions concerning proper documentation of complications on the provided questionnaire. Complications were defined as the presence of hemorrhage immediately following surgery, the incidence of self-trauma and the presence of swelling within 72 hours following surgery. Patients were monitored for the presence of post operative pain, bleeding, self-trauma and swelling or hematomas (See appendix B). Any animal experiencing a complication was treated appropriately (See appendix C). Complications were broken down into the presence and absence of hemorrhage (blood from the incision site), pain (vocalization on

palpation of the incision site), self-trauma (licking, chewing or scratching at the incision) and swelling of the incision site and scrotum. Swelling was evaluated at 2, 4, 6, 24, 48, and 72 hours following the surgery.

Efficiency was recorded for the procedures done by MSU surgeons. Efficiency was measured in minutes of surgical time starting with the incision and concluding after the last suture was placed.

Data were entered into a spreadsheet (Excel[g]) and analyzed for efficiency and the presence or absence of complications using SAS[h] statistical software.

[g] Excel – Microsoft corp, Redmond, WA
[h] SAS Statistical Institute Cary, NC

CHAPTER IV

RESULTS

Surgeries performed at Humane Alliance (HA) and Mississippi State University (MSU) were evaluated together as well as individually. The results from the group evaluations were also consistent between the two populations.

Four hundred thirty seven dogs fit the criteria and were included in the study. The average weight of the dogs included was 17 kgs ($\pm$ 0.15 kg), and ranged from 1 kg to 60 kgs. The prescrotal approach was performed on 206 dogs, while the remaining 231 were castrated using the scrotal approach. Of the total surgeries performed, 164 were performed at MSU and 273 were performed at HA. Surgeries were performed by nine licensed veterinarians. All veterinarians were proficient in high quality/high volume spay/neuter and had a minimum of 4 years of experience.

No complications were noted during the surgical procedures.

For statistical purposes, complications were broken down into the presence or absence of hemorrhage, self-trauma, pain, and swelling (table 1).

Table 1 Comparison of Complication by Scrotal and Prescrotal Castration Method

	Prescrotal			Scrotal		
	MSU[1]	**HA[2]**	**Total**	**MSU[1]**	**HA[2]**	**Total**
Complication	#(%)	#(%)	#(%)	#(%)	#(%)	#(%)
Hemorrhage	33(39%)	2(2%)	35(15%)	29(36%)	5(3%)	34(17%)
Pain	22(26%)	8(7%)	30(13%)	20(25%)	3(2%)	23(11%)
Trauma	29(35%)	5(4%)	34(15%)	18(23%)	2(1%)	20(10%)
	Total Cases=231			Total Cases=206		

Note: [1]Mississippi State University, [2]Humane Alliance
#= number of complications recorded
%= percentage of complications recorded

Table 2 Univariate Analysis: Complications of Castration According to State and Method

Outcome	Variable	Comparison	*n (%)	OR	95% Wald's CI	p-value
Hemorrhage	Method	scrotal	36 (15.6%)	0.93	0.560,1.56	0.793
		prescrotal	34 (16.5%)	1.0		
	State	MS[1]	63 (38.4%)	23	10.5, 53.5	<0.0001
		NC[2]	7 (2.6%)	1.0		
Pain	Method	scrotal	22 (9.52%)	.61	0.344, 1.11	0.1067
		prescrotal	30 (4.56%)	1.0		
	State	MS[1]	41 (45.00)	7.9	3.95, 16.0	<0.0001
		NC[2]	11 (4.03)	1.0		
Trauma	Method	scrotal	20 (8.66%)	0.50	0.275, 0.897	0.0203
		prescrotal	33(16.02%)	1.0		
	State	MS[1]	46 (28.05%)	14	6.50, 33.8	<0.0001
		NC[2]	7 (2.56%)	1.0		
Swelling 2 hours	Method	scrotal	29 (12.55%)	0.81	0.470, 1.40	0.45
		prescrotal	31 (15.05%)	1.0		
	State	MS[1]	53 (32.32%)	18.1	7.99, 41.1	<0.0001
		NC[2]	7 (2.56)	1.0		
Swelling 4 hours	Method	scrotal	24 (10.39)	0.68	0.383, 1.21	0.1875
		prescrotal	30 (14.56)	1.0		
	State	MS[1]	46 (28.05)	13	5.91, 28.2	<0.0001
		NC[2]	8 (2.93)	1.0		
Swelling 6 hours	Method	scrotal	27 (11.74)	0.75	0.431, 1.31	0.3108
		prescrotal	31 (15.05)	1.0		
	State	MS[1]	42(25.61)	5.5	2.97, 10.2	<0.0001
		NC[2]	16 (5.88%)	1.0		
Swelling 24 hours	Method	scrotal	47 (20.43)	0.85	0.536, 1.33	0.4695
		prescrotal	48 (23.30%)	1.0		
	State	MS[1]	35 (21.47%)	0.97	0.606, 1.56	0.9017
		NC[2]	60 (21.98)	1.0		
Swelling 48 Hours	Method	scrotal	49 (23.79)	0.70	0.439, 1.11	0.1315
		prescrotal	41 (17.90)	1.0		
	State	MS[1]	25 (15.43%)	0.58	0.351, 0.972	0.0384
		NC[2]	65 (23.81%)	1.0		
Swelling 72 hours	Method	scrotal	31 (13.60%)	0.67	0.403, 1.13	0.1328
		prescrotal	39 (18.9%)	1.0		
	State	MS[1]	16 (9.94%)	0.44	0.247, 0.812	0.0082
		NC[2]	54 (19.78)	1.0		

Note: [1]Mississippi State University, [2]Humane Alliance
n = number of complications
%= percentage of complications recorded
OR= odds ratio

Sixty nine animals had hemorrhage following surgery (prescrotal = 35, scrotal = 34). The weight of the animal and site (state) of surgery were significantly associated

with hemorrhage (table 3). The odds of hemorrhage increased significantly as weight increased and were significantly increased at 72 hours following surgery (table 4). The method of castration (scrotal vs prescrotal) did not influence the incidence of hemorrhage.

Table 3 Analysis of Maximum Likelihood Estimates of Prescrotal and Scrotal Castration (Complication by State and Weight in kgs)

Parameter	**Estimate**	**Std Error**	**OR**	**95% Wald's CI**	**p-value**
State (MS vs. NC)	3.27	0.43	26	11.4, 61.0	<0.0001
kgs	0.04	0.016	1.0	1.01, 1.07	0.015
kgs = 5			1.2	1.04, 1.42	

Note: OR = Odds ratio

Table 4 Odds Ratio Estimates/Confidence Interval for Complications Following Castration According to Weight (kgs)

Complication	0/1	n	average wt (kg)	OR	CI	P-value
hemorrhage	0	360	16.46	1.0		
	1	70	18.46	1.0	0.994,1.04	0.1517
pain	0	378	16.56	1.0		
	1	52	18.45	1.0	0.990, 1.04	0.2304
trauma	0	377	16.71	1.0		
	1	53	17.33	1.0	0.979, 1.03	0.6897
swell2	0	370	16.61	1.0		
	1	60	17.85	1.0	0.986, 1.04	0.4054
swell4	0	376	16.61	1.0		
	1	54	18.01	1.0	0.986, 1.04	0.3672
swell6	0	371	16.54	1.0		
	1	58	18.57	1.0	0.992, 1.04	0.1791
swell24	0	335	16.18	1.0		
	1	94	18.91	1.0	1.00, 1.05	0.0293
swell48	0	339	15.96	1.0		
	1	89	19.69	1.0	1.01, 1.05	0.0037
swell72	0	357	15.68	1.0		
	1	70	22.03	1.1	1.03, 1.08	<0.0001

Note: n= number of cases
0 = no complication
1 = complication present

Fifty three animals (prescrotal = 34, scrotal = 20) were recorded as inflicting self-trauma through biting, licking or chewing their incision. The incidence of self-traumatization was found to be significantly ($p \leq .05$) higher in animals undergoing the prescrotal method than in those undergoing the scrotal method (table 5).

Table 5 Self-trauma Following Castration According to State and Weight

Parameter	Estimate	Std Error	OR	95% Wald's CI	p-value
State (MS vs. NC)	2.67	0.42	15	6.377, 33.3	<0.0001
Method (scrotal vs. prescrotal)	-0.64	0.32	0.53	0.279, 0.992	0.0473

Note: OR = Odds ratio

There were no significant associations between the surgical method and weight of the animal in the incidence of post-operative hemorrhage or pain.

Dogs were evaluated for swelling at 2, 4, 6, 24, 48, and 72 hours following the surgery (table 6). Animals recorded as having swelling of the incision site post-operatively ranged from 23 to 50 but were not mutually exclusive.

Table 6 Swelling According to State and Method

	Prescrotal			Scrotal		
Hour Post Op	MSU[1] #(%)	HA[1] #(%)	Total #(%)	MSU[1] #(%)	HA[1] #(%)	Total #(%)
2	31(37%)	2(2%)	33(14%)	23(29%)	5(3%)	28(14%)
4	28(33%)	4(3%)	32(14%)	19(24%)	4(3%)	23(11%)
6	24(29%)	8(7%)	31(13%)	18(23%)	8(5%)	26(13%)
24	22(26%)	27(22%)	49(21%)	14(18%)	33(22%)	47(23%)
48	16(19%)	34(28%)	50(22%)	10(13%)	31(21%)	41(20%)
72	11(13%)	29(24%)	40(17%)	6(6%)	25(17%)	31(15%)
	Total Cases=231			Total Cases=206		

Note: # = number of cases
% = percentage of complications
[1]Mississippi State University, [2] Humane Alliance

There were no significant associations between method or weight and swelling at 2, 4, or 6 hours. However, weight was significant at 24, 48 and 72 hours post surgery (table 7).

Table 7 Comparison of Swelling at 72 hrs Following Surgery According to State and Method

Comparison of Swelling at 72 hrs Following Surgery According to State and Method					
Parameter	**Estimate**	**Std Error**	**OR**	**95% Wald's CI**	**p-value**
State (MS[1] vs. NC[2])	-0.08	0.31	0.47	0.255,0.859	0.0142
kgs	0.05	0.01	1.1	1.03, 1.08	<0.0001

Note: OR = Odds ratio

The length of surgery was recorded for cases at MSU. Time was found to be associated with hemorrhage. For every additional minute of efficiency, the odds of hemorrhage were 1.3 times greater. A difference was recorded between the two procedures, with the average surgical time for the scrotal approach being 1.53 minutes faster than the prescrotal approach (Table 8). The scrotal method was approximately 30% faster than the prescrotal method. Minimal difference in efficiency was noted between surgeons (Table 9), but results for overall efficiency were consistent between the two surgeons.

Table 8 Average Surgical Time

Method	**#**	**Mean**	**Std. Dev**	**Std. Error**	**CI**
Prescrotal	84	5.1	1.26	0.138	(4.86, 5.41)
Scrotal	80	3.6	1.0	0.100	(3.38, 3.82)

Note: # = number of cases

Table 9 Average Surgical Time According to Surgeon

Average Surgical Time by Surgeon (minutes)						
Surgeon	**Method**	#	**Mean**	**Std. Dev**	**Std. Error**	**CI**
1	prescrotal	21	5.8	1.18	0.260	(5.22, 6.30)
	scrotal	20	3.9	1.09	0.240	(3.34, 4.36)
2	prescrotal	63	4.9	1.24	0.160	(4.61, 5.23)
	scrotal	60	3.5	0.97	0.130	(3.28, 3.77)

Note: # = number of cases

CHAPTER V

DISCUSSION

Canine castration is one of the most common procedures performed in veterinary medicine[25]. The prescrotal approach to canine castration has traditionally been the most accepted approach and perhaps the only approach taught in most veterinary schools[6, 51]. Recently, the evolution of high quality/high volume spay neuter organizations has increased the need for more efficient techniques. It is imperative that surgical techniques be safe and associated with a low level of morbidity as the animals are often returned to group shelter housing with limited resources and personnel to care for them.

Consideration should be given to other possible approaches that may be as effective, safe and efficient when compared to the long-accepted prescrotal castration. The author has practiced a non-traditional scrotal approach for several years, and has noticed no apparent difference in complication rate. To the author's knowledge there have been no previous studies comparing either the surgical efficiency or the incidence of complications between the traditional prescrotal and scrotal methods. This study was designed to evaluate the differences in complication rate and efficiency between scrotal and prescrotal canine castration.

While inherent variability introduced by the participation of multiple surgeons was unavoidable, differences were kept to a minimum by using standardized methods.

Surgeons were unable to be blinded, but were not permitted to evaluate post surgical complications. While possible interobserver bias was unavoidable, technicians and shelter staff were verbally trained regarding possible complications. Every effort was made in this study to reduce variability and bias. However, due to the nature of the study some variability and bias was inevitable. Also, animals were obtained from several different environments, including individual homes, sheltering organizations and foster situations. Unlike other studies that examined only owned animals, this study examined some dogs kept in traditionally high stress situations that may increase the risk of destructive behavior and may possibly lead to extended healing times. Possible shortcomings of previous case studies include a high variability between what is considered a complication and relying on subjective reports from numerous clinics. The studies employed no instrument to assure consistency in the reporting of complications. Furthermore, what one clinician/observer might label a surgical complication may be overlooked as normal healing by another. The degree of scrutiny of a healing incision may have varied between individual researchers.

The overall complication rates within each of the locations were not significantly different between the two methods of castration. However, the reported incidence of complication rates was significantly higher in animals castrated at MSU than those castrated at HA. Animals at MSU were more likely to have reported complications of hemorrhage, pain and swelling. However, this could likely explained by the variability in observers. Animals at MSU were observed by shelter personnel of varying experience and education levels. Animals at HA were observed initially by trained medical staff consisting of technicians and veterinarians and follow-up observations (at 24, 28, and 72

hours) were made and recorded by the animal owners, accounting for further variability in the complications that were recorded. It is likely that there was variability between what was considered excessive hemorrhage, pain or swelling by the staff at HA, animal owners, and shelter employees working with MSU.

Individuals that assessed the animals post-operatively were given verbal instructions concerning the accurate assessment and recording of complications. In the event that an animal was owned or was housed in a foster home, the owner or foster owner of the animal assessed that animal. In the shelters, shelter personnel were responsible for reporting complications. As far as possible, the same individual was to assess the dogs at each facility. However, in some cases, multiple personnel may have been required to fulfill the 3-day duration of follow-up in each case introducing some additional variability to the study. Personnel had various levels of education and training which may have led to differences in their ability to report the data correctly. Additionally, since multiple facilities participated in data collection, variation in the scoring of complications could have occurred.

Overall, animals with prescrotal incisions had a significantly higher incidence of self-trauma ($p \leq 0.05$). This data is noteworthy considering the perception of scrotal consciousness in the canine and may indeed provide evidence to disprove the idea that a scrotal approach may increase the incidence of self-trauma. This is likely due to the fact that less suture material is required to close the wound in a scrotal incision than that required to close a prescrotal incision.

Animals in this study presented from many varied backgrounds. Beyond the basic pre-anesthetic physical examination, there was no information available on health

status, as is typical in shelters. No pre-anesthetic blood/urine screening was performed to assess organ function, heartworm status or exposure to pathogens such as *Ehrlichia*. The financial and time constraints of many high quality/high volume spay/neuter organizations do not allow for extensive work-ups. However, underlying parasitic infections or other diseases could have adversely affected the ability of an individual animal to achieve normal hemostasis and normal post-surgical healing. These variations, however, would likely involve dogs in all subsets.

The duration of each surgery at MSU was recorded by a veterinary assistant present in the surgery suite. No data on duration of the surgery was available from HA. There were minimal differences in surgical time between surgeons performing the surgeries at MSU. There were differences in the surgical time for prescrotal and scrotal approaches. The mean surgical time for the prescrotal approach was 5.1 minutes, while the average time for the scrotal approach was 3.6 minutes. The difference in surgical time was consistent between the two surgeons.

This study indicates that complication rates between the two approaches are similar, while the scrotal approach offers faster surgery times and lowered incidence of self-trauma. In the future studies, efforts to eliminate or further minimize interobserver variability. While swelling was tracked out to 72 hours, pain, self trauma and hemorrhage were recorded only in the hours immediately following recovery from anesthesia. It would be helpful to follow the incidence of pain, self-trauma and hemorrhage out to at least 7 days.

CHAPTER VI

CONCLUSION

Scrotal castration was not found to have a significantly greater incidence of post-operative complications when compared with traditional prescrotal castration. In the category of self-trauma, however, the scrotal method was in fact associated with less self-trauma. Scrotal castration also offers an approximately 30% faster surgery time. It was determined that either method may be safely and effectively utilized in high quality/high volume spay neuter organizations and that the ultimate choice can be left up to the discretion of the surgeon. Surgeons should be trained on both procedures and then employ the one with which they are most confident.

REFERENCES

1. The Humane Society of the United States, *Estimates of Pet Overpopulation.* http://www.humanesociety.org/issues/pet_overpopulation/facts/overpopulation_estimates.html.

2. Clevenger, J. and P.H. Kass, *Determinants of adoption and euthanasia of shelter dogs spayed or neutered in the university of california veterinary student surgery program compared to other shelter dogs.* J Vet Med Educ, 2003. **30**(4): p. 372-8.

3. Hart, B.L. and R.A. Eckstein, *The role of gonadal hormones in the occurrence of objectionable behaviors in dogs and cats.* Applied animal behaviour science, 1997. **52**(3/4): p. 331-344.

4. Stubbs, W.P. and M.S. Bloomberg, *Implications of early neutering in the dog and cat.* Semin Vet Med Surg (Small Anim), 1995. **10**(1): p. 8-12.

5. Bryan, J., et al., *A Population Study of Neutering Status as a Risk Factor for Canine Prostate Cancer.* The Prostate, 2007. **67**: p. 1174-1181.

6. Fossum, T.W., *Small Animal Surgery 2ed.* 2002: p. 619-620.

7. Trevejo, R., M. Yang, and E.M. Lund, *Epidemiology of surgical castration of dogs and cats in the United States.* J Am Vet Med Assoc, 2011. **238**(7): p. 898-904.

8. Nassar, R., J. Talboy, and C. Moulton, *Animal shelter reporting study 1990.* Englewood: American Humane Association, 1992.

9. New, J.C., Jr., et al., *Birth and death rate estimates of cats and dogs in U.S. households and related factors.* J Appl Anim Welf Sci, 2004. **7**(4): p. 229-41.

10. Patronek, G.J., A.M. Beck, and L.T. Glickman, *Dynamics of dog and cat populations in a community.* J Am Vet Med Assoc, 1997. **210**(5): p. 637-42.

11. Maarschalkerweerd, R.J., et al., *Influence of orchiectomy on canine behaviour.* Vet Rec, 1997. **140**(24): p. 617-9.

12. Serpell, J.A. and J.T. Hsu, *Effects of breed, sex and neuter status on trainability in dogs.* Anthrozoos, 2005. **18**(3).

13. Alexander, S.A. and S.M. Shane, *Characteristics of animals adopted from an animal control center whose owners complied with a spaying/neutering program.* J Am Vet Med Assoc, 1994. **205**(3): p. 472-6.

14. Miller, L. and S. Zawistowski, *Shelter Medicine for Veterinarians and Staff, 2 ed.* 2013: p. 635.

15. Stubbs, W.P., et al., *Effects of prepubertal gonadectomy on physical and behavioral development in cats.* J Am Vet Med Assoc, 1996. **209**(11): p. 1864-71.

16. Hart, B.L., *Effects of neutering and spaying on the behavior of dogs and cats: questions and answers about practical concerns.* J Am Vet Med Assoc, 1991. **198**(7): p. 1204-5.

17. Obradovich, J., R. Walshaw, and E. Goullaud, *The influence of castration on the development of prostatic carcinoma in the dog. 43 cases (1978-1985).* J Vet Intern Med, 1987. **1**(4): p. 183-7.

18. Whitehair, J.G., P.B. Vasseur, and N.H. Willits, *Epidemiology of cranial cruciate ligament rupture in dogs.* J Am Vet Med Assoc, 1993. **203**(7): p. 1016-9.

19. Duval, J.M., et al., *Breed, sex, and body weight as risk factors for rupture of the cranial cruciate ligament in young dogs.* Journal of the American Veterinary Medical Association, 1999(6): p. 811-814.

20. Slauterbeck, J.R., et al., *Canine ovariohysterectomy and orchiectomy increases the prevalence of ACL injury.* Clin Orthop Relat Res, 2004(429): p. 301-5.

21. Witsberger, T.H., et al., *Prevalence of and risk factors for hip dysplasia and cranial cruciate ligament deficiency in dogs.* J Am Vet Med Assoc, 2008. **232**(12): p. 1818-24.

22. Teske, E., et al., *Canine prostate carcinoma: epidemiological evidence of an increased risk in castrated dogs.* Mol Cell Endocrinol, 2002. **197**(1-2): p. 251-5.

23. Lawrence, J.A. and C.F. Saba, *Tumors of the male reproductive system.* 2013: p. 557-571.

24. White, C.R., et al., *Cutaneous MCTs: associations with spay/neuter status, breed, body size, and phylogenetic cluster.* J Am Anim Hosp Assoc, 2011. **47**(3): p. 210-6.

25. Kustritz, M.V., *Determining the optimal age for gonadectomy of dogs and cats.* J Am Vet Med Assoc, 2007. **231**(11): p. 1665-75.

26. Fazili, M.R., et al., *Evaluation of pinhole castration technique in rams.* Small Ruminant Research, 2009. **84**(1-3): p. 61-64.

27. Melches, S., et al., *Castration of lambs: a welfare comparison of different castration techniques in lambs over 10 weeks of age.* Vet J, 2007. **173**(3): p. 554-63.

28. Ponvijay, K.S., *Pinhole castration: a novel minimally invasive technique for in situ spermatic cord ligation.* Vet Surg, 2007. **36**(1): p. 74-9.

29. H, M., et al., *A Survey of Equine Castration Complications.* J Equine Vet Sc, 1995. **15**(12): p. 522-526.

30. Price, J., et al., *Current practice relating to equine castration in the UK.* Res Vet Sci, 2005. **78**(3): p. 277-80.

31. Diesel, G., D. Brodbelt, and C. Laurence, *Survey of veterinary practice policies and opinions on neutering dogs.* Veterinary Record, 2010. **166**(15): p. 455-458.

32. Greenfield, C.L., D.J. Schaeffer, and A.L. Johnson, *Influence of demographic variables on the frequency of use of various procedures, skills, and areas of knowledge among veterinarians in private small animal exclusive or predominant practice and proficiency expected of new veterinary school graduates.* J Am Vet Med Assoc, 2005. **226**(1): p. 38-48.

33. Oliveira, K., L. Muzzi, and B. Torres, *A comparative study among three open orchiectomy techniques in cats.pdf.* Acta Scientiae Veterinariae, 2010. **38**(2): p. 177-183.

34. Pollari, F.L., et al., *Postoperative complications of elective surgeries in dogs and cats determined by examining electronic and paper medical records.* J Am Vet Med Assoc, 1996. **208**(11): p. 1882-6.

35. Adin, C.A., *Complications of ovariohysterectomy and orchiectomy in companion animals.* Vet Clin North Am Small Anim Pract, 2011. **41**(5): p. 1023-39, viii.

36. Looney, A.L., et al., *The Association of Shelter Veterinarians veterinary medical care guidelines for spay-neuter programs.* J Am Vet Med Assoc, 2008. **233**(1): p. 74-86.

37. Howe, L.M., *Surgical methods of contraception and sterilization.* Theriogenology, 2006. **66**(3): p. 500-9.

38. Knecht, C.D., *An alternate approach for castration of the dog*. 1976. p. 469-473.

39. Pollari, F.L. and B.N. Bonnett, *Evaluation of postoperative complications following elective surgeries of dogs and cats at private practices using computer records.* Can Vet J, 1996. **37**(11): p. 672-8.

40. Parkinson, T.J., *Progress towards less invasive veterinary surgery.* Vet Rec, 2012. **171**(3): p. 67-8.

41. Grigoropoulou, V.A., et al., *Scrotal Flap for Closure of Perineal Skin Defects in Dogs.* Vet Surg, 2012: p. 1-6.

42. Matera, J.M., et al., *Use of the scrotum as a transposition flap for closure of surgical wounds in three dogs.* Vet Surg, 2004. **33**(2): p. 99-101.

43. Kutzler, M. and A. Wood, *Non-surgical methods of contraception and sterilization.* Theriogenology, 2006. **66**(3): p. 514-25.

44. Sangeeta, D.G., A.; Mishra, A.; Singh, *Chemical Sterilization in Animals - an overview.* Veterinary Practioner, 2006. **7**(1): p. 91-92.

45. Ark Sciences, *FAQ.* http://www.arksciences.com/faq.html, 02/19/2013.

46. Levy, J.K., et al., *Comparison of intratesticular injection of zinc gluconate versus surgical castration to sterilize male dogs.* Am J Vet Res, 2008. **69**(1): p. 140-3.

47. Oliveira, E.C., et al., *Permanent contraception of dogs induced with intratesticular injection of a Zinc Gluconate-based solution.* Theriogenology, 2012. **77**(6): p. 1056-63.

48. Immegart, H.M. and W.R. Threlfall, *Evaluation of intratesticular injection of glycerol for nonsurgical sterilization of dogs.* Am J Vet Res, 2000. **61**(5): p. 544-9.

49. Jung, M.J., et al., *Induction of castration by immunization of male dogs with recombinant gonadotropin-releasing hormone (GnRH)-canine distemper virus (CDV) T helper cell epitope p35.* J Vet Sci, 2005. **6**(1): p. 21-4.

50. Munks, M.W., *Progress in development of immunocontraceptive vaccines for permanent non-surgical sterilization of cats and dogs.* Reprod Domest Anim, 2012. **47 Suppl 4**: p. 223-7.

51. Tivers, M.S., et al., *Questionnaire study of canine neutering techniques taught in UK veterinary schools and those used in practice.* J Small Anim Pract, 2005. **46**(9): p. 430-5.

APPENDIX A

CLIENT CONSENT FORM FOR CLINICAL STUDY

Client Consent Form for Clinical Study

Study:
Comparison of Scrotal and Prescrotal Castration Techniques

Purpose of Study:
The purpose of this study is to compare the safety and efficiency of the prescrotal castration technique and the scrotal castration technique.

Principal Investigators: Dr. Phil Bushby and Dr. Kimberly Woodruff (College of Veterinary Medicine),

Description of Study:
For many years, prescrotal castration has been the only accepted technique of surgical sterilization in the male canine. While this is a safe form of sterilization, there are side effects occassionally encountered. These include scrotal hematomas and self mutilation of the incision site. In recent years some high-quality/high-volume spay/neuter clinics have begun to utilize scrotal castration. This method is thought to be associated with fewer complications. The purpose of this study is to evaluate the safety of the scrotal castration in comparison with the prescrotal castration technique. This study will utilize animals from animal shelters in the surrounding Mississippi area currently being serviced by the Mobile Veterinary Unit. Four hundred thirty four healthy male adult dogs will be selected and randomly assigned to undergo either scrotal castrations or prescrotal castrations with all surgeries being performed by Dr. Woodruff. The surgery will be performed on site at the shelter in the Mobile Unit and dogs will be returned to the shelter post-operatively. Questionaires will be provided for each animal addressing pain, post-operative hemorrhage and swelling, and any post-operative self-trauma. The animals will be evaluated by veterinary students at 2 hours and 4 hours post op and by shelter staff at 24 hours post op. Any complications will be treated appropriately.

Risks:
Dogs involved in this study will be placed under general anesthesia and undergo an elective procedure, which always carries a slight risk of complication, including hemorrhage or anesthetic complications. However, this study will utilize animals already scheduled for castration on the mobile unit and no animal will be subject to castration solely for the purpose of this study.

Voluntary Participation:

Participation in this study is voluntary. You will not be penalized in any way if you elect not to participate.

Confidentiality of Records:

Although information gained from this investigation may be published and used for educational or regulatory purposes, your identity and your animal's identity will remain confidential to the extent provided by law.

Financial Obligation, Withdrawal from Study:

_____

☐ **I agree to the previously listed guidelines, and want to enter my pet into this study.**
I understand that there will be no extra cost to me, and that all information derived from the study will belong to the study sponsor. I also understand that the investigators may terminate my animal's participation in the study if continuation is not in the best interest of my animal.

Owner Name: Pet Name:

Owner Signature: Date:

Clinician Signature: Date:

Thank you for agreeing to enter your dog into this study. If you have any questions about this study, please contact Drs. Phil Bushby or Kimberly Woodruff at 662-325-3432.

APPENDIX B

SCROTAL CASTRATION POST-OPERATIVE ASSESSMENT

Date: _____

Scrotal Castration Post-operative assessment

Organization: _____

Animal ID: _____

Post-operative assessment

Please assess the amount of post-operative hemorrhage (bleeding).

1. no post-operative bleeding occurred
2. minimal post operative bleeding occurred – ceases within 2 hours
3. minimal post operative bleeding occurred – takes more than 2 hours to cease
4. significant post operative bleeding occurred – did not require additional medical measures
5. additional medical measures were needed to control bleeding

Please assess the amount of post-operative pain.

1. no pain
2. minimal vocalizing when moving or palpated – ceases within 2 hours
3. minimal vocalizing when moving or palpated – takes more than 2 hours to cease
4. significant post operative vocalizing when moving or palpated – does not require intervention
5. significant post operative vocalizing when moving or palpated – requires additional pain intervention

How much does the patient lick or chew at his incision site?

1. no licking or chewing

2. minimial licking or chewing – ceases within 2 hours
3. minimal licking or chewing – takes more than 2 hours to cease
4. significant post operative licking or chewing – no intervention needed
5. significant post operative licking or chewing – e-collar or some other intervention needed

Please assess the amount of post-operative swelling (at 2 hours).

1. no swelling
2. minimal swelling of incision site only
3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

Please assess the amount of post-operative swelling (at 4 hours)

1. no swelling
2. minimal swelling of incision site only
3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

Please assess the amount of post-operative swelling (at 6 hours)

1. no swelling
2. minimal swelling of incision site only
3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

Please assess the amount of post-operative swelling (at 1 day)

1. no swelling
2. minimal swelling of incision site only
3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

Please assess the amount of post-operative swelling (at 2 days)

1. no swelling
2. minimal swelling of incision site only
3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

Please assess the amount of post-operative swelling (at 3 days)

1. no swelling
2. minimal swelling of incision site only

3. minimal swelling of scrotum
4. significant swelling of scrotum (looks like dog was not castrated)
5. significant swelling of the scrotum (scrotum larger than before dog was castrated)

APPENDIX C

SCROTAL CASTRATION POST-OPEATIVE INSTRUCTIONS

Scrotal Castration Post-operative instructions

Patients in this project will be monitored primarily by veterinary students and shelter personnel. It is anticipated that most post-operative complications would occur within the first 4 – 6 hours after surgery while the Veterinary Team and the Mobile Veterinary Unit is still on site. Complications that could occur include:

Post-operative hemorrhage

Post-operative swelling

Post-operative pain

Licking or chewing at the incision site.

For all suspected complications that occur while the mobile veterinary unit is on site have Dr. Woodruff or Dr. Bushby examine the patient. For all suspected complications that occur following the departure of the mobile veterinary unit call Dr. Woodruff at 901-355-5638 or Dr. Bushby at 662-312-5654 for instructions.

For post-operative hemorrhage instructions could include:

1. Emergency surgery to stop severe hemorrhage
2. A scrotal wrap to stop minor hemorrhage.

For post-operative swelling instructions could include:

1. Placement of an Elizabethan collar
2. Apply cold compresses

For post-operative pain instructions could include:

1. Administration of additional post-operative analgesics

For self-trauma (licking or chewing) at the incision site instructions could include:

1. Administration of additional post-operative analgesics
2. Placement of an Elizabethan collar

Personnel involved in post-operative monitoring will be trained on specifically what to look for and on placement of scrotal wraps, application of cold compresses, and placement of Elizabethan collars.