



A Review of Chemical Castration in Domestic Animals

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Abstract

This review article discusses the use of numerous chemical agents supplied through various routes to regulate the population of several animal species, including dogs, guinea pigs, rabbits, rams, and rats. While surgery is the safest and most effective procedure, it is also the most expensive. Therefore, non-surgical sterilization methods that would make male sterilization cheap, simple, and quick for sterilizing a large number of male animals in a short amount of time were introduced in an effort to slow down the increase in the animal population effectively.

Keywords non-surgical sterilization, Cost-effective sterilization, Animal sterilization techniques

Introduction

Sterilization of domestic animals is used to reduce the number of animals, improve genetic gain by limiting gene transfer to genetically elite animals, change animal behavior, and change the makeup of carcasses in animals raised for food. But there isn't any solid information on how many pigs, dogs, cats, calves, or bulls are out on the streets of towns, cities, or metropolises. Chemical castration can be achieved via intratesticular injection of substances like lactic acid [1], CaCl₂ [2], and NaCl [3] that cause the death of testicles through osmotic or caustic processes. Physical castration can be achieved via emasculation, which involves cutting off the blood flow to the testicles with Burdizzo clamps, stenotic elastic rings, or strips [4]. Alternatively, surgery can be used to accomplish an orchiectomy. Immunological castration is predicated on immunocontraception, which lowers testosterone levels and causes the body to produce antibodies against GnRH [5].

One of the most widely used and dependable techniques for reducing the number of stray animals on the loose is non-surgical sterilization, which produces male sterility. By using these techniques to stop undesired pregnancies in stray animals, the number of animals that end up as stray each year in India can be decreased. Chemical sterilization prevents the formation of spermatic granulomas, which happens after vasectomy, making it an effective population control technique [6].

In the past few years, scientists have been working to create a chemical castration technique that could be a superior substitute for surgery [7]. A chemical sterilizing agent that successfully inhibits spermatogenesis, androgenesis, and libido while having no harmful or unfavorable side effects would be ideal [8]. Chemical castration has several benefits, including the obvious reduction of discomfort and tension and the removal of

surgical sequelae such as myiasis, bleeding, hernia, and infection. It is also easy to use and reasonably priced for large-scale sterilizing [9].

Scientific research on chemical castration sorted down by species

Calves and bulls

According to [10], intra-testicular injections of 3-12% zinc tennate, administered to Hereford bull calves who were 70 days old and weighed 99 kg, proved to be a more successful method of chemical castration than surgical castration. Between the groups, there was no discernible variation in the weight and quality of the carcass or the weight of the lion, leg, or pistol cut.

In the first few weeks following a male calf's castration, [11] assessed the effectiveness of intra-testicular injection of hypertonic sodium chloride (NaCl; 20%) solution. Testicular fibrosis was caused by the coagulative necrosis of seminiferous tubules and Leydig cells caused by intra-testicular injections. When breeding soundness was assessed, no testicular structure or sperm cells were found in the 12-month-old animals, indicating a significant impairment in testosterone secretion and testicular development. In summary, intra-testicular injections of hypertonic NaCl solution during the first 20 days of life result in sterility and total suppression of testosterone release.

[12], assessed the impact of injecting bull calves with a zinc solution as a castration technique prior to their pre-weaning. Due to the concentration of Zn solution used during weaning, there were no variations in growth, serum testosterone, or scrotal thickness, and the injectable castration procedure produced serum testosterone concentrations that were comparable to those of surgical castration.

Buck and ram

Examining intratesticular injections of calcium chloride, sodium chloride, citric acid solutions, or sterile deionized water as a nonsurgical castration method for Black Bengal bucks was the goal of the research. Each buck's spermatic cord was infused with 2% lidocaine hydrochloride as a local anesthetic. Next, bilateral intratesticular injections of 30% calcium chloride (CaCl₂), 25% sodium chloride (NaCl), 50% citric acid (C₆H₈O₇) solutions, and sterile deionized water dosed at 2 ml per testis. All of the bucks showed a notable reduction in scrotal circumference from the intra-testicular injection to day 14. Day 14 after injection. Histopathology showed that the testicular parenchyma was disorganized and that the seminiferous tubules had been severely destroyed. Day 14 saw a significant drop in serum testosterone concentration when compared to Day 0. As a result, the steady increase in serum LH concentration was noteworthy. Thus, injections of intratesticular [13].

The effectiveness of castration using Burdizzo technique, ethanol, and bilateral intratesticular injections of calcium chloride dihydrate (CaCl₂) in twenty Sahelian bucks. In order to maintain control, group A received a bilateral intratesticular injection of 1.0 ml of normal saline. The bucks were received a bilateral intratesticular injection of olive oil and CaCl₂ (1 ml each), while group C received a Burdizzo castration of their bucks. Analysis was done on the bucks' sonograms and semen profiles. Day 7 saw a significant increase ($P < 0.05$) in the diameters of the castrated bucks in Burdizzo, CaCl₂, and Olive oil, which decreased by day 60.

In the bucks castrated with CaCl₂, after day 14, there was no longer any sperm movement. On day 7, all of the castrated goats—Burdizzo, CaCl₂, and Olive oil—had a significant decrease in spermatozoa concentration. CaCl₂ deposition resulted in discrete focal hyperechoic areas on the sonogram of the castrated testes, which were surrounded by hypoechoic areas within the parenchyma. The testes of bucks castrated with olive oil had distinct hyperechoic areas inside the parenchyma, encircling a central hypoechoic area. The conclusion was that Burdizzo, CaCl₂, and oil were administered intrarectally [14].

Dogs and Cats

According to Kutzler and Wood (2006) [15], the zinc-gluconate injection does not result in a drop in testosterone levels that is sustained long enough to lessen the treated dogs' bothersome behaviors. Local and systemic reactions have also been documented following intra-testicular injection of zinc-gluconate, and these include scrotal dermatitis and ulceration, preputial swelling, scrotal self-mutilation, diarrhea, vomiting, lethargy, anorexia, and leukocytosis [15].

A different study found that approximately 4% of dogs given zinc gluconate experienced necrotizing reactions at the injection site, requiring major surgery to correct [16]. Regulatory bodies in certain countries have not authorized the commercial preparation of zinc-gluconate for use in the mass chemosterilization of dogs and cats, and it is not currently available anywhere in the world [17].

Calcium chloride (CaCl₂) is administered by intratesticular injection and is currently being investigated as an inorganic chemical sterilant in dogs. Following intratesticular injection of CaCl₂, necrosis, fibrosis, and degeneration of the seminiferous tubules and Leydig cells occur, which reduces or eliminates the production of sperm, testosterone, and sperm count in male dogs in a dose-dependent manner [18].

Although CaCl₂ did not affect food intake, chronic stress, or blood cell counts in dogs, testicular swelling persisted for 3 weeks after injection, and the behavior of the animals returned to normal (although no definition of "normal" was given) 1 month after treatment [18].

Moreover, During the nine-month trial, azoospermia was achieved in dogs treated with CaCl₂. It was established that a dependable technique for inducing sterilization in male dogs used a single, bilateral intratesticular injection of 20% CaCl₂ in 95% ethanol. Injections into the head of the epididymis likewise resulted in sterility, although there was no discernible drop in the amount of testosterone in the blood. In addition, administering the intraepidermal injection into the epididymal head required the same amount of time as an orchiectomy. When an owner prefers to maintain testosterone levels and anatomic integrity in their dog, this method can be the best one to employ [19].

Cats received a 0.25 mL intratesticular injection of 20% CaCl₂ combined with 0.5% DMSO in each testis. Animals were azoospermic and had a 50% reduction in total testicular volume after 80 days. Histologically, the testes showed different degrees of degeneration, necrosis, and calcification, and connective tissue and Leydig cell hyperplasia were replaced in 7/12 of the testes. The intratesticular injection of 20% CaCl₂ solution with 0.5% DMSO suggested that a single injection of this compound can cause azoospermia after 80 days[20].

Guinea pig and swine

In Sen et al.'s 2017 [21] study, the researchers explored the effectiveness and safety of using calcium chloride (CaCl₂) and 4-vinylcyclohexene 1, 2-monoepoxide (VCM) injections in the testes of guinea pigs for reproductive control. Fifty male guinea pigs were divided into five groups, with each group receiving injections of the chemical agents into both testes using 1% lidocaine hydrochloride. Groups I, II, and III were given a single dose of sterile physiological saline, 15 mg/100 g CaCl₂, and 240 mg/kg VCM, respectively, while Groups IV and V received daily doses of 15 mg/100 g CaCl₂ and 240 mg/kg VCM for three days. The treatment led to a decrease in epididymal sperm count in all groups, with Group V showing a complete absence of sperm (azoospermia) except for two animals. Group V also had the highest blood prolactin levels and lowest testosterone levels, while Group III had the highest testosterone levels. Additionally, histopathological examination did not show any signs of intoxication.

The chemical method of castrating pigs involves injecting 2 milliliters of a prepared chemical (0.25 grams of potassium permanganate plus 17 milliliters of glacial acetic acid plus 83 milliliters of sterile distilled water) into each testis. The effects of this procedure on body weight gain and testicular histopathology were then compared to the traditional surgical method of castration in the same species. The results showed that chemical

castration of pigs was a straightforward, affordable, and simpler procedure with noticeably higher ($P < 0.01$). A farmer will profit more from weight gain than from surgical castration [22].

In conclusion

Chemical sterilization is a cost-effective and non-invasive method for male sterilization. It is suitable for large-scale population control programs in domestic animals. The method involves introducing a sterilizing agent directly into the testicles or epididymis, leading to cell deterioration, necrosis, and fibrous occlusion. This process disrupts sperm cell transportation and ultimately results in azoospermia. Agents like formalin, zinc acetate + arginine, potassium permanganate, and calcium chloride are commonly used for chemical sterilization.

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