Indian J Anim Health (2023), 62(1): 114-120
DOI: https://doi.org/10.36062/ijah.2022.14122

Research Article

Evaluation of the pinhole castration technique in piglets compared to the traditional open castration method

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Abstract

Castration of male piglets aids in the production of high-quality meat and lessens boar taint. The purpose of the current study was to compare two castration techniques in piglets, i.e., the traditional open-covered method of castration and the pinhole castration technique with special emphasis on histopathological changes in testicles after the former castration. The pinhole castration technique involves ligating the spermatic cord with a suture percutaneously which results in atrophy and degeneration of the testicle. In piglets, both castration methods proved successful. However, as histopathology revealed avascular coagulation necrosis of all testicular parenchymal cells, the pinhole castration technique is simple, affordable, and less time-consuming and can be thought of as an alternative way of castration in piglets.

Keywords: Boar taint, Piglets, Pinhole castration, Surgical castration

Highlights

- Pinhole castration technique was found effective in male piglets. This technique is easy, economical, and less time-consuming than conventional surgical castration techniques.
- Pinhole castration method can be an alternative to the conventional open-covered method of castration.
- Pinhole castration technique involves ligating the spermatic cord with a suture percutaneously which results in atrophy and degeneration of the testicle.
- Histopathological examinations of testicles extracted from pinhole castrated piglets indicated avascular coagulation necrosis of all cells in the testicular parenchyma.

INTRODUCTION

The castration of male piglets to improve pork production is a conventional management practice in the piggery industry. Although the traditional open castration method has been used for some time, there has been no conclusive research on its difficulties and negative effects. Pinhole castration is a new minimally invasive procedure that involves ligating the spermatic cord percutaneously in piglets without cutting it or entering the scrotum to cause full ischemic atrophy and testicular shrinkage.

Pinhole castration is now used in many domestic animal species including calves, kids, donkeys, and dogs, because it is less invasive, less expensive, easier to perform, and faster than conventional surgical sterilization (Ponvijay,

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2007; Okwee-Acai *et al.*, 2008; Abou-Ahmed *et al.*, 2012; Okwee-Acai *et al.*, 2012; Abid and Al-Baghdad, 2013; Baba *et al.*, 2013). Piglets raised in tropical, humid environments have not yet been tested for the pinhole castration procedure. As a result, the current study aimed to compare the pinhole castration method with the conventional surgical castration method in piglets, with a focus on histopathological changes in the testicles.

MATERIALS AND METHODS

The study involved 18 healthy Large White Yorkshire crossbred piglets raised at the Centre for Pig Production and Research, Mannuthy of KVASU, Wayanad. The piglets aged one to two months with an approximate weight of less than 10 kg were selected for the study.

Design of the study

All the piglets had a pre-operative clinical examination including careful palpation of the scrotum to confirm the presence of two normally descended testes. The piglets were randomly divided into two main groups *viz.* Group I and Group II consisted of twelve and six animals, respectively. Piglets in Group I were assigned to the pinhole method of castration, while those in Group II were castrated using the standard surgical method. Both castrations were performed under local infiltration with 2 percent lignocaine hydrochloride injections. Piglets were not fed for six hours preoperatively, and both procedures were performed in the cool morning hours. All aseptic precautions were taken before, during, and after the surgical procedure.

Castration techniques

Pinhole castration: In Group I piglets, the spermatic cords of both testicles were ligated in a single knot with a polyglactin-910 suture percutaneously using a straight cutting needle (40mm/60mm). The piglet was manually restrained in right lateral recumbency by holding the forelimbs and hindlimbs by an assistant in such a way that the testicles were exposed. The scrotal skin was aseptically prepared by applying the tincture iodine.

The testicle was pulled posteriorly using the left thumb and index fingers of the surgeon. Lignocaine hydrochloride (2%) was infiltrated on both the lateral walls of the scrotal neck. The spermatic cord on either side was felt and fixed between the fingers. A straight traumatic needle threaded with polyglactin 910 suture of 2-0 size was passed vertically down, dorsal to the spermatic cord, piercing through ipsilateral and contralateral walls of the scrotal neck including the medial septum. The same needle was pierced back ventral to the spermatic cord through the previous needle penetration points and brought back to the ipsilateral scrotal wall, making a circular loop around the two spermatic cords. The ends of the suture were knotted by applying traction so that it was tightened against the spermatic cords through the skin, and excess suture material was removed (Figs. 1 to 4). A similar surgical procedure was reported by Fazili *et al.* (2009) and Baba *et al*. (2013) in kids and dogs, respectively.

Surgical castration technique: Open covered method of castration was done in all Group II piglets. Local anaesthesia was obtained by injecting 1.5 mL to 2 mL of 2 percent lignocaine hydrochloride subcutaneously on either side of the median raphae along the length of both testicles and intra-testicularly (Haga and Ranheim, 2005; Fredriksen and Nafstad, 2006; von Borell *et al.*, 2009; Hofmann *et al*., 2019).

After five minutes, one testicle was fixed against the scrotal skin, and an anteroposterior longitudinal incision was made parallel to the median raphae cutting through skin and dartos with a Bard-Parker surgical blade (No. 22). The testicle along with the spermatic cord was squeezed out without incising the cover of tunica vaginalis. Two artery forceps were clamped across the spermatic cord, and a ligature was applied using polyglactin 910 suture of 2-0 size over the spermatic cord proximally. The spermatic cord was incised

Pinhole castration technique in piglets

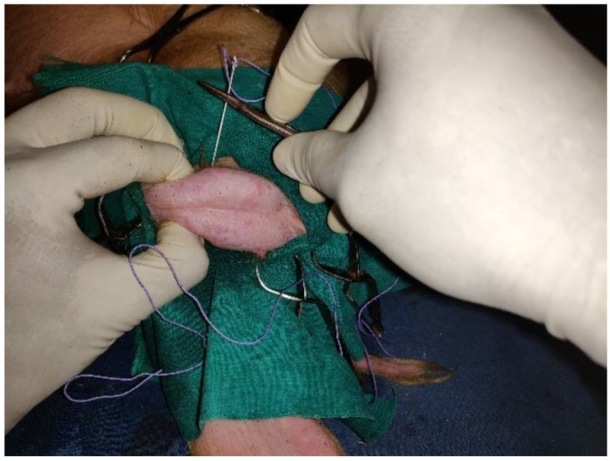

Fig. 1. Needle insertion vertically down through the two scrotal skins and medial septum after pulling the testicle posteriorly

Fig. 2. Needle insertion from upward through the same hole by positioning the spermatic cord in between

Fig. 3. Needle withdrawal through ipsilateral scrotal wall side through previous skin bite making a loop around both spermatic cords

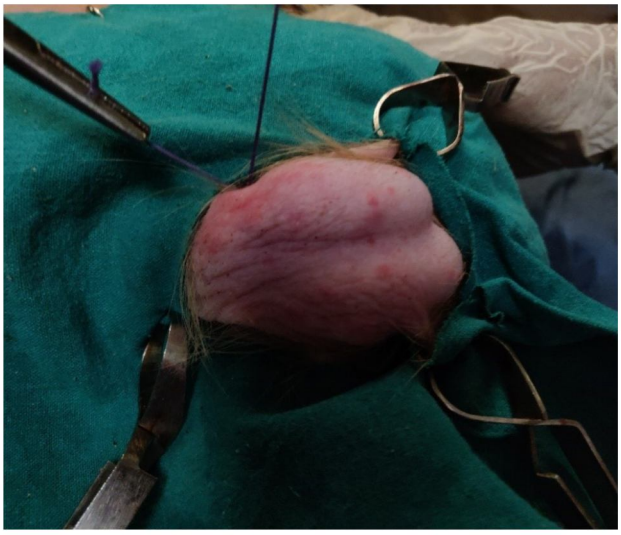

Fig. 4. Both spermatic cords are ligated in knots by applying traction to the suture ends and by pulling the suture through the skin against the spermatic cord. Excess suture material was cut.

distally to the ligature, and the testicle was removed. The second testicle was removed in the same way. The surgical incision was left open without suturing.

Inj. tetanus toxoid (0.5 mL IM), inj. enrofloxacin long-acting (5 mg/kg body weight IM) and inj. meloxicam (0.2 mg/kg body weight IM) was given to all the piglets of both groups postoperatively (Gottardo *et al.*, 2016). Since pain is a typical reaction to tissue damage and inflammation that happens with tissue injury or surgery, a non-steroidal anti-inflammatory medicine, meloxicam was administered (Anil *et al.*, 2002; Hellyer *et al.*, 2007). The surgical wound was dressed routinely using a povidone-iodine solution.

Evaluation of body weight and scrotal dimensions

To evaluate the effect of pinhole castration and compare it with the surgical castration technique on the growth of piglets, body weight was recorded using electronic measuring balance on day 0 and days 14 and 28 postoperatively in both groups. The changes occurring in the biometry of the testicles of the piglets subjected to pinhole castration were also evaluated. Dimensions of testicles (length and width) were recorded on days 0, 14, and 28 posts spermatic cord ligation in Group I, using a Vernier Calliper.

Histopathological examination

After 28 days of the pinhole method of castration, testes, epididymis, and spermatic cord were removed under local anaesthesia from all Group I animals, and tissue specimens were immediately fixed in 10% neutral phosphate-buffered formalin for at least 24 hours and were embedded in paraffin. Sections of 5 μ thickness were stained with hematoxylin and eosin (H&E) according to the method described by Suvarna *et al.* (2018) and were examined under a light microscope (100 X).

Statistical analysis

During the study period, all data collected were statistically analyzed using two-way repeated measures ANOVA and the Student's t-test (SPSS 24.0) between groups and within groups, and expressed as the mean ± standard error of the mean. The significance value of $P \leq 0.05$ was considered statistically significant.

RESULTS

Body weight: Mean ± SE values of body weight of Group I and Group II at various time intervals are presented in Table 1. The mean body weight of the piglets in Group I at various time points ranged from 9.38 kg to 11.72 kg and that of Group II ranged from 9.58 kg to 11.56 kg. Even while there was an upward trend in body weight in both groups' animals from day 0 to day 28 with significant differences within the group at various points ($P \leq 0.05$), there was never a significant difference between the treatment groups at any point in time. But on day 28, the mean body weight of piglets that had undergone pinhole castration was considerably higher ($P \leq 0.05$) than those of piglets that had undergone standard surgical castration.

Scrotal dimensions: The testicular length (L) and width (W) were measured and recorded on day 0 and days 14 and 28 post-ligation. The mean length of both testicles at different time intervals ranged between 4.89 cm and 3.33 cm, and the mean width of both testicles ranged between 3.69 cm and 2.3 cm. All the values of testicular length and width were significantly

Table 1. Mean ± SE changes in body weight of both treatment groups

Parameter	Group/day	0 Day	Day 14	Day 28
Body weight (kg)	Group I (n= 12)	9.31±0.26	10.56±1.02*	11.72±2.93*
	Group II (n= 06)	9.58±0.39	10.66±0.39*	11.56±0.43*

*Indicates significant difference from the base value within the group ($P<0.05$)

Table 2. Mean ± SE changes in testicular length and width of treatment Group I

Parameter	0 Day	Day 14	Day 28
Testicular length	4.89±0.15*	6.77±0.32*	3.33±0.27*
Testicular width	3.69±0.39*	4.13±0.06*	2.30±0.67*

*Indicates significant difference from the base value within the group (P<0.05)

different (P<0.05) at different time intervals. Higher values were noted on day 14 than on day 0, and lesser values were noted on day 28 after pinhole castration (Table 2). Mean ± SD values of testicular dimensions (length and width) of Group I at various time intervals have been presented in Table 2.

Histopathological examination: The histopathology finding of the testicles from the piglets subjected to the pinhole technique revealed testicular degeneration, atrophy, and acute ischemic coagulative necrosis of germinal epithelium and hyalinization of the seminiferous tubules. Histopathology helped in the confirmation of testicular dysfunction in piglets subjected to the pinhole castration method.

Duration of the surgical procedure: Ligation of both the spermatic cords of one piglet required an average of 4 min in the pinhole castration method, whereas the conventional surgical method of castration was completed within 10-15 minutes.

Evaluation of surgical procedure and complications: In piglets subjected to the pinhole method of castration, other than slight resistance during restraint, these non-sedated piglets showed no discomfort during needle penetration. But transient hind leg movement occurred when ligatures were tightened. At the end of the procedure, contraction of the dartos muscle caused the pinhole-sized skin wounds to be barely visible.

In one piglet, the abscess was noticed, which may be a complication of the pinhole technique due to the entry of infection through a needle prick.

Following pinhole castration, spermatic cords were efficiently ligated in all cases. In Group II, one piglet showed minor bleeding through skin sutures. This bleeding did not require any intervention and got arrested spontaneously.

DISCUSSION

The primary goal of the study was to compare the new method of castration known as pinhole castration to the conventional surgical method of castration in male piglets. Any reports regarding the castration of piglets by pinhole method in a tropical, hot, and humid climate are not available through perusal of literature. Several studies demonstrate that a minor disruption in testicular blood flow could result in testicular dysfunction. In rats, a five-hour decrease in flow could result in the death of around 70% of spermatogonia and early primary spermatocytes. All areas of the testis suffer necrotic damage from high-grade ischemia (Bergh *et al.*, 2001).

The pinhole castration procedure in dogs resulted in total ischemic necrosis (Baba *et al.*, 2013). A modified technique (through and through ligature at the lateral scrotal neck) was employed for cord ligation because, like in other animals, the spermatic cord in piglets is difficult to access through the scrotum. The pinhole castration method used in this study was devised in a manner that was reported in calves, kids, and dogs (Ponvijay, 2007; Okwee -Acai *et al.*, 2012; Baba *et al.*, 2013).

The art of making the suture material go around the spermatic cord is the elegance of this two-hole percutaneous ligation technique. This study makes use of a straight traumatic suturing needle and polyglactin 910 suture. Polyglactin 910, an absorbable suture material, provides more knot security than silk and catgut (Silver *et al.*, 2016). Since a non-absorbable

suture felt less appropriate in an animal intended for meat consumption, the absorbable suture was chosen. Studies on the effects of spermatic cord twisting (Turner and Brown, 1993) and ligation (Bergh *et al.*, 2001) on rats suggested that 10 days of ischemia was more than enough to result in a full testicular infarction. The use of this absorbable suture for spermatic cord ligation in piglets, therefore, seems to be all that was required to produce the total atrophy seen in the present investigation. Fazili *et al.* (2009) and El-Wahed *et al.* (2014) accomplished spermatic cord ligations in dogs using a similar technique employing a traumatic suture needle and silk.

In the present study, one piglet that underwent pinhole castration developed an abscess close to the testicles, and pus was observed at the site of needle insertion. One piglet from the same group died from dermatitis, multiple abscesses, and general debility, but the other 10 piglets recovered uneventfully. The pinhole produced near the spermatic cord may have caused an infection, and a cold, wet climate and damp flooring increased the chance of an infection. The castration of the piglets performed using a conventional open-covered surgical technique had no post-operation complications. Similar findings and complications of castration were reported by Adin (2011) and Fubini and Ducharme (2017).

The total surgical time needed to perform the castration process using the pinhole castration approach was shorter (4-5 minutes) than that of an open-covered method of castration (10-15 minutes). When performing the pinhole castration technique on ruminants, Fazili *et al.* (2009) and Ponvijay (2007) reported shorter surgical times of 4-5 minutes, but Fredriksen *et al.* (2011) found an average of 7-8 minutes in ruminants. As a result of this novel pinhole castration technique, more piglets can be castrated in less time.

In the current investigation, there was no significant difference in the mean body weights of the piglets in Groups I and II before treatment on Days 14 and 28 ($P>0.05$). However, on day 28, the body weight of piglets that had undergone pinhole castration exhibited a non-significant increase. Gonadal hormones may affect body weight directly by affecting brain regions that control satiety and activity or indirectly by changing cellular metabolism (Salmeri *et al.*, 1991). Testicular oedema measured from the mean testicular length and width values on day 14 was significantly higher than on day 0 (Ponvijay, 2007), which diminished during days 16 to 28 and suggested atrophy of the testicular tissue (Fazili *et al.*, 2009). While Okwee-Acai *et al.* (2008) observed that the ligated caprine testis swelled to its greatest extent on day 2 and subsequently began to shrink at the end of the one-month monitoring period. Baba *et al.* (2013) reported mean values of testicular length and width of ligated testicles in dogs were highest on day 3 and significantly greater on days 7, 14, and 21 compared to that on day 28, which was significantly lower than that of day 0.

The histopathology findings of the testicles from the piglets subjected to the pinhole technique revealed testicular degeneration and atrophy. These findings were suggestive of testicular dysfunction (Awal *et al.,* 2004). Moreover, there were marked interstitial fibrosis and degenerative and necrotic changes of Sertoli cells and Leydig cells. These findings are in line with those of Smith (1955), who claimed that after four hours of testicular ischemia induction, canine spermatogenesis stopped and some Sertoli and Leydig cells in some testicles became damaged, while 10 hours or more of sustained ischemia resulted in the elimination of all Leydig cells and the replacement of testicular elements by fibrous connective tissue. Acute ischemic coagulative necrosis of the germinal epithelium and hyalinization of the seminiferous tubules were two additional pathologies of the testicles that might be seen after spermatic cord ligation. These findings were similarly reported in previous studies of pinhole castration in bull calves, goats, and dogs (Ponvijay, 2007; Okwee-Acai *et al.*, 2008; Fazili *et al.,* 2009;

Baba *et al.*, 2013), and it is responsible for irreversible testicular dysfunction (Bergh *et al.*, 2001).

In the present study, ligated testes were retained in the scrotum for 28 days before collection for microscopic examination, thus allowing sufficient time for complete ischemic necrosis. Histopathology revealed avascular coagulation necrosis of all cells of the testicular parenchyma. From the results of this study, it was concluded that pinhole castration in piglets is simple, minimally invasive, efficient, and less time-consuming technique. However, the procedure needs to be evaluated in a greater number of piglets for a longer period of post-operative evaluation before being recommended for large-scale castration on commercial pig farms.

In contrast to the conventional open-covered form of surgical castration, the pinhole castration approach is quick, easy, minimally invasive, effective, and takes less time to complete. It was determined from the findings of this study that pinhole castration in piglets is an efficient method of castration since histopathology indicated avascular coagulation necrosis of all testicular parenchymal cells.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: SVU, GPP: Conceptualized the study, were involved in the validation and data curation and wrote the first draft of the manuscript; SVU, UMP, SSN, LMP, RV: Reviewed and collected the data; SVU, SR, NJBM: Involved in formal analysis; SKV, JMKD: Involved in supervision and editing the draft. All authors read and approved the final manuscript.

ACKNOWLEDGMENTS

The authors thank the Hon'ble Vice-Chancellor, KVASU, Pookode, Kerala, and the Dean of CVAS, Mannuthy, Kerala for providing the necessary facilities and logistics support to conduct the study. Thanks, are also due to the Indian Council of Agricultural Research and the Government of India for the support provided to the first author.

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Received- 20.10.2022, Accepted- 26.12.2022, Published- 29.12.2022 (Online), 01.06.2023 (Print)
Section Editor: Prof. S. K. Nandi, Associate Editor