# An ultrasonographic technique to locate retained testes in swine

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## Abstract

Cryptorchidism is apparently more common in boars than most other domesticated mammals. This condition causes economic losses due to diminished carcass quality. Furthermore, although rarely reported, it can be life-threatening to companion swine. Surgical excision is usually the treatment of choice. This article describes the use of ultrasonography to diagnose cryptorchidism and locate retained testes, as well as a surgical approach to remove testes.

**Keywords:** Cryptorchid, boar, swine, surgery, ultrasonography

## Introduction

Cryptorchidism is commonly defined as failure of one or both of the testes to descend into the scrotum in the time frame typical for a particular species.[1] The probability of cryptorchidism is higher in companion animals and pigs than in sheep or cattle.[2] In pigs, retained or undescended testes are usually unilateral. Cryptorchidism is further classified, based on testis location, as being abdominal, inguinal, or subcutaneous. Approximately 1% of male pigs are born cryptorchid, with an increasing percentage in association with inbreeding.[3] Cryptorchidism is not considered a single disease, but rather, an early indication of testicular dysgenesis syndrome,[1,2] with causes grouped into genetic, epigenetic, or environmental components.[2]

To recognize potential causes or timing of the insult that causes cryptorchidism, one must understand normal testicular development and descent. Primordial germ cells migrate from the hindgut onto the gonadal ridge of the mesonephros during early embryogenesis. Mesenchymal cells then migrate to the developing gonad, surround the primordial germ cells, differentiate into Sertoli cells and produce anti-Mullerian hormone, halting Mullerian duct formation. Further proliferation and differentiation of Sertoli and primordial germ cells continue for the next 7 to 14 days, until the gonad becomes a functional testis. During this proliferation, other mesenchymal cells migrate into the spaces among the developing seminiferous tubules and become Leydig cells. In the pig, differentiation of the gonad to a functional testis occurs around gestational day 35.[2] During differentiation, the gubernaculum and cremaster muscles form from abdominal muscles and the vaginal process forms in the area of the internal inguinal ring as an evagination of the peritoneal lining.[1,2] The genitofemoral nerve also begins to innervate the cremaster muscle.[1] At this point in development, the testis is located between the neck of the bladder and the internal inguinal ring. It becomes anchored to the caudal abdomen by the gubernaculum. This anchor prevents the testis from migrating cranially while the fetal abdomen expands cranially.

As the fetus and testis grow, the gubernaculum extends and vaginal process extend through the inguinal ring. Leydig cells are important at this point, producing testosterone and insulin-like peptide-3,[1,2] a peptide with an important role in increasing gubernaculum size. This enlarged gubernaculum dilates the inguinal canal to facilitate passage of the enlarging fetal testis.[1,2] Testosterone masculinizes the genitofemoral nerve, which then produces calcitonin gene-related peptide, a peptide that serves as a chemoattractant and directs migration of the gubernaculum and testis to its final scrotal location.[1,2] Testosterone also stimulates gubernacular regression once the testis reaches its scrotal location, as well as the inguinal canal to constrict or close.[1] In the pig, this final scrotal descent occurs 14 days before to 14 days post-farrowing, whereas final testicular maturation occurs when testis is in the scrotum.[1,4]

Cryptorchidism results when a problem occurs during one of the three phases of testicular descent and one or both testes do not reach a final scrotal location. In swine, cryptorchidism occurs in 1% of male offspring, with unilateral occurrence more common.[3] In cryptorchid boars, the unilateral phenotype represents 59% of the cryptorchid cases.[2] Of the many theories regarding the cause of cryptorchidism in

pigs, genetic predisposition remains a common concern. It has been suggested that there is incomplete penetrance, because not all males in an affected litter will be cryptorchid.[2] Another study indicated that cryptorchidism is a recessive trait with genes on at least two loci[3] and inbreeding increased frequency of cryptorchidism to 3%. This is more likely in potbellied pigs compared to domestic pigs.[3] Failure of testicular descent could also be hormone related. Increased estrogen production could limit insulin-like peptide-3 production and prevent gubernacular enlargement if exposure occurs just prior to testosterone dependency.[1,5,6] Without gubernacular enlargement, the developing fetal testis cannot fit through the inguinal ring and becomes retained.

## Surgical Correction

Removal of retained testis or testes is important for animal health and for economics of commercial pork production. It was estimated that testicular tumors occur 4 - 11 times more frequently in cryptorchid than non-cryptorchid males.[2] The most commonly reported tumors in pigs are gonocytic seminomas and carcinoma *in situ;* these are more common in pet pig dues to their longer lifespan.[2] Furthermore, this condition results in economic losses to the commercial producer due to increased culling rates and market discounts. Retained testes produce increased amounts of 5-androst-16-ene-3-one resulting in boar odor tainted meat, with lower consumer appeal.[1,3,7]

For pigs with abdominal retention of a testis, the most commonly described approach for surgical excision is inguinal or para-inguinal on the side of the retained testis.[8,9,10] Alternatively, a ventral midline approach is more likely if the side of retention is unknown or if retention is bilateral. Male pigs are often presented to the veterinarian after the descended testis has been removed, assuming that the retained testis will descend at a later date.[9] Unfortunately, by the time the pig presents for cryptorchid surgery, the incision over the descended testicle has healed and a scar is not detectable. The literature suggests that retained testes are more common on the left side. In the author's experience, >99% of retained testes are in the abdominal cavity. Furthermore, the author proposes real-time B-mode ultrasonography to locate retained testes, followed by way a paramedian incision directly over the testis.

The author prefers that pigs, especially companion pigs, weigh at least 4.5 - 5 kg. Surgery is performed under general anesthesia (induced with a combination of Telazol® reconstituted with 250 mg of xylazine (100 mg/ml) and 250 mg ketamine and then dosed at 4.4 mg/kg IM of this mixed solution[11]) and positioned in dorsal recumbency. A 5 MHz frequency, linear-array ultrasound transducer is used to locate the abdominal testis. If the descended testis is still present or the surgical scar from the previous castration is evident, the probe is placed on the abdomen on the opposite side of the scar or testis. The testis is usually found by placing the transducer midway between the inguinal canal and the preputial orifice and midway between the flank fold and midline, with the tip angled toward the pig's head (Figure 1). It is not uncommon to need to adjust transducer position to detect the testis, depending on its general location within 1 - 2 cm below skin level. This transducer position usually provides a sagittal section of the retained testis. The ultrasonographic image of the testis is usually oblong, with the tunica albuginea producing a hyperechoic border. In addition, the mediastinum testis produces a hyperechoic band in the center of the testis that runs the entire length of the testis. Testicular parenchyma has a homogenous, granular pattern with medium echodensity on both sides of the mediastinum testis, and within the tunica albuginea (Figure 2).[12,13]

Once the testis has been located, a paramedian incision is made the length of the testis and extended through the abdominal musculature and peritoneum. The surgeon inserts a gloved finger into the abdomen and locates the testis or epididymis by moving the finger in a sweeping motion on either side of the incision. Once the structure is located, the surgeon hooks the structure with their finger and exteriorizes it through the incision (Figure 3). It is often helpful at this point to use the thumb of the same hand to press downward on the skin near the incision to help "pop" the testis through the incision. Once exteriorized, the surgeon must examine the structure to identify testis, epididymis, spermatic cord and cremaster muscle. The spermatic cord is separated from the cremaster and each structure is ligated individually. Preferably ligatures are placed 5 mm apart and the structure transected between ligatures. Following removal of the testis, the incision is closed in a two-layer closure. If there is a large amount of

abdominal fat, a three-layer closure may be necessary to minimize dead space. The author prefers to close the skin using an intradermal suture pattern using poliglecaprone 25 (Monocryl®; Ethicon, Bridgewater, NJ) for cosmetic purposes. Choice of suture is at surgeon's discretion, but the author prefers polydioxanone (PDS®II, Ethicon, Brdigewater, NJ) for ligation of the spermatic cord and closure of the body wall.

Conventional pigs are routinely given flunixin meglumine (2.2 mg/kg) intramuscularly and ceftiofur crystalline free acid (Excede® for Swine; Zoetis, Kalamazoo, MI) at a dose of 5 mg/kg IM. For companion swine, carprofen (4.4 mg/kg orally once daily for 3 days) is often used in lieu of flunixin meglumine.

## Conclusion

Use of ultrasonography is likely more common with companion swine, unless the domestic pig is considered valuable. The use of this approach facilitates locating a retained testis prior to surgery, thereby increasing successful procedures. In general, there are minimal complications with this surgical procedure. Rare complications include excessive hemorrhage due to improper vessel ligation, incisional dehiscence, or incisional abscessation.

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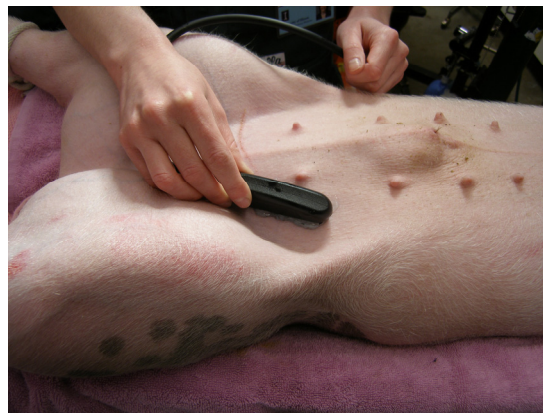
**Figure 1**. Transducer placement to locate abdominal testes in swine.
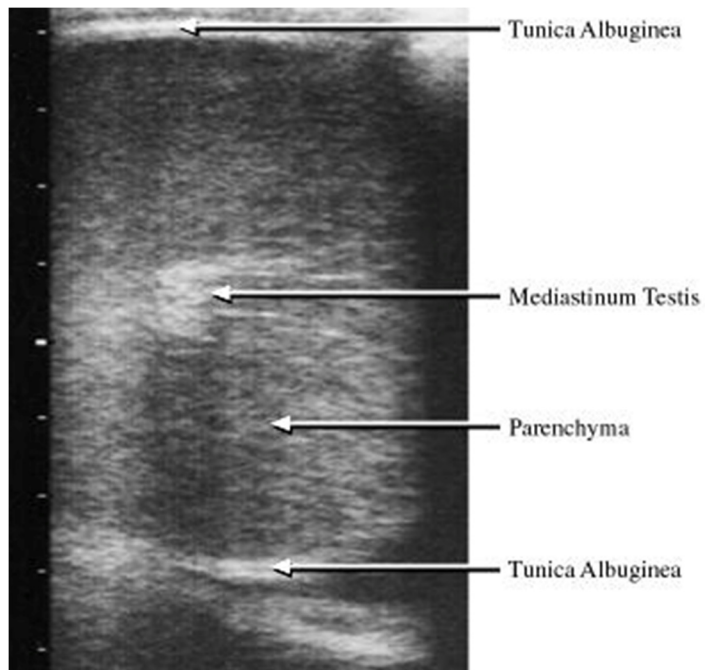
**Figure 2.** B-Mode ultrasonographic image of a porcine abdominal testis, with key structures identified.
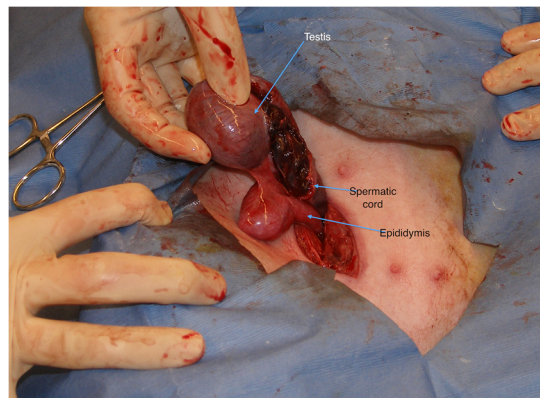


**Figure 3.** Porcine testis exteriorized through a paramedian incision and key structures identified.

(Editor's note: Online edition of the manuscript has color photographs)