



CASE REPORT

First Report of True Hermaphroditism in a Goat in Peru

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ABSTRACT

Sexual development disorders in animals are congenital disorders and have significant genetic and clinical implications. This study reports the case of a six-month-old hornless Creole goat with true hermaphroditism. The clinical examination revealed an ambiguous phenotype, with the presence of a vulva, prominent clitoromegaly (4.5cm in length), a scrotum, and two testicles in normal position. The necropsy confirmed the presence of the testicles along with a complete Müllerian tract (uterus and vagina). Male gonads measured 3.5 and 3.6cm in length for the right and the left, respectively. The right and left ovaries measured 1.6 and 2.5cm, respectively; they did not contain follicles or corpus luteum. Pyometra was present. Hematology revealed mild leukocytosis ($17.41 \times 10^3/\mu\text{L}$), supporting the presence of a localized chronic inflammatory condition. This case highlights the complexity of this reproductive developmental disorder. Blood testosterone level of 0.068ng/mL confirmed the endocrine functionality of the testes, while baseline progesterone levels (0.566ng/mL) ruled out the presence of cyclic ovarian tissue. It was concluded that the case was a true hermaphroditism.

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INTRODUCTION

Disorders of sexual development (DSD) encompass a range of congenital abnormalities that are classified according to chromosomal, gonadal, and phenotypic presentation (Castro *et al.*, 2025). Generally, DSD cases are categorized as true hermaphrodites and pseudohermaphrodites (Gupta *et al.*, 2022). True hermaphrodites possess both male and female gonadal tissue in any possible combination, which can be in separate gonads or in an ovotestis (Poth *et al.*, 2010). Pseudohermaphrodites are characterized by an external phenotype that does not match their genotype (Gupta *et al.*, 2022).

Male hermaphroditism is a form of DSD in which individuals have male genotype and male gonads (male gonadal sex) but an ambiguous or complete female external phenotype. In goats, the incidence of this disorder is strongly linked to hereditary factors (Pailhoux *et al.*, 2001).

According to Meyers-Wallen (2001), individuals with disorders of sexual development may present ambiguous genitalia, that is, underdeveloped genitalia with no clear genetic or histological evidence of their origin: In cases of hermaphroditism with uterine persistence, clinical examination reveals genital ambiguity, with clitoromegaly and the presence of a scrotum (Smith and Sherman, 2022). In this regard, Polled Intersex Syndrome (PIS) is one of the most documented causes, an autosomal recessive condition linked to the gene for horn absence. Genetically female (XX) individuals who are homozygous for this gene develop testis, resulting in a sterile intersex phenotype. This genetic basis has been identified as a specific deletion in the *FOXL2* gene (Pailhoux *et al.*, 2001).

Previous studies in ruminants have found that one of the causes of these anomalies is alterations in gonadal and ductal differentiation during embryonic life, making early diagnosis difficult (Paredes *et al.*, 2024; Castro *et al.*, 2025). In ruminants, minor hormonal alterations during

critical periods of embryonic development can trigger intersex phenotypes similar to those described in goats (Sapanidou *et al.*, 2025). Regarding diagnosis, tests such as gonad palpation and hormonal analysis are required (Castro *et al.*, 2025), in addition to ultrasound examinations to identify abnormal internal structures, such as a persistent uterus. However, since differentiating pseudohermaphroditism from true hermaphroditism is often complex, an autopsy is required, which allows for the elucidation of the coexistence of male gonads and Müllerian ducts (Smith and Sherman, 2022). The objective of this study was to describe a case of true hermaphroditism in a goat.

Case history: A 6-month-old hornless Creole goat weighing 22kg was reported on December 21, 2024, in the town of Pauca Santa Rosa, district of Shirac, province of San Marcos, Department of Cajamarca, Peru. History about the sire and dam for the goat was unknown. The goat had no health records or deworming schedule. It was raised under an extensive production system and fed mainly on kikuyu grass (*Cenchrus clandestinus*). Regarding its physical appearance, the animal presented an indeterminate phenotype (hermaphrodite phenotype), characterized by the presence of a vulva and testicles. The goat was donated for teaching purposes to Veterinary Pathology Laboratory at Universidad Nacional de Cajamarca, Peru.

General clinical and macroscopic examination of the genitalia: Upon general inspection, the animal presented a body condition score of 2 out of 5, with pink mucous membranes and physiological parameters within normal ranges: heart rate 80bpm, respiratory rate 18rpm evaluated with a double stethoscope (HONSUN-30B, China) and rectal temperature of 39.2°C evaluated with a digital thermometer (SCANMED, DMT 437, China). Clinical evaluation revealed a vulva (5cm in length) of normal anatomical conformation and location. However, protruding from the ventral commissure of the vulva, a cylindrical structure was identified, which was 4.5cm long, firm in consistency and covered by mucosa. This structure was identified as a markedly hypertrophied clitoris, resembling an underdeveloped penis. The scrotum and gonads caudal to the rudimentary udder and in the normal anatomical position expected for a male were present. On palpation, two ovoid gonads were confirmed inside the scrotum; these were well-developed, firm, elastic, and mobile within their tunics, the characteristics compatible with testicles. During the examination, a yellowish-white, non-foul-smelling, mucopurulent discharge was observed, draining intermittently through the vulvar opening. This mixed phenotype, with the coexistence of female (vulva) and male (hypertrophied clitoris, scrotum, and testicles) external characteristics, is the usual definition of genital ambiguity.

Clinical examination and preliminary assessments: The goat was sacrificed on January 4, 2025 for necropsy and definition of its hermaphroditism, with the established protocols of the Veterinary Pathology Laboratory of the Universidad Nacional de Cajamarca. Prior to sacrifice, heparinized whole blood was collected. The postmortem

examination revealed the coexistence of male and female reproductive organs (Fig. 1). Following complete removal of the reproductive tract, two well-developed testicles and two ovaries were identified. The right testis measured 3.5cm in length (Fig. 1A) and the left testis was 3.6cm long (Fig. 1B). A right ovary measuring 1.6cm (Fig. 1C) and a left ovary measuring 2.5cm (Fig. 1D) were observed, with no evidence of corpus luteum or follicles on either ovary.

Gonads: Two normal-appearing testicles were confirmed, with their respective epididymides clearly identifiable and anatomically attached. Gonadal measurements were taken using a Vernier caliper (Insize USA LLC caliper: 0–24 inches), ruling out the presence of hypoplasia because all measurements fell within the normal range for the species and age. The right testicle was 3.5cm long, 2.10cm wide and 1.75cm thick (Fig. 1A), while the left testicle was 3.6cm long, 2.16cm wide and 1.80cm thick (Fig. 1B). Two ovarian structures were also identified; and the right ovary measured 1.6cm long, 0.96cm wide and 0.80cm thick (Fig. 1C), while the left ovary measured 2.5cm long, 1.50cm wide and 1.25cm thick (Fig. 1D).

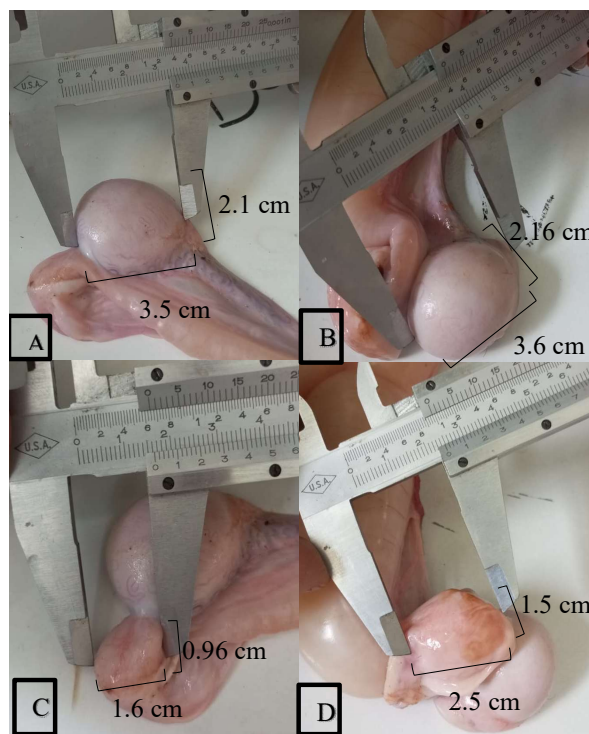


Fig. 1: A: Right testicle measuring 3.5cm in length. B: Left testicle measuring 3.6cm in length. C: Right ovary measuring 1.6cm in size, with no corpus luteum or follicle. D: Left ovary measuring 2.5cm in size, with no corpus luteum or follicle.

Persistent Müllerian duct syndrome (PMDS): A well-developed bicornuate uterus with a body and two horns was observed. Both horns were thickened, edematous, and had multiple saccular dilatations, indicating some severe pathology. The right horn showed massive distension, confirming severe chronic pyometra. The tract terminated in a vagina and vestibule that was connected to the external vulva (Fig. 2A). Dissection confirmed the coexistence of functional male gonads (testicles with

epididymides) with a complete and pathological Müllerian duct (uterus and vagina), confirming hermaphroditism (Fig. 2B).

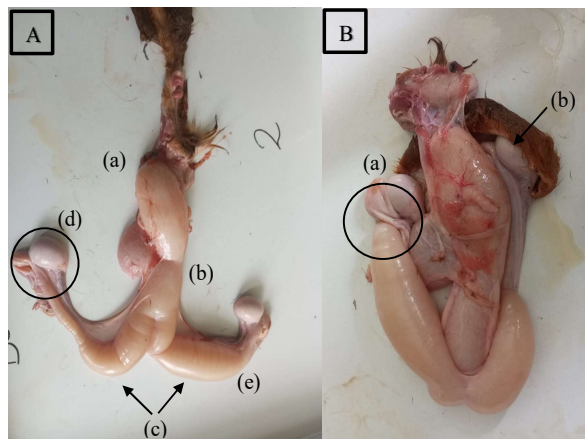


Fig. 2: A: Complete reproductive system showing: (a): Urinary bladder; (b): Body of the uterus; (c): Uterine horns; (d): Ovary and testis; and (e): Pyometra in the right uterine horn. B: Internal position of the reproductive system, with the ovary (a) and testis inside the scrotum (b).

Complete blood count: Before the goat was sacrificed, peripheral blood was collected via jugular venipuncture using the Vacutainer system. A blood sample was collected in a 3-ml vacuum tube containing EDTA-K2 anticoagulant for hematological analysis, and in a separate 6-ml tube without anticoagulant for serum collection. The whole blood sample was processed on an automated hematology analyzer (Mindray, BC-2800Vet, China). Mild leukocytosis was observed ($17.41 \times 10^3/\mu\text{L}$; reference range: $5\text{--}16 \times 10^3/\mu\text{L}$). All other parameters were within normal ranges. This finding is consistent with a chronic, localized inflammatory process (pyometra), with no evidence of an acute systemic septic response. The red blood cell and platelet counts were within the normal reference ranges.

Hormonal profile: Serum testosterone and progesterone analysis was performed using the electrochemiluminescence method on an analyzer (ECLIA), eCL8000 (LIFOTRONIC). The serum testosterone concentration was 0.068 ng/mL, a value below the normal range (1.55 ± 0.08 to 8.33 ± 0.35 ng/mL) reported for an adult male goat, suggesting that the gonads present were probably active and functional testicles (Todini *et al.*, 2007). On the other hand, serum progesterone concentration was 0.566 ng/mL, a basal level that indicates the absence of a functional corpus luteum and, therefore, the unlikelihood of the presence of cyclic ovarian tissue.

Histopathology: Samples of partial cardiac muscle tissue and mesenteric lymph node were collected at the time of necropsy and properly preserved in 10% buffered formalin for 24 hours before being sent for processing to the CrisHisto Laboratory in San Luis, Lima, Peru. The samples were processed using routine histological techniques (dehydration in increasing series of alcohols, clearing, and paraffin embedding) and cut into sections approximately 4–5 μm thick. They were then stained with

hematoxylin and eosin (H&E) following the standard procedure. Histopathologically, cardiac muscle fibers appeared elongated, cylindrical, and branched, with longitudinal orientation, oval and central nuclei (Fig. 3A). An atypical architecture was observed in the mesenteric lymph node, with the presence of disorganized tissue and abundant inflammatory cells; the cellular infiltrate was dense and mixed, consisting of lymphocytes and polymorphonuclear leukocytes (neutrophils), indicating an acute-subacute inflammatory process. The stroma showed irregular clear areas that may correspond to interstitial edema, and some dilated blood vessels (Fig. 3B). No extensive hemorrhages or transmural necrosis typical of infarction were observed.

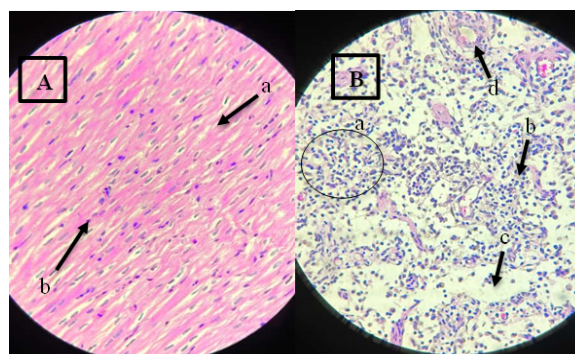


Fig. 3: (A): Photomicrograph of cardiac muscle showing: (a): Elongated, cylindrical, and branched muscle fibers, with longitudinal orientation; (b): Oval, central nuclei (400X). (B): Photomicrograph of mesenteric lymph node showing: (a): Disorganized tissue; (b): Neutrophils; (c) Interstitial edema; and (d): Dilated blood vessels (400X).

DISCUSSION

Disorders of Sexual Development (DSD) in goats are congenital anomalies resulting from early failures in sexual differentiation. These not only result in infertility but can also cause serious clinical complications that threaten life of the animal. According to Poth *et al.* (2010), an accurate diagnosis of DSD is necessary to differentiate the forms of intersexuality, considering that male pseudo-hermaphroditism has a different etiology and clinical consequences than true hermaphroditism or female pseudo-hermaphroditism. Furthermore, classic studies in ruminants have shown that many of these anomalies originate from early failures in gonadal differentiation and regression of the sex ducts, which increases the complexity of clinical diagnosis (Paredes *et al.*, 2024; Castro *et al.*, 2025).

Previous studies have reported a high incidence of intersexuality in goat breeds such as Saanen and Toggenburg, likely related to a high number of matings in which the breeding animals are dehorned (Zhang *et al.*, 2024). Regarding the reproductive repercussions of hermaphroditism, significant economic losses have been recorded since affected animals do not contribute to reproduction and can hinder genetic selection programs. Likewise, in intensive dairy herds, the presence of intersex animals can affect fertility rates and overall economic performance (Ali *et al.*, 2022).

In the case under report, a close association was found between the *in vivo* findings and the postmortem

evidence. The ambiguous phenotype, particularly the severe clitoromegaly (4.5cm in length), is a direct result of androgen action. The decision to perform a hormonal profile was felt necessary, and serum testosterone concentration of 0.068ng/mL confirmed that the gonads present were functional. Similarly, the baseline progesterone levels (0.566ng/mL) ruled out the presence of cyclic ovarian tissue.

The coexistence of male gonads (testicles with well-developed epididymides) with a complete and persistent Müllerian tract (bicornuate uterus and vagina) were recorded in the goat under report. The persistence of a complete uterus indicates a failure in the anti-Müllerian hormone (AMH) pathway, which normally induces the regression of these structures in males. This pathological mechanism has been widely described in domestic mammals with Müllerian persistence, especially in functional failures of the AMH receptor (Welsh *et al.*, 2023). Results regarding gonadal biometry were crucial in demonstrating that the gonads were not dysgenetic, but rather normally developed testis for the age, reinforcing the diagnosis of true hermaphroditism over other gonadal dysgenesis conditions.

Pyometra is considered as a serious clinical complication. In the case under report, it was first noted during the clinical examination due to the presence of intermittent mucopurulent vaginal discharge and was confirmed at necropsy by the distension of the uterine horns. Histological samples from the mesenteric lymph node revealed atypical tissue architecture, disorganized tissue, and abundant inflammatory cells with a dense neutrophil infiltrate, confirming an acute-subacute inflammatory process. This represents a serious and predictable complication in cases of persistent Müllerian structures in mammals (Smith and Sherman, 2022).

Considering the species and medical history, the most likely etiology seems to be polled intersex syndrome (PIS). This is a well-documented autosomal recessive genetic syndrome in goats, linked to the polled gene associated with absence of horns (Smith and Sherman, 2022). Genetic studies by Pailhoux *et al.* (2001) identified the cause as a deletion in the *FOXL2* gene, which causes genetically female (XX) individuals homozygous for the polled gene to develop testicles.

Although karyotyping (to confirm XX chromosomal sex) could not be performed in the goat used in the current study, the history of a similar case in a previous study reinforces the suspicion of a hereditary basis consistent with PIS (Batista *et al.*, 2000). Another study by Abyar *et al.* (2023) has documented pseudo-hermaphroditism in goats, highlighting the importance of these reports for epidemiological surveillance and for understanding the genetic mechanisms underlying intersexuality.

Conclusions: It was concluded that the case under report was a male hermaphroditism, highlighting the importance of necropsy as a final diagnostic tool in such cases and other cases of testosterone deficiency syndrome (TDS) and reinforcing the need for genetic counseling for producers in herds where such pathologies are detected.

Ethical statement: The study was carried out in accordance with the Guidelines of Animal Research:

Reporting of *in vivo* Experiments 2.0 (Percie du Sert *et al.*, 2020). The procedure was performed by professional veterinary medical personnel trained in the Faculty of Veterinary Sciences of the National University of Cajamarca.

Conflict of interest: The Authors declare that there is no conflict of interest.

Acknowledgments: None.

Authors contribution: Conceptualization of the idea was carried out by POS and MCR. JPT and POS carried out the investigation, while POS and MCR prepared the original draft. Project administration and acquisition of funds was done by CQP and WA. LZ and CQP carried out manuscript revision, while review and English editing was done by MCR and JPT. All authors approved the final manuscript.

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