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URACHUS ANOMALY IN SHEEP: INCIDENCE AND CONSIDERATIONS PRESENTED IN NEONATAL LAMBS IN THE PERU

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Supporting Information

CASE REPORT

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ABSTRACT: Over the years, an anomaly has been observed in newborn lambs, manifesting itself as a curvature in their posture and a slight dampness in the navel, known by the locals as "pupote". For this reason, the present study was carried out to document and present for the first time to the scientific community an anomaly of the urachus in sheep and its incidence. In the sampling process, five lambs who died of starvation were selected. The specimens were transported to the Animal Health Laboratory of the Faculty of Zootechnics of the National University of Central Peru. Radiographic analyses were carried out there. Then the incidence was found in the collected records. The incidence of the anomaly is an average of 0.825±0.09%. This case highlights the persistence of urachus in newborn lambs, evidenced by the identification of a ligament that establishes a connection between the umbilicus and the liver. Specifically, the ligament identified in the described anomalies corresponds to the *ligamentum teres*.

Keywords: Congenital disease, Ligament of the liver, Pupote, Sheep breeding, Urachus.

INTRODUCTION

A Chilean livestock complex stands out as a pre-eminent player in the sheep production sector, housing a considerable population of around 60,000 sheep (Valenzuela et al., 2019; Carhuas et al., 2022). Its role in Peruvian livestock farming is of significant economic relevance. It originated as a cooperative of surrounding communities, and later consolidated under the Agrarian Reform Law, as an Agrarian Society of Social Interest (SAIS) (Hurtado, 2020). Given the considerable magnitude of sheep production in this entity, several diseases and rare cases have been recorded that deserve attention from the scientific community.

The characterization of the patent urachus is established by the permanence of the tubular connection between the urinary bladder and the umbilicus after the delivery process, as has been noted by previous studies (Buddha et al., 2019; Wilson et al., 2019; Shi et al., 2022). Throughout the gestational period, this phenomenon plays a crucial role in facilitating the drainage of the bladder into the allantoic sac, as documented by Perondi et al. (2020). This process proves to be an essential component in the understanding of fetal physiology, establishing a structural connection that persists beyond birth and thus contributes to physiological dynamics during prenatal and postnatal development.

After birth and subsequent rupture of the umbilical cord, the urachus is expected to close, allowing urine to pass through the urethra (Steiner and Lejeune, 2009). In situations of patent urachus, a constant dribbling of urine from the umbilical stump is evident (Naiem et al., 2022). The process of involution of the umbilical arteries, which connect the internal iliac arteries to the placenta, results in their transformation into the round ligaments of the bladder (Sarmiento et al., 2021). For its part, the umbilical vein, establishing the connection between the placenta, the liver, and the porta cava, regresses to become the round ligament of the liver within the falciform ligament (Mottet et al., 2017).

This anatomical phenomenon, on which the present review is based, highlights the importance of the urachus in the perinatal context and its anatomophysiological repercussions according to the current scientific literature.

CASE PRESENTATION

The study was carried out in the company "SAIS Pachacútec S.A.C", in the facilities of the Production Unit: Corpacancha (11021'46" S; 76013'11" W), located in the district of Marcapomacocha, Province of Yauli, Junín Region - Peru (Figure

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1). In Peru, especially in large livestock companies such as SAIS, lambing usually begins in November. This company belongs to the livestock sector, producing more than 60,000 sheep of the Corriedale breed (Carhuas et al., 2023), 17,000 alpacas, and 4,000 cattle.

During the sampling process, five lambs that had died of starvation and exhibited the anomaly were selected. All of them had similar weights, belonged to the Corriedale breed, and were offspring of ewes from the cattle section, with a dental age of "4D." All lambs were disinfected with iodine at birth and their first lactation was ensured by the "huateros" (field personnel in charge of ensuring the first lactation of the rejected lambs). To evaluate the incidence, lambing records were collected for the 2023 lambing season from the Corpacancha, Santa Ana, and Conocancha production units.

We proceeded to identify lambs with peculiarities in their birth and physiology, manifesting themselves as hunched neonates (Figure 2a), without evidence of fever and with a slight dampness in the umbilicus. Subsequently, the deceased lambs identified with the aforementioned peculiarities underwent an autopsy (Figure 2b) which confirmed the reason for their death, known since the 1980s by the workers as "pupote". This term refers to lambs that, on post-mortem examination, showed a ligament connecting the liver to the umbilicus, characterized by a hunched posture and listless behavior. After that, the specimens were kept in a refrigerated thermal box for transport to the Animal Health Laboratory of the Faculty of Animal Science of the Universidad Nacional del Centro del Perú. In this phase, radiographic analyses were carried out with the El Detector Careray equipment (Figure 2c), using analog radiography to obtain images that facilitated the detailed description of the pathology.

Finally, a thorough autopsy was performed, during which tissues, veins, ligaments, and organs were identified and examined. This was done with the support of the research group to ensure proper identification and description of the anomaly.

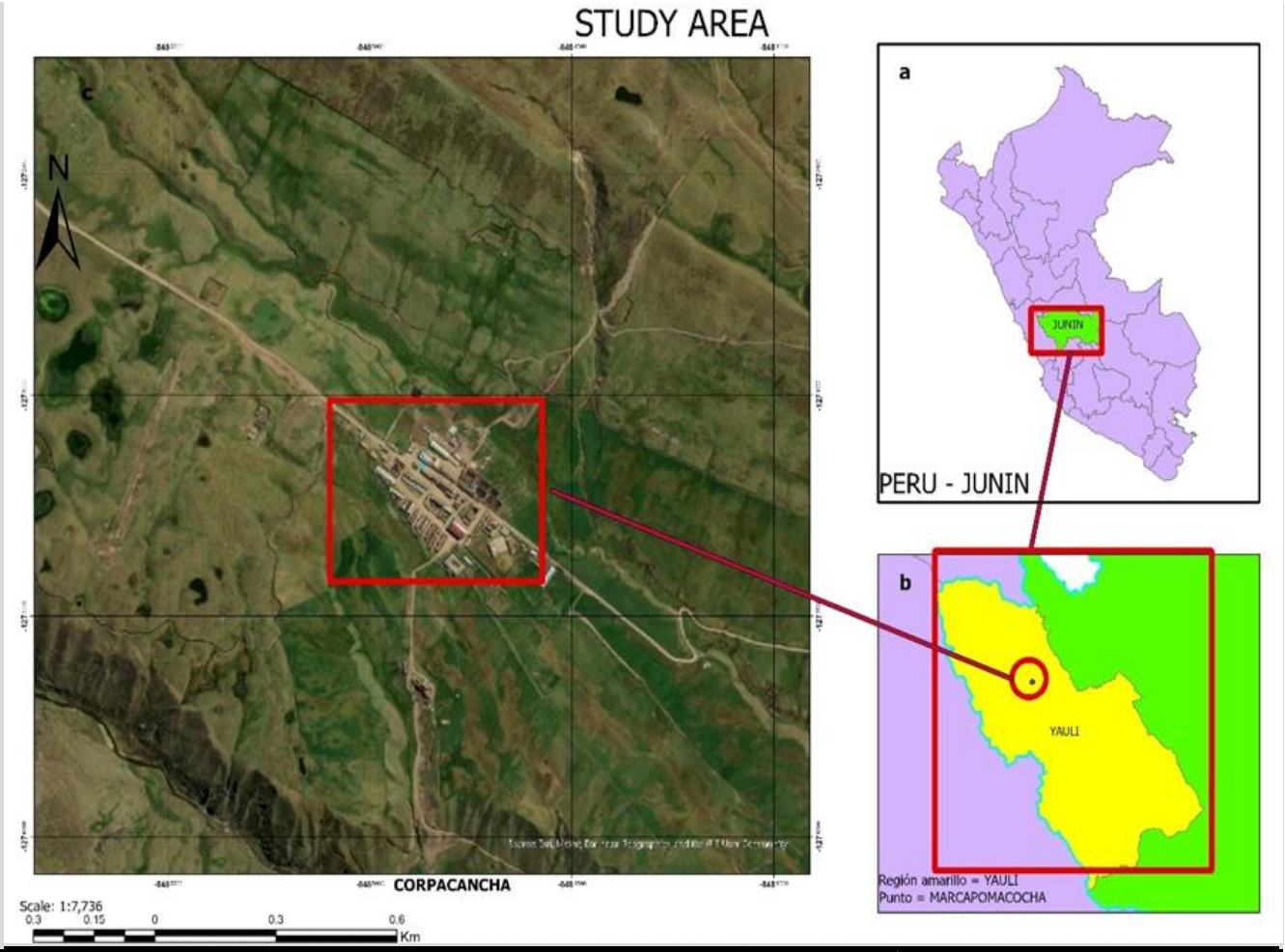

Figure 1 - Location of the study; a. map of Peru by region (green color, shows the Junín region); b. map of the Junin region (yellow color, shows the province of Yauli). District of Marcapomacocha; c. Satellite image, shows the study site, which belongs to the SAIS "PACHACUTEC" SAC - U.P. Corpacancha.

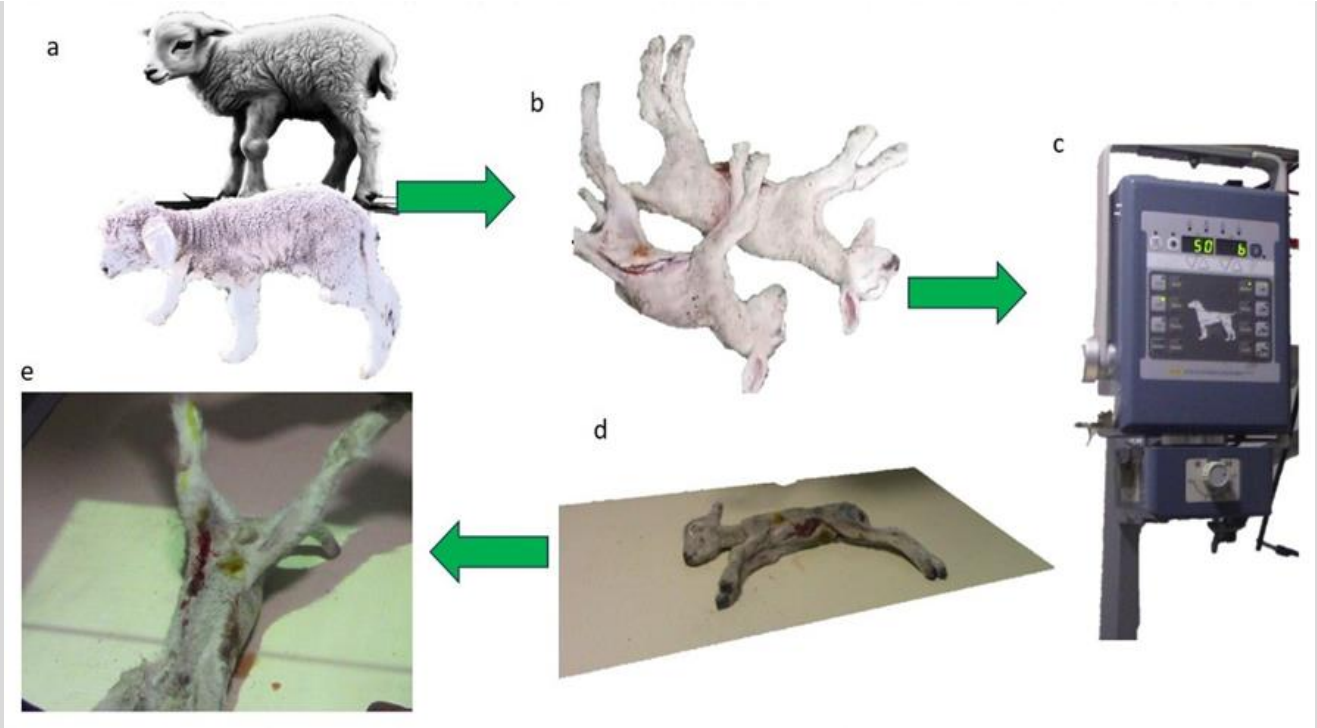

Figure 2 - Study procedure. A. Lambs identified by their hunched morphology and apathetic behavior; b. Autopsy to check for the presence of the abnormality; c. Careray Detector; d. Analogue radiograph of the lamb in lateral recumbency; e. Analogue radiograph of the lamb in dorsal decubitus.

DISCUSSION

The incidence of the anomaly averages 0.825 ± 0.09 % (Table 1) show similarities with the findings reported in Canada, where incidental incidences of urachal anomalies were recorded in a pediatric center caring for newborns (Gleason et al., 2015). There is also agreement with previous studies addressing this issue in infants, such as the work of Chiarenza et al. (2009). Similarly, our results are consistent with those of Dhillon et al. (2015), who claim that urachal abnormalities do not exceed 1% of the population. A comprehensive review of the literature evidences, through parenthetical citations, consistency in the paucity of reported cases of persistent urachus (Hirose et al., 2017; Rojas-Quintero et al., 2023;), underscoring the infrequency of this condition. Diagnostics and some treatment approaches, such as surgical incisions via laparoscopy and cauterizations (Sarmiento et al., 2021), appear to be the best options. These results highlight the importance of undertaking comprehensive longitudinal studies in the future, as indicated by Wilson et al. (2019).

The results obtained from the analog radiographs revealed the presence of the anomaly, commonly referred to by villagers as "pupote", in the lambs submitted for analysis and positioned in dorsal recumbency (Figure 3a,b). In contrast, an X-ray of a lamb without the above-mentioned anomaly, which was in the lateral decubitus position, was included. For ease of comparison, Figure 4 illustrates both a lamb with the presence of the anomaly (Figure 4a) and a lamb with uncomplicated natal development (Figure 4b).

The clinical manifestations identified corroborated the diagnosis of persistent urachus. In the analysis, the presence of transitional epithelium in the inner layer was evident (Figure 5a), corresponding to the same type of epithelium characteristic of the tunica interna of the urinary bladder, as established by Bacha and Bacha (2001), Zamora (2006), and Del Cid et al. (2023). Persistence of the urachus, which results in the non-complete obliteration of this structure after birth, may be due to various causes (abnormal development, genetic, urachal regression problems, and environmental factors; Cappele et al., 2001; Gelikman et al., 2023). It is important to note that persistent urachus can vary in severity and presentation, and is not always associated with significant health problems. However, in some cases, it may predispose to urinary tract infections or other urinary tract complications (Kim et al., 2021). Moreover, to explain the detected anomaly, the configuration of the systemic venous system has been the subject of analysis by several scholars (CFW, 1925; Beaubien-Souligny et al., 2020; Ziętek, 2022), who have sought to understand the anomaly present in the connection between the umbilicus and the liver. One possible explanation for the formation of this anomaly is visualized in Figure 4a. It is postulated that, during the early stages of embryonic development, the venous system is characterized by the persistence of the left vitelline venous connection to the liver (Azuma et al., 2002). Later, the left vitelline vein disappears, and blood from the placenta is redirected to the right sinus horn (Hikspoors et al., 2017; Terasaki et al., 2020), apparently giving rise to the presence of the round ligament of the liver (*ligamentum teres*).

Terasaki et al. (2020) mentioned that surgeons should be aware of portal and hepatic vein anomalies in patients with alterations in the *ligamentum teres*, as this could carry significant risks. Persistent urachus in sheep is a rare phenomenon that has been identified as an exceptional anatomical case. The urachus, a tubular structure that connects the urinary bladder to the umbilicus during fetal development, normally closes after birth, forming the umbilical ligament (Ziętek, 2022). However, this case report highlights an unusual variation in which a persistent ligament connecting the umbilicus to the liver is observed in newborn lambs identified as *ligamentum teres*, which, from the literature reviewed, lambs with persistence of the urachus have this persistence of the *ligamentum teres* (Figure 5b). Clarifying the terminology used by the field shepherds of "Pupote".

Table 1 - The incidence of the anomaly averages

Place*	Lambs born (n)	Lambs with the presence of the anomaly (n)	Incidence
U.P. Corpacancha	10501	98	0.933
U.P. Conocancha	3502	26	0.742
U.P. Santa Ana	3004	24	0.799

Explanatory notes: *epidemiological units.

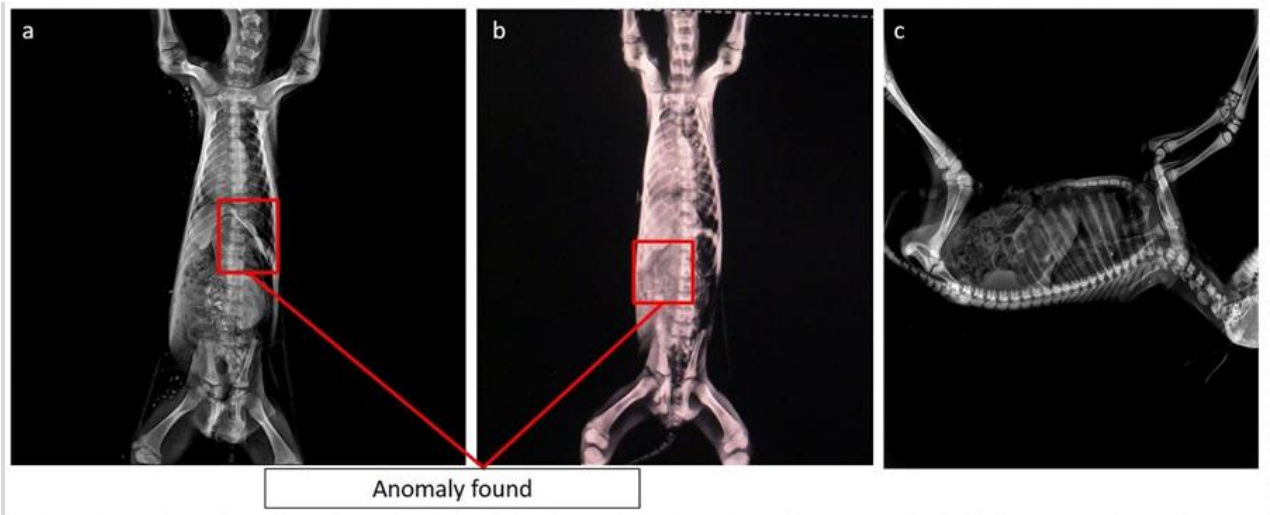

Figure 3 - Analogue radiographs of three lambs. a. Analogue radiograph of lamb in dorsal recumbency (lamb with abnormality); b. Analogue radiograph of lamb in dorsal recumbency (lamb with abnormality); c. Analogue radiograph of lamb in lateral decubitus (lamb without abnormality).

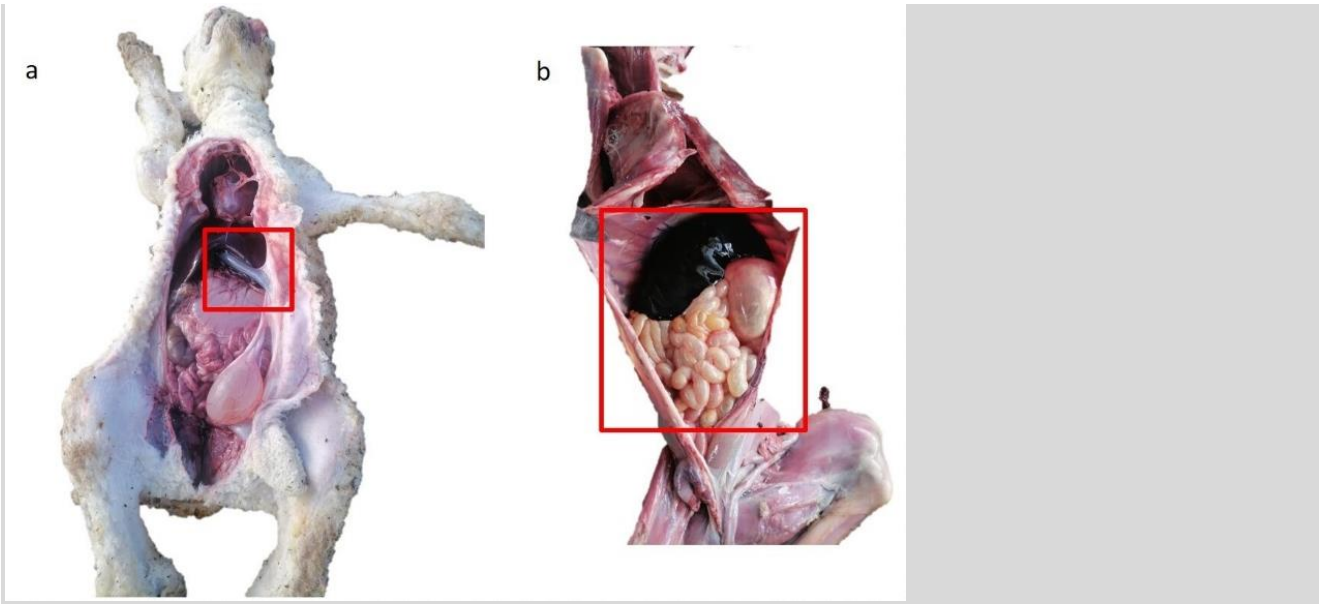

Figure 4 - Autopsy of two lambs. (a) Autopsy of lamb with abnormality; (b) Autopsy of normal lamb.

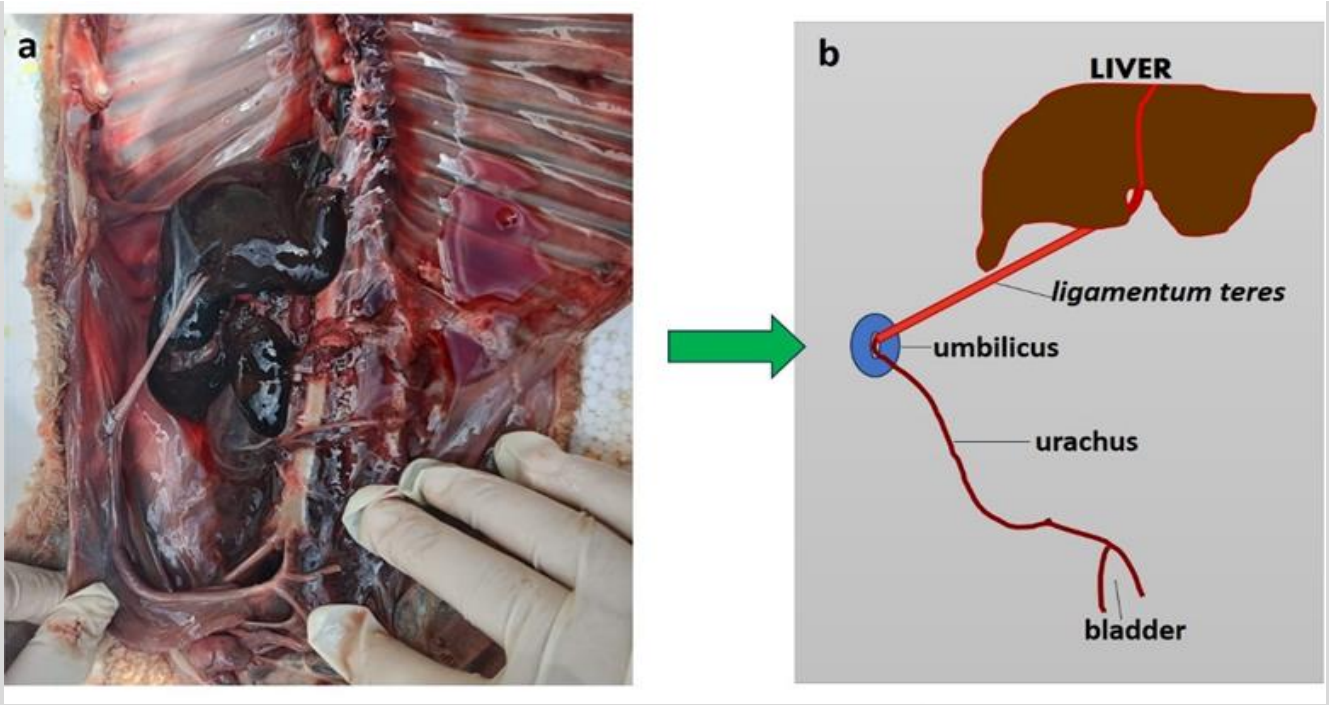

Figure 5 - Identification of the abnormality. a. Lamb with persistent urachus, ligamentum teres present; b. Identifying the components observed in the Lamb.

CONCLUSION

This "pupote" case highlights the persistence of urachus in newborn lambs, evidenced by the identification of a ligament that establishes a connection between the umbilicus and the liver. Specifically, the ligament identified in the described anomalies corresponds to the *ligamentum teres*. The incidence of persistent urachus, represented by persistent *ligamentum teres*, in neonatal lambs is 0.82%. This condition is classified as a congenital disease, possibly influenced by several factors, including abnormal development, genetic factors, problems in urachal regression, and environmental variables.

DECLARATIONS

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Ethical regulations

The present research is subject to the rules and ethical codes of Peruvian Law No. 30407, article 19, which establishes the animal welfare protocols and the conditions under which specimens should be included for academic-scientific purposes only. In addition to having the approval by the ethical charter of animal welfare LETTER N° 003-GRJ-DRA-AAC-PERÚ-2023.

Authors' contribution

J.N. Carhuas: conceptualization, research, writing-revision and editing. N.M. Salguedo: conceptualization, sampling and research. F.A. Villar: writing the original draft, visualization, and revision. E. García-Olarte: visualization, formal analysis, writing, revision and editing. C.Q. Eulogio: visualization, formal analysis, and conceptualization. Yakelin Mauricio Ramos: methodology, photo editing, and revision. I.U. Payano: Redaction.

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Consent to publish

All authors agree to the publication of this manuscript.

Competing Interests

The authors have not declared any competing interest.

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