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FULL PAPER

Surgery

Superficial swellings in sheep (*Ovis aries*) and goats (*Capra hircus*): Clinical and ultrasonographic findings

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ABSTRACT. This study describes the clinical presentation of superficial swellings and evaluates the utility of ultrasonography in the diagnosis of such swellings in sheep and goats. Ninety-three sheep and 73 goats were included in this study on the basis of presence of superficial swellings on the head (n=56), neck (n=16), chest wall (n=3), abdominal wall (n=40), umbilicus (n=14), scrotum (n=16), testes (n=1), udder (n=7), limbs (n=2), gluteal region (n=5), tail (n=1), and penile urethra (n=5). Ultrasonographic evaluation of these superficial swellings allowed the diagnosis of abscesses (n=54; 32.52%), cysts (n=12; 7.23%), hernias (n=57; 34.33%), hematomas (n=14; 8.44%), tumors (n=24; 14.45%), and urethral diverticula (n=5; 3.03%). Each lesion type could be precisely discriminated (sensitivity, 88–100%; specificity, 80–100%; and *P*=0.001). Ultrasonography was found to have a specificity of 100% for the diagnosis of hernias, urethral diverticula, and tumors, and a lower specificity of 80% for hematomas and 93% for abscesses when used for evaluation of superficial swellings in sheep and goats. In conclusion, ultrasonography is a unique, non-invasive diagnostic imaging tool that allows the diagnosis, differential diagnosis, and subsequent surgical treatment of different types of superficial swellings in sheep and goats.

KEY WORDS: clinical, goat, sheep, swelling, ultrasonographic

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Various superficial swellings have been recorded in sheep and goats, resulting in low production of milk, meat, hide, and wool, as well as high economic losses [4, 19]. Superficial swellings affecting sheep and goats are commonly abscesses [4], hematomas [19], hernias [9, 15], cysts [2, 7], urethral diverticula [5, 16, 18,], and neoplasms [3, 12].

The diagnosis of such swellings can be made clinically, based on their consistency upon palpation and their location, and with needle aspiration and biopsy. However, the evaluation of superficial swellings by routine clinical examinations alone is sometimes challenging because of their similar features, such as location, massive size, and the pain associated with them. Ultrasonography is a non-invasive diagnostic imaging tool that enables the differentiation of most such swellings from the surrounding organs based on the alteration in echogenicity [14]. The differential diagnosis of superficial swellings is important, but is challenging for veterinarians, as different types of swellings may have similar clinical features. Ultrasound can provide information about the architecture of these swelling. It allows differentiation of solid from cystic structures and provides greater details that are not demonstrated on clinical and radiological examinations [13].

Few studies have assessed superficial swellings in sheep and goats, and to the best of our knowledge, there are not many studies evaluating the utility of ultrasonography as a unique and non-invasive imaging tool in the diagnosis of superficial swellings in sheep and goats. Therefore, in order to improve relevant knowledge, in this study we aimed to describe the clinical and ultrasonographic features of superficial swellings in sheep and goats and to evaluate the utility of ultrasonography in the diagnosis of such swellings.

MATERIALS AND METHODS

Animals

A total of 166 animals were included in the present study (93 sheep and 73 goats). These animals were admitted to the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Qassim University, Saudi Arabia between January 2017 and

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February 2019. There were 42 male and 51 female sheep of three local breeds (Nagdi=80, Naimi=10, and Sakni=3), with age ranging from one to 72 (mean, 34 ± 18) months and weight ranging from 18 to 65 (mean, 36 ± 13) kg. There were 34 male and 39 female goats of two breeds (48 Syrian and 25 Baladi), aged between one and 60 (mean, 30 ± 14) months and weighing between 10 and 60 (mean, 35 ± 12) kg.

These animals had superficial swellings at different body regions (Table 1; Figs. 1–5). The swellings were classified as acute or chronic according to the inflammation stage, as recent or organized according to the duration, and as reducible or irreducible according to the cause (Table 2). The Animal Welfare and Ethics Committee of Qassim University approved the protocol of the study.

Clinical examination

Sheep and goats were clinically examined to determine the physical characteristics of the swellings, their cause, duration, site, nature, size, and contents. In addition, the breed, age, and sex of the affected animal were recorded. All these parameters were evaluated, compared, and statistically analyzed. The consistency of the swelling and the nature of its content were detected by palpation and exploratory puncture under aseptic conditions. The type and anatomical site of the superficial swellings in all investigated sheep and goats are presented in details in Table 2.

Ultrasonographic examination

According to the anatomical site of the swelling, ultrasonographic examinations were performed in the standing or lateral recumbent position, using 7.5 MHz linear transducers and 3.5–5 MHz sector (SSD-500, Aloka, Tokyo, Japan). The examined sheep and goats were lightly sedated, when required, using an intravenous injection of 0.02 mg/kg xylazine HCl (Seton 2%, Laboratorios Calier, S.A., Barcelona, Spain). According to the anatomical site of the swelling, preparation of the examined area on each sheep and goat was performed by clipping and shaving of the skin. For evaluation of the size and contents, the swellings were examined by moving the transducer craniocaudally and dorsoventrally, beginning from the healthy part towards the swelling. Ultrasonographic evaluation of the swellings depends on the echogenicity of their contents, in addition to their relationship with the surrounding tissues. Ultrasound-guided aspiration of the contents was performed to confirm the diagnosis.

Histopathological examination

The specimens obtained from the swellings for histopathological assessment were fixed routinely in 10% formalin, processed, and stained with hematoxylin and eosin stain. The findings were analyzed and reported.

Statistical analysis

GraphPad Prism statistical software program (version 8.0, GraphPad Software Inc., La Jolla, CA, U.S.A) was used for statistical analysis. The efficacy of ultrasonography for diagnosis of the superficial swellings in the examined sheep and goats was assessed using contingency table analysis. The sensitivity, specificity, *P* value, and predictive values (positive and negative) were calculated. *P* value <0.05 was considered significant (Table 3).

Table 1. Number and incidence of the superficial surgical swellings in sheep (n=93) and goats (n=73)

Type of swelling	Subdivision	Sheep			Goat			Total	%
		No.	Subtotal	%	No.	Subtotal	%		
Abscesses	Parotid abscess	12			5				
	Submandibular abscess	5			6				
	Umbilical abscess	3			3				
	Prescapular abscess	1	28	16.86	1	26	15.66	54	32.52
	Thoracic wall abscess	1			2				
	Pelvic wall abscess	2			3				
	Ophthalmic abscess	3			6				
	Testicular abscess	1			-				
Cysts	Wattle (tassel) cyst	2			5				
	Thyroid cyst	1	5	3.02	2	7	4.21	12	7.23
	Interdigital cyst	2			-				
Hernias	Umbilical hernia	5			3				
	Ventral abdominal hernia	20	32	19.27	13	25	15.06	57	34.33
	Scrotal hernia	7			9				
Hematomas	Head	3	9	5.43	4	5	3.01	14	8.44
	Ear	6			1				
Tumors	Different parts of the body	17	17	10.24	7	7	4.21	24	14.45
Urethral diverticula	Penile urethra	2	2	1.23	3	3	1.80	5	3.03
Total		93	93	56.05	73	73	43.95	166	100

Table 2. Type and anatomical site of the superficial swellings assessed in sheep (n=93) and goats (n=73)

Location	Abscess (n=54)		Cysts (n=12)	Hernias (n=57)		Hematomas (n=14)		Tumors (n=24)	Urethral diverticula (n=5)
	Acute (n=22)	Chronic (n=32)		Reducible (n=36)	Irreducible (n=21)	Recent (n=9)	Organized (n=5)		
Head (n=56)	15	22	0	0	0	9	5	5	0
Neck (n=16)	1	1	10	0	0	0	0	4	0
Chest wall (n=3)	1	2	0	0	0	0	0	0	0
Abdominal wall (n=40)	0	0	0	21	12	0	0	7	0
Umbilicus (n=14)	2	4	0	5	3	0	0	0	0
Scrotum (n=16)	0	0	0	10	6	0	0	0	0
Testes (n=1)	0	1	0	0	0	0	0	0	0
Udder (n=7)	0	0	0	0	0	0	0	7	0
Tail (n=1)	0	0	0	0	0	0	0	1	0
Forelimb (n=2)	0	0	2	0	0	0	0	0	0
Gluteal region (n=5)	3	2	0	0	0	0	0	0	0
Penile urethra (n=5)	0	0	0	0	0	0	0	0	5

Table 3. Statistical parameters for ultrasonographic discrimination of superficial swellings in the studied sheep (n=93) and goats (n=73)

Swelling type	Sensitivity	Specificity	Positive value	Negative value	*P* value
Abscess vs. others	96.30	98.21	96.30	98.21	0.0001
Acute vs. chronic abscess	90.91	93.75	90.91	93.75	0.0001
Cysts vs. others	90.91	99.31	90.91	99.31	0.0001
Hernia vs. others	100.00	100.00	100.00	100.00	0.0001
Reducible vs. irreducible hernia	94.44	95.24	97.14	90.91	0.0001
Hematoma vs. others	92.86	99.34	92.86	99.34	0.0001
Recent vs. organized hematoma	88.89	80.00	88.89	80.00	0.0099
Tumor vs. others	100.00	100.00	100.00	100.00	0.0001
Urethral diverticulum vs. others	100.00	100.00	100.00	100.00	0.0001

Sensitivity, specificity, positive and negative predictive values are expressed as percentages. *P* value <0.05 was considered significant.

RESULTS

Clinical findings

Of the 166 evaluated animals, 54 (32.52%) were diagnosed with abscesses (22 acute and 32 chronic), 12 (7.23%) with cysts, 57 (34.33%) with hernias (36 reducible and 21 irreducible), 14 (8.44%) with hematomas (9 recent and 5 organized), 24 (14.45%) with tumors, and 5 (3.03%) with urethral diverticula.

Abscesses in sheep and goats were found at different parts of the body; parotid region (n=17), submandibular region (n=11), umbilicus (n=6), chest wall (n=5), gluteal region (n=5), testes (n=1), and eye (n=9) (Fig. 1A–F). They were of various sizes and shapes, the pus color was yellowish to greenish and the consistency was watery, milky, creamy, cruddy, and cheesy. The abscesses appeared as compressible, circumscribed, firm inflammatory swellings that were red, warm to touch, and very painful during manipulation in their acute form, and mostly had a thick fibrous capsule with a small amount of pus and without signs of inflammation in the chronic form.

Cysts were recorded in 5 sheep and 7 goats in the present study: Wattle (tassel) cysts (n=7) (Fig. 2A), thyroid cysts (n=3), and interdigital cysts (n=2). The exploratory puncture of these cysts revealed a transparent fluid in the wattle (tassel) cysts (Fig. 2B and 2C), a violet-brown semi-transparent fluid in the thyroid cysts, and sebaceous cheesy material in the interdigital cysts.

Three types of hernias were recorded in the studied sheep and goats; abdominal (n=33), umbilical (n=8), and scrotal hernias (n=16). The hernial ring ranged in size from one finger to more than 2-hands breadth. There were 36 and 21 reducible and non-reducible hernias, respectively (Fig. 3A, 3B and 3D).

Hematomas were diagnosed in 9 sheep and 5 goats with a history of exposure to trauma. They appeared generally as circumscribed, soft, small-to-large-sized swellings on the head of sheep and goats (Fig. 4A and 4B), which occurred due to fighting among the animals. Auricular hematomas occurred mainly due to trauma and appeared as ovoid or round, tender, fluctuating swellings on pressure. The swelling was either in the inner or outer surface of the ear flap (Fig. 4C), and was fluctuant and fluid-filled, like a water balloon. Exploratory puncture and aspiration revealed pure blood in recent hematomas and hemoserous fluid in older hematomas.

Urethral diverticula were diagnosed in two rams and three kids and were seen along the whole length of the penile urethra. They

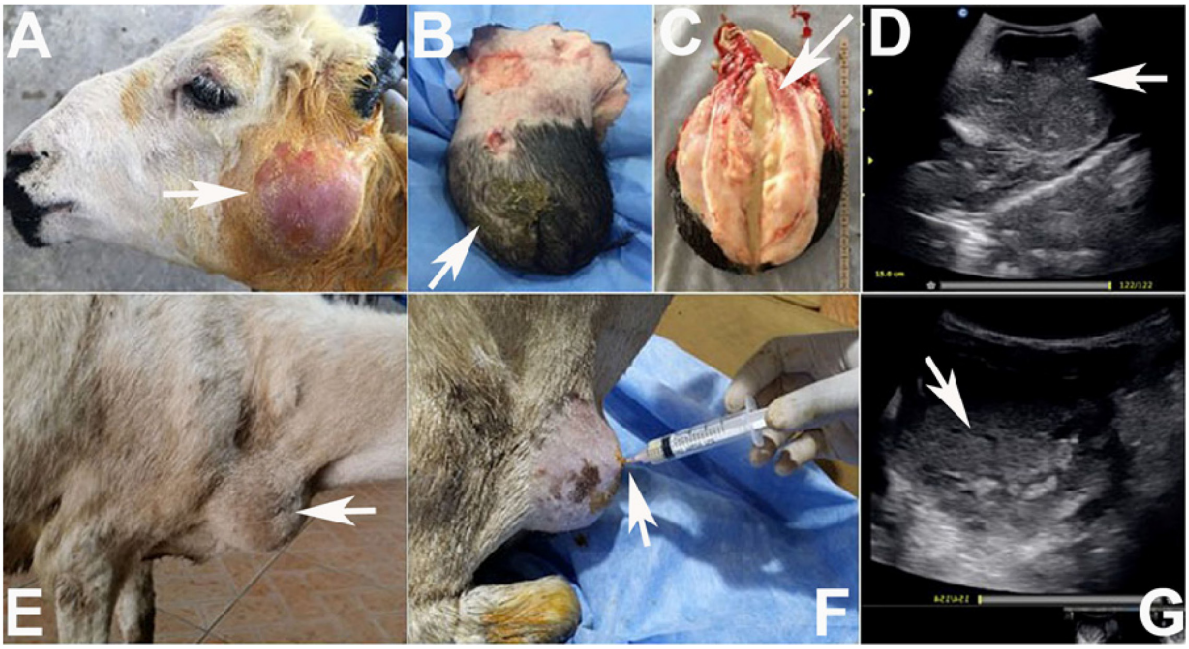

Fig. 1. A: 4 cm-sized parotid acute abscess in sheep (arrow). B and C: Pre- and postoperative testicular abscess in sheep. D. Accumulation of homogenous echogenic contents inside a thick hyperechoic capsule (arrow). E: Prescapular chronic abscess in sheep. F: Aspiration of pus from the abscess (arrow). G: Accumulation of hypoechoic contents with hyperechoic caseated materials with a well-defined echogenic wall (arrow).

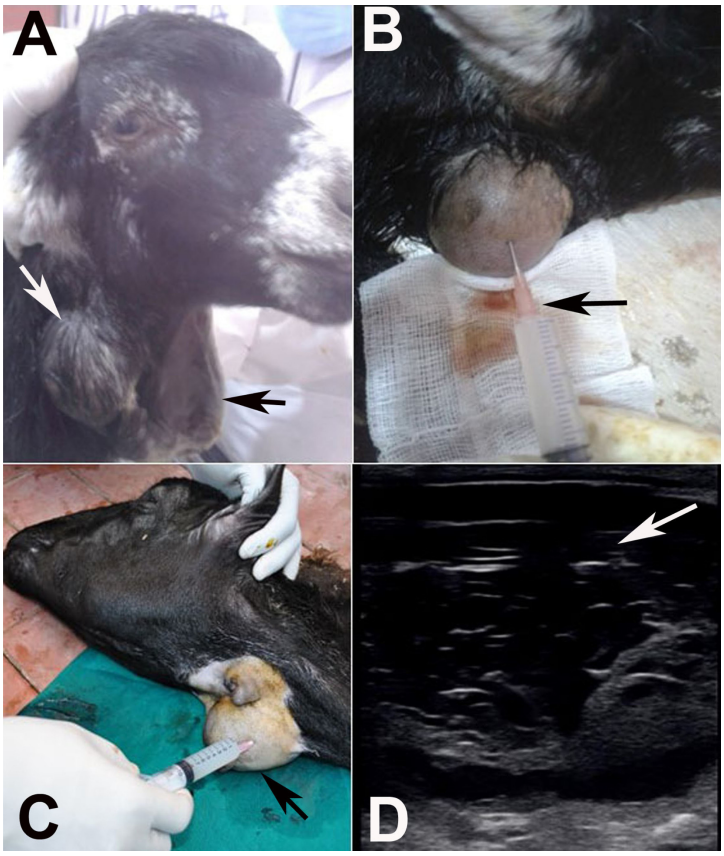

Fig. 2. A: Wattle (tassel) cyst in a goat (arrow). B: Aspiration of colorless fluid from the swelling. C: Aspiration of colorless fluid from a wattle (tassel) cyst in a sheep (arrow). D. The cyst appeared as anechoic structure with thick hyperechoic septa (arrow).

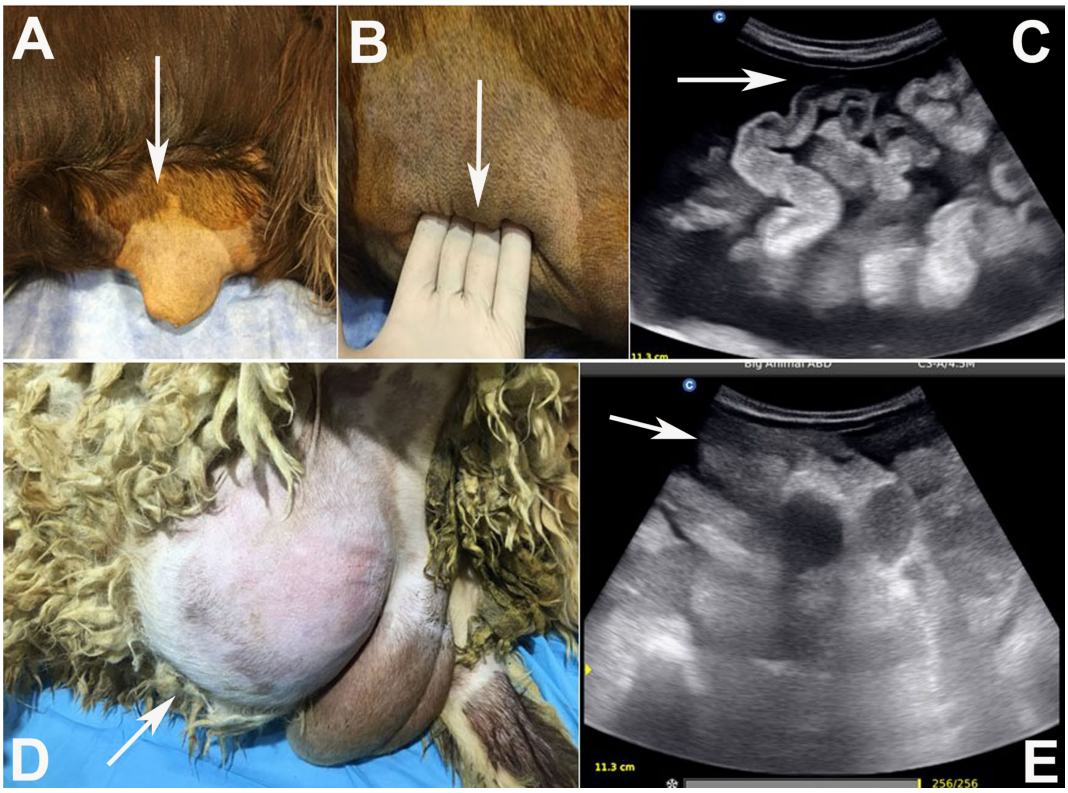

Fig. 3. A and B: Reducible umbilical hernia in a goat (arrow). C. Ultrasonographic view of longitudinal intestinal loop within the hernial sac represents clear anechoic peritoneal fluid (arrow). D: Irreducible ventral abdominal hernia in a sheep (arrow). E. Ultrasonographic view of transverse intestinal loop with presence of a thickened echogenic hernial sac due to adhesions (arrow).

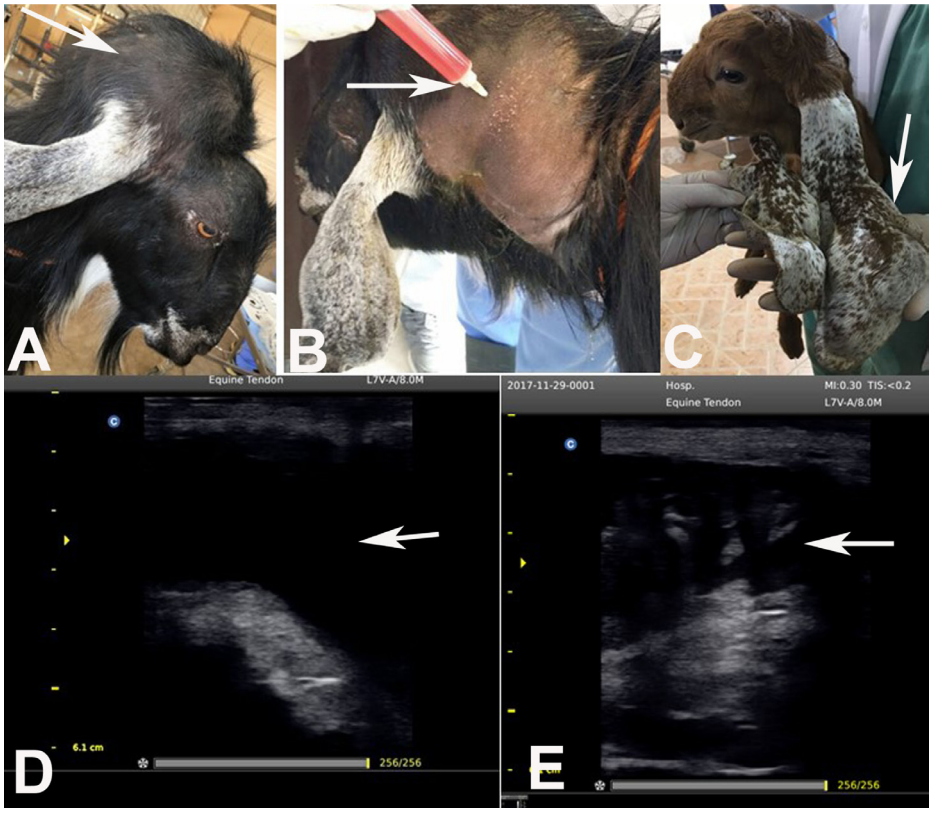

Fig. 4. A and B: Recent hematoma in a goat with presence of aspirated blood (arrow). C. Organized hematoma in a ram. D. Hypoechoic to anechoic infiltrated blood within the tissues in a recent hematoma (arrow). E: Organized hematoma appeared as hyperechoic sac divided by echogenic septa (arrow).

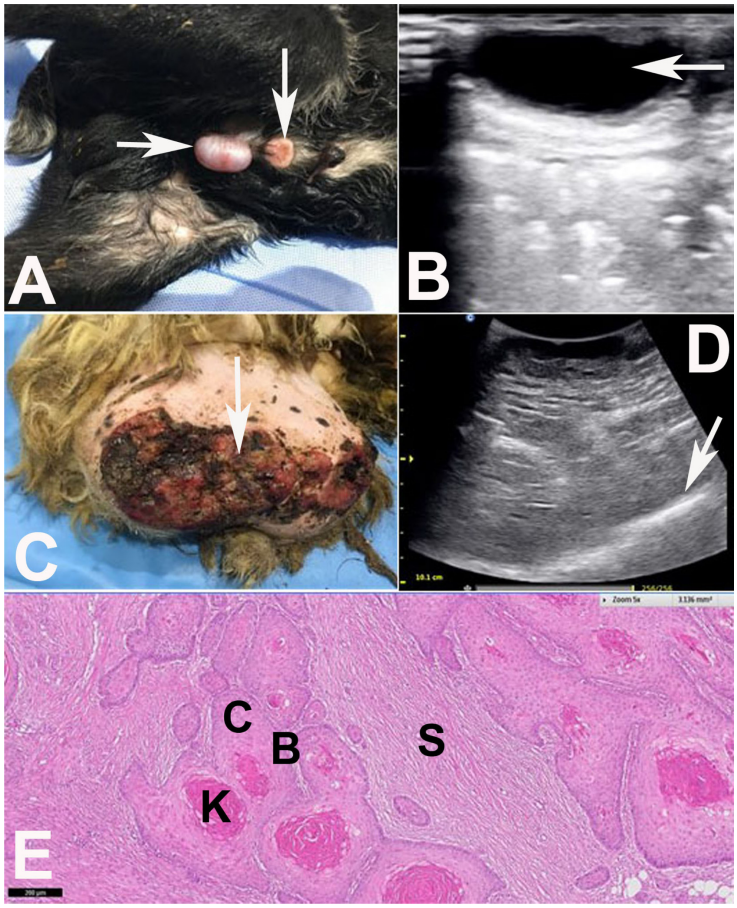

Fig. 5. A: Urethral diverticulum in a 2-month kid (horizontal arrow) and preputial orifice (vertical arrow). B. The urethral diverticulum appeared as hypoechoic to anechoic content (arrow) enclosed with a well-defined, thick echogenic wall. C. Sheep fatty tail revealed an ulcerated exophytic outgrowth of squamous cell carcinoma. The tumor was lobulated with a rough and ulcerated surface. Dark brown rough cornified spots on the surface were observed. D. The tumor appeared as a heterogeneous mass surrounded by a hyperechoic wall (arrow). E. The neoplastic mass disrupted the basement membrane and invaded the subcutaneous connective tissue. The neoplastic mass was composed of a basal cell layer (B) at the periphery and centered with proliferated acanthocytes (C) and keratohyaline pearl materials (K). The neoplastic epithelial cells were moderately anaplastic. The tumor was a well-differentiated squamous cell carcinoma. The neoplastic cell nests were supported with desmoplastic stroma (S) heavily infiltrated with mononuclear cells.

were situated 2–3 cm caudal to the preputial orifice (Fig. 5A), and measured 4–6 cm in diameter in the examined cases; the size of such swellings varied according to the degree of infiltrate. Physical examination revealed dribbling of urine from the preputial orifice.

Seventeen sheep and 7 goats were diagnosed with tumors at various parts of the body—nose, neck, abdomen, udder, as well as at the tail. Physical palpation and manipulation of the tumors revealed friable to hard consistency (Fig. 5C). Squamous cell carcinoma and malignant melanoma were diagnosed sonographically and confirmed by histopathological examination (Fig. 5E).

Ultrasonographic findings

The superficial swellings in sheep and goats were classified ultrasonographically according to the stage of inflammation, duration, and cause into acute/chronic, recent/organized, and reducible/irreducible, respectively (Table 2). Their echogenicity varied according to the type, location, contents, and duration. The swellings were localized as follows: 56 in the head, 40 in the abdominal wall, 16 in the neck, 16 in the scrotum, 14 in the umbilicus, 7 in the udder, 5 in the gluteal region, 5 in the penile urethra, 3 in the chest wall, 2 in the limbs, 1 in the testes, and 1 in the tail. Superficial swellings in the studied sheep and goats mostly occurred at the head (n=56), particularly abscesses and hematomas, followed by the abdominal wall (n=40, Table 2).

According to the stage of inflammation (acute/chronic), the echogenicity of the abscesses varied from anechoic to hyperechoic areas surrounded by a thickened hyperechoic wall, which demarcated the contents of the abscess from the surrounding tissues. The echogenicity of the contents depended on the abscess duration. In the acute stage, abscesses were characterized by the presence of homogeneous echogenic contents within a thick hyperechoic capsule, whereas chronic abscesses appeared as hyperechoic structures with presence of internal septa and were demarcated with an echogenic wall (Fig. 1D and 1G). The echogenicity of the abscess content increased over time due to absorption of the fluid content and deposition of minerals within the pus.

Cysts appeared as anechoic structures with presence of thick and hyperechoic septa (Fig. 2D). Hernias were diagnosed in 57 sheep and goats (36 reducible and 21 irreducible). The hernial ring in case of reducible hernias was diagnosed as a disruption of the abdominal wall continuity at the site of the defect. Intestinal loops as hernial content were observed as longitudinal echogenic lines or circles within the hernial sac according to the transducer orientation, either in the sagittal or transverse plane (Fig. 3C), with more or less anechoic, hypoechoic, and echogenic contents. The intestinal contents were ingesta, gases, or fluids, which appeared as hypoechoic, echogenic, and anechoic contents, respectively. Irreducible hernias in the studied sheep and goats had a thick and hyperechoic hernial ring and a hernial sac. This was contributed to the presence of adhesions between them and the abdominal wall (Fig. 3E).

Hematomas occurred commonly in the ear of examined sheep and goats. It differed sonographically according to the case history, duration, and location. Recent hematomas appeared as hypoechoic to anechoic structures due to infiltration of blood within the tissues (Fig. 4D). With increased duration, organized hematomas were diagnosed as hyperechoic round to ovoid sacs that were divided by echogenic septa (Fig. 4E).

Urethral diverticula in 2 rams and 3 kids were diagnosed sonographically as homogenous, hypoechoic to anechoic structures enclosed with a well-defined, thick echogenic wall, with acoustic enhancement of the fluid contents (Fig. 5B). Echogenicity variation with appearance of hyperechoic sediments was attributed to the variation in the concentration of the urine. Ultrasound-guided needle aspiration ensured accurate diagnosis and was followed by surgical intervention. Tumors appeared as heterogeneous masses surrounded by a hyperechoic wall (Fig. 5D). Based on the clinical and ultrasonographic findings, tumors were radically excised in all cases as a curative intervention. Histopathological examination revealed squamous cell carcinomas (Fig. 5E).

DISCUSSION

Superficial swellings are common in sheep and goats with a global distribution. They represent one of the most frequent reasons for surgical interference in these animals [4, 7, 11, 12]. However, there is limited literature available about the utility of ultrasound for the diagnosis and differential diagnosis of such swellings in sheep and goats. Thus, the present study was designed to evaluate the clinical and ultrasonographic findings of superficial swellings in sheep and goats. Case history, physical examination, and exploratory puncture are routinely performed for the diagnosis of superficial swellings in sheep and goats. Ultrasonography could be used as a unique, non-invasive imaging technique for diagnosis and differential diagnosis of various superficial swellings in these animals, particularly when physical examinations are inaccurate and inconclusive. In the present study, the ultrasonographic appearance of superficial swellings varied according to the type, location, duration, and contents. Similar results were reported by Streeter *et al.,* 2007 [17] and Hashefi, 2009 [8].

Abscesses and hematomas are common surgical disorders that are mostly caused by muscular trauma and are deceptively similar. Their diagnosis is considered an important challenge for veterinarians, given their similarity on physical examinations. In this study, the utility of ultrasound for evaluation of these swellings and their contents provided a fast and reliable paradigm for their differential diagnosis. Our findings were similar to those of Kofler, 2009 [10]. The echogenicity differed according to the duration and the character of the contents. The contents of the abscesses diagnosed in this study varied from homogenous echogenic in recent cases to hyperechoic with distinct hyperechoic capsule and echogenic septa in old (chronic) cases, whereas the contents of the hematomas varied from hypoechoic to anechoic in recent cases, progressing to greater echogenicity with thick septa as they become more organized; this may be contributed to progressive filling with fibrinous septations. These findings were in accordance with those of Hashefi, 2009 [8].

In the examined sheep and goats, cysts and hematoma appeared mostly similar. Differentiation between them could be achieved according to the animal's history of previous blunt trauma in case of hematoma, whose predilection site was in the ear. In contrast, cysts were characterized by thicker and more hyperechoic internal septa than those seen in hematomas. This result was in agreement with that of Hashefi, 2009 [8].

Abdominal hernias can be confused clinically with other inflammatory swellings of the abdominal wall due to the similar clinical features and history of acute onset. In this study, the hernial rings were easily demarcated ultrasonographically as a discontinuation of the abdominal wall echogenicity; therefore, the hernial contents were isolated from the surrounding tissues with presence of more or less hypoechoic inflammatory exudates in the recent hernias. However, the differential diagnosis of hernias from other abdominal swellings could be confirmed by the clearly visible peristaltic movement of the intestines within the hernia. Similar results were reported by Young *et al.,* 2007 [20] and Hashefi, 2009 [8]. The degree of adhesions between the hernial sac and surrounding tissues and the intensity of the peristaltic movements were clearly evaluated ultrasonographically; therefore, decision for herniorrhaphy, whether open or closed, should be made in regard to such evaluation. These findings were in accordance with those of Abouelnasr *et al.* 2016 [1].

Regarding the urethral diverticula, they were diagnosed in the studied sheep and goats as anechoic structures surrounded by a thick echogenic wall. The echogenicity of the diverticula could vary and this may be contributed to the variation in the concentration of urine or to urinary diseases, such as cystitis or pyelonephritis. A similar result was reported by Braun, 1993 [6] and Abouelnasr *et al.* 2016 [1]. Squamous cell carcinoma and malignant melanoma were prevalent neoplasms in sheep and goats, respectively [3]. Tumors were diagnosed sonographically as heterogeneous masses surrounded by a hyperechoic wall. These findings were not in accordance with those of Abouelnasr *et al.* 2016 [1]. In conclusion, ultrasound provides a fast, non-invasive diagnostic imaging tool for the diagnosis, differentiation, and subsequent surgical interference of various types of superficial swellings in sheep and goats.

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