



Diagnosis and treatment of foreign bodies swallowing syndrome in camels (*Camelus dromedarius*) with special reference to the role of mineral deficiency

Madeh SADAN^{1,2)*}, El-Sayed EL-SHAFAEY^{1,3)} and Fahd AL-SOBAYIL¹⁾

¹⁾Department of Veterinary Medicine, College of Agriculture and Veterinary Medicine, Qassim University, Qassim, P.O. Box 51452, Saudi Arabia

²⁾Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, South Valley University, Qena 83523, Egypt

³⁾Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Mansoura University, Mansoura 35516, Egypt

ABSTRACT. This study describes the clinical presentation of ruminal and reticular foreign body syndrome (RRFBS), and evaluates the effect of mineral deficiency on its occurrence in dromedary camels. Thirty dromedary camels were divided into two groups. Group 1 (control) included 10 apparently healthy she-camels. Group 2 consisted of twenty dromedary camels diagnosed with RRFBS on the basis of clinical, ultrasonographic, hematological, and biochemical examinations. Clinical findings showed decreased appetite and milk yield, tympany, and gradual body weight loss. Ultrasonographic examinations revealed the presence of hyperechoic material with variable degrees of shadowing. Hematological evaluation showed a significant ($P < 0.05$) decrease of the total erythrocyte and lymphocyte count and a significant increase of neutrophils in the camels with RRFBS compared to the controls. Biochemical tests showed a significant elevation in the activity of serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), creatine kinase (CK), glucose, creatinine, and blood urea nitrogen and a significant decrease of sodium, chloride, potassium, cobalt, iron, and selenium in the camels with RRFBS compared to the controls. Rumenotomy was performed on the 20 camels as a surgical intervention for treating the RRFBS. By the 6th month postoperatively, all surgically treated camels had completely recovered except for one with tympany and slight swelling *in situ*. In conclusion, trace element deficiency might play an important role in the occurrence of foreign body ingestion syndrome in dromedary camels. Moreover, clinical, ultrasonographic, hematological, and biochemical examinations are considered as tools assisting in the accurate diagnosis, prognosis, and treatment stratagem for RRFBS in camels.

KEY WORDS: camel, foreign body, mineral deficiency, rumenotomy, ultrasonography

J. Vet. Med. Sci.

82(8): 1097–1103, 2020

doi: 10.1292/jvms.19-0621

Received: 15 November 2019

Accepted: 27 May 2020

Advanced Epub:

8 June 2020

Foreign body ingestion syndrome is a common pathological condition in ruminants that is primarily attributed to the indiscriminate feeding habits of these animals. It leads to several serious effects on animal health and economy, such as decreases in the production and reproduction of the affected animals [18, 20, 23]. Foreign body ingestion syndrome is a common reason for abdominal surgery in such species [2, 7]. Poor farming hygiene is considered to be one of the principles causes of high occurrence rates of foreign body ingestion syndrome [12, 14, 21]. A high percentage of the foreign objects are comprised of common organic materials and objects including thorns, wood, plastic bags, clothes, hair balls, and sand. The low radiopacity of these foreign bodies make them of a diagnostic challenge and thus, they are routinely overlooked with standard radiography [10, 21].

Foreign body ingestion syndrome has been associated with dietary deficiency and imbalances in animal nutrients, especially minerals and trace elements such as copper, iron, cobalt, and manganese as well as selenium. Serious complications of this syndrome have been reported, such as traumatic reticuloperitonitis in cases where foreign bodies have penetrated the alimentary tract, and obstruction of the digestive tract because of accumulations of wool, fiber, or sand [4, 17, 18, 23].

Foreign body diagnosis in ruminants depends on the diagnostic imaging technique used and the nature of the foreign material ingested [3, 14, 18, 20]. However, clinical diagnosis of rumenal and reticular foreign bodies may be inconclusive, so their

*Correspondence to: Sadan, M.: madehsadan@vet.svu.edu.eg

©2020 The Japanese Society of Veterinary Science



This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License. (CC-BY-NC-ND 4.0: <https://creativecommons.org/licenses/by-nc-nd/4.0/>)

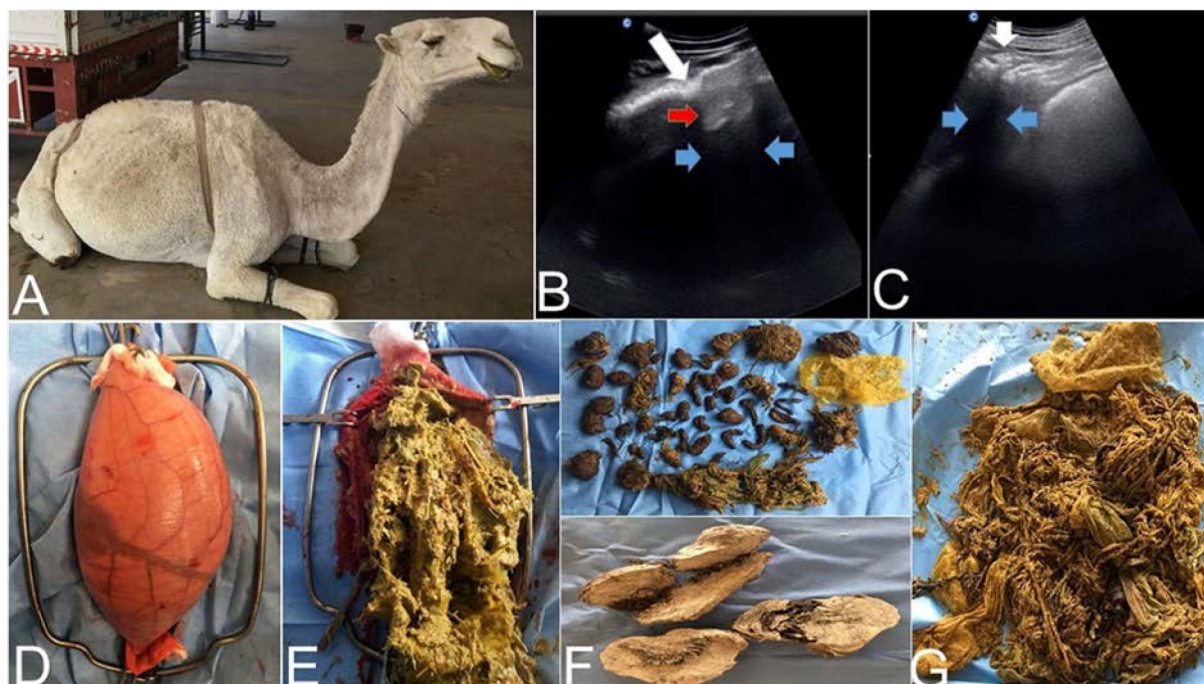


Fig. 1. A: An Arabian Wadeh she camel with a history of decreased appetite, rumenal impaction and loss of body weight. B: Ultrasonographic examination of the rumen (white arrow referred to rumenal wall), plastic bags (red arrow) was diagnosed as irregular hyperechoic structures with dirty distal shadowing (blue horizontal arrows). C: Sand was diagnosed in the rumen as hyperechoic object (vertical arrow) with posterior acoustic shadowing (blue horizontal arrows). D: Surgical exposure of the rumen during rumenotomy in male camel. E: Surgical removal of rumenal foreign bodies. F: Surgically removed 8.5 kg of foreign material from rumen and reticulum of one she camel (hair balls, wood pieces, and plastic bags). G: Surgically removed 6.4 kg of plastic bags from the rumen of another she camel.

diagnosis depends mainly on radiographic, ultrasonographic, hematological, and biochemical examinations. Exploratory surgery and advanced modern diagnostic techniques such as laparoscopy could be used for confirmation of the diagnosis [21, 22].

Many reports have described foreign body ingestion syndrome in ruminant animals [21, 23]. Despite the popularity of camels, little was found in the literature about the diagnosis and treatment of this syndrome or on the evaluation of trace element deficiency when it occurs in camels. We hypothesized that camels with rumenal and reticular foreign body syndrome (RRFBS) would exhibit visible changes in blood and biochemical parameters, especially with regard to trace elements, in comparison to controls. Therefore, the present study was designed to describe the diagnosis and treatment of RRFBS, and to evaluate the role of trace element deficiency in the occurrence of this affection in dromedary camels.

MATERIALS AND METHODS

Animals

Thirty camels were randomly allocated into two groups. Group 1 (control group) included 10 apparently healthy adult she-camels with a weight range of 300–450 kg (350 ± 100 , mean \pm SD). Group 2 (RRFBS group) included twenty dromedary camels (7 males and 13 females) aged between 12 and 120 months (mean \pm SD: 94 ± 12 months), weighing between 180 and 350 kg (240 ± 90 , mean \pm SD) and of different breeds (16 Wadeh, 2 Asfar, 1 Ashaal and 1 Mejhem) admitted to the Veterinary Teaching Hospital at the Qassim University Faculty of Veterinary Medicine, Saudi Arabia, between October 2018 and October 2019. The camels of Group 2 were included in the study on the basis of clinical, ultrasonographic, hematological, and biochemical evidence of RRFBS (Fig. 1A–G). The extracted ruminal and reticular foreign bodies of each rumenotomy surgery were weighed and classified according their nature. The protocol of the study (No. 369) was approved by the Committee for Animal Welfare and Ethics under the Laboratory Animal Control Guidelines of Qassim University.

Clinical examination

Upon admission, the camels were clinically evaluated via subjective foreign body ingestion assessment. Routine clinical examinations were carried out and body temperature, rumenal movement, and respiratory rate were recorded for each animal. Data for all investigated camels, including age, sex, and breed were assessed and recorded to be compared and analyzed.

Hematological and biochemical examination

For both groups a blood sample (5 ml) was collected in EDTA tubes from each camel by jugular venipuncture and analyzed

using the VetScan HM5 (Abaxis, Union City, CA, USA). A complete blood count was carried out which included total and differential leukocytic count, erythrocyte count (RBCs), hematocrit (HCT), hemoglobin (HGB), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

For biochemical analysis, 10 ml of blood was collected from all camels by jugular venipuncture in test tubes without anticoagulant and then centrifuged to obtain clear serum. An automated biochemical analyzer (VetScan VS2; Abaxis) was used to determine the serum concentrations of total protein (TP), albumin (ALB), globulin (GLOB), glucose (GLU), blood urea nitrogen (BUN), creatinine (CR), creatine kinase (CK), aspartate aminotransferase (AST), γ -glutamyl transferase (GGT), alkaline phosphatase (ALP), alanine aminotransferase (ALT), calcium (CA), phosphorus (PH), magnesium (Mg), sodium (NA), and potassium (K). The concentrations of zinc (Zn), copper (Cu), iron (Fe), cobalt (Co), manganese (Mn), chloride (Cl), and selenium (Se) were determined using an inductively coupled plasma-mass spectrophotometer (ICP-MS) (Model no. 7800, Agelint, Santa Clara, CA, USA).

Metal detector examination

All admitted camels were examined using a metal detector (DTM-1377, Hauptner-Herberholz, Germany). The detector was moved over the left flank region and the ventral abdominal wall cranially, up to the xyphoid cartilage, in order to detect the presence of metal foreign bodies in the rumen and reticulum of the affected camels.

Ultrasonographic examination

Ultrasonographic examinations of the rumen and reticulum of the affected animals were carried out using 3.5 MHz sector and 7.5 MHz linear transducers (SSD-500, Aloka, Tokyo, Japan). For examination, the camels were placed in a sitting position with the fore- and hind limbs tied. The animals were lightly sedated using intravenous 0.2 mg/kg xylazine HCl (Seton 2%, Laboratorios Calier, S.A., Barcelona, Spain). The left flank region was clipped and shaved for routine ultrasonographic examination. Following application of the transmission gel to the transducer, the left flank was examined for detection of foreign bodies.

Surgical treatment

Based on clinical, ultrasonographic, hematological, and biochemical examinations, surgical intervention (rumenotomy) of the affected camels was applied as a curative decision for the removal of rumenal and reticular foreign bodies. Routine clinical and hematological evaluations were carried out for the camels undergoing surgery. Feed and water were withheld for 12 hr preoperatively. Intramuscular (IM) administration of penicillin-streptomycin (Pen & Strep, Norbrook Laboratories, Newry, UK) at a dose rate of 30,000 IU/kg penicillin and 10 mg/kg streptomycin. Flunixin meglumine (Finadyin; Schering-Plough, Welwyn Garden City, Hertfordshire, UK) at 1.1 mg/kg was administered preoperatively. Sedation was performed via IV injection of xylazine HCl at a dosage rate of 0.3 mg/kg. The camel was placed in sternal recumbency, with subsequent clipping and aseptic preparation of the left flank for surgery. The incision site was anaesthetized with local infiltration analgesia using lidocaine HCl (lidocaine hydrochloride 2%, Norbrook Laboratories). When the appropriate depth of anesthesia had been achieved; a 20-cm incision was made in the skin approximately 4 cm caudal to the last rib and 5 cm ventral to the transverse processes of the lumbar vertebrae. Using a combination of blunt and sharp dissection, the incision was made deeper, continuing through the subcutaneous tissue, external oblique abdominal muscle, internal oblique abdominal muscle, transverse abdominal muscle, and peritonium. The rumen was grasped and fixed into a Weingart frame using two rumenal forceps. A clean, sterile surgical towel was placed in-between the rumen and abdominal incision to prevent any material from entering the abdominal cavity (Fig. 1D). The rumen was incised and the scalpel discarded, and then widening of the wound was performed using scissors, with the wound lips fixed by hooks onto the frame. Evacuation of a part of the rumenal contents and examination of the rumen and reticulum for presence of foreign bodies was performed. The reticulo-omasal opening was examined for any obstructive foreign body. After removing the foreign bodies (Fig. 1E), a 101 g Laxavet sachet (Avico, Amman, Jordan) and 1–2 l paraffin oil (Saudi Pharmaceutical Industries, Riyadh, Saudi Arabia) were introduced into the rumen of the camels for improvement of the rumioreticular function. The hooks were removed and suturing of the rumenal wound and abdominal wall was performed in a routine manner.

Postoperative care and follow-up

The preoperative antibiotic was continued for 10 days following surgery, and the anti-inflammatory was continued for five successive days in addition to IM injection of 10 ml of vitamins A, D₃, and E (ADVIT-DE; Morvel Laboratories P. Ltd., Simandhar Jain Temple, Mehsana, Gujarat, India). The camels were given stall rest with daily monitoring of the healing progress and were discharged from the clinic approximately four weeks postoperatively. A long-term (6-month) post-operative follow-up was carried out via a telephone survey to evaluate the progress of their health status. The owners were asked about recurrence of tympany, discharge from the surgical site, and final functional results of the surgery.

Statistical analysis

The unpaired *t*-test was used to compare the means of the variables in the camels with rumenal and reticular foreign bodies with those of the healthy camels. Before application of the *t*-test, the normal distribution of data was assessed using homologous disapprove yes. The results were considered significant at $P < 0.05$.

RESULTS

Clinical findings

Ruminal and reticular foreign bodies were clinically diagnosed in 20 dromedary camels (Group 2). The affected camels displayed decreased appetite, loss of body weight (Fig. 1A), decreased milk yield, ruminal impaction, and repeated chronic tympany.

Foreign bodies of different types were found in the camels that underwent surgery including clothes, plastic bags, pieces of wood, sand, hair balls, ropes, and leather (Fig. 1F and 1G). The amount of foreign material surgically removed from the camels ranged from 6.4–44 kg. In most of the cases (n=17), because of the large size of the foreign bodies and their very hard consistency, they were cut into smaller pieces inside the rumen during surgery to facilitate their removal from the 15–20 cm incision. In a few cases (n=3), the foreign bodies were found floating in the rumen. Sand was found in both the rumen and the reticulum of only one she-camel and its weight ranged from 8–10 kg. Hard hair balls of 8–10 cm in diameter were found in both the rumen and reticulum of five camels. Plastic bags were the most common, and were found in all the surgical cases (n=19) except for one. A total of 6.4 kg of plastic bags were surgically removed from one she-camel. The bags were found only in the rumen of the surgically treated camels. Clothes, ropes, leather, and wood pieces were found only in the rumen of three camels, while in others, wood pieces were found in both the rumen and reticulum. A total of 44 kg of plastic bags, ropes, and clothes were surgically removed from one she-camel. In all surgically treated camels, neither pins nor nails were found either in the rumen or in the reticulum. Finally, none of these foreign bodies were metallic and none had penetrated the wall of the reticulum or the rumen.

Hematological and biochemical findings

Total and differential leukocytic counts, RBCs, PCV, HGB, MCV, MCH, and MCHC were determined in the twenty surgically treated camels. There was a significant increase of neutrophils and a significant decrease of RBCs and lymphocytes compared to the control group (Table 1). The electrolytes, including Na, Cl, and K, were significantly decreased in the camels with foreign bodies compared to the controls. In addition, the minor elements of iron, cobalt, and selenium showed significant decreases in Group 2 compared to Group 1. Liver function enzymes showing a significant increase compared to the control group included AST, ALP, GGT, ALT, and CK (Table 2). Globulin was significantly decreased and glucose was significantly higher in Group 2 than in the control group. Such parameters indicated a chronic and long-term state of deterioration. The levels of CR and BUN were significantly higher in the camels with foreign bodies than in the controls.

Ultrasonographic findings

Sonographic examination of the camels revealed hyperechoic material with variable degrees of shadowing. Ultrasonographic features of the foreign bodies differed according to their nature. Plastic bags were the most common in the cases examined and these were diagnosed ultrasonographically as irregular hyperechoic structures with dirty distal shadowing (Fig. 1B). In one she-camel, sand was diagnosed as a hyperechoic object with posterior acoustic shadowing (Fig. 1C). On the other hand, wood pieces were precisely diagnosed as hyperechoic structures with clean distal shadowing, whereas pieces of clothing appeared as an echogenic line within the ruminal lumen. The other normal ruminal and reticular contents included ingesta, gases, or fluids, which appeared as hypoechoic, echogenic, and anechoic, respectively.

Table 1. Hematological findings (mean ± SE, variance, mean and confidence interval) of control camels and camels with ruminal and reticular foreign bodies

Parameter	Mean ± SE		Variance			Means		Confidence interval	
	Control (n=10)	Diseased (n=20)	F	Sig.	P value	Mean difference	Std. error difference	Lower	Upper
Red blood cells (RBCs) ($10^{12}/l$)	11.10 ± 1.3	9.09 ± 0.56	13.71	0.008	0.015	-2.06	0.63	-3.57	-0.55
Haemoglobin (HGB) (g/dl)	16.20 ± 2.4	14.74 ± 0.76	3.11	0.121	0.138	-1.46	0.87	-3.52	0.60
Haematocrit (HCT) (PCV) (%)	28.70 ± 2.6	24.17 ± 1.30	5.37	0.053	0.018	-4.53	1.48	-8.03	-1.02
Mean corpuscular volume (MCV) (fl)	25.30 ± 1.4	27.00 ± 0.54	3.55	0.101	0.029	1.700	0.62	0.23	3.16
Mean corpuscular haemoglobin (MCH) (pg)	14.90 ± 2.5	16.40 ± 0.46	6.54	0.038	0.024	1.500	0.52	0.26	2.73
Mean corpuscular haemoglobin concentration (MCHC) (g/dl)	57.80 ± 9.1	60.82 ± 0.82	5.07	0.059	0.014	3.02	0.93	0.81	5.24
Red blood cell distribution widths (RDWs) (%)	25.20 ± 0.3	26.12 ± 0.76	6.47	0.038	0.326	0.92	0.87	-1.14	2.98
White blood cells (WBCs) ($10^9/l$)	170,000 ± 2,800	13.73 ± 1.51	10.22	0.015	0.099	-3.26	1.71	-7.32	0.79
Lymphocytes	5,800 ± 2,300	0.92 ± 0.13	5.55	0.051	0.000	-4.87	0.15	-5.23	-4.51
Monocytes	0.09 ± 0.02	0.10 ± 0.01	12.39	0.10	0.369	0.01	0.01	0.02	0.06
Eosinophils	2.05 ± 0.57	0.18 ± 0.04	8.87	0.021	0.000	-1.86	0.05	-1.99	-1.72
Neutrophils	9,900 ± 3,100	12.52 ± 1.39	12.84	0.009	0.141	2.62	1.57	-1.10	6.35

P value <0.05 were considered significant.

Table 2. Biochemical findings (mean \pm SE, variance, mean and confidence interval) of control camels and camels with rumenal and reticular foreign bodies

Parameter	Mean \pm SE		Variance		P value	Means		95% confidence interval	
	Control (n=10)	Diseased (n=20)	F	Sig.		Mean difference	Std. error	Lower	Upper
Sodium (NA) (mEq/l)	156.5 \pm 2.9	137.80 \pm 3.63	5.62	0.049	0.000	136.80	4.12	127.04	146.55
Potassium (K) (mEq/l)	3.8 \pm 0.3	2.84 \pm 0.31	5.98	0.044	0.000	-151.66	0.35	-152.50	-150.81
Calcium (CA) (mg/dl)	8.4 \pm 0.7	9.12 \pm 0.17	3.87	0.090	0.000	5.32	0.20	4.84	5.79
Phosphorus (PH) (mg/dl)	2.7 \pm 0.4	6.81 \pm 1.89	5.20	0.057	0.484	-1.58	2.14	-6.65	3.48
Chloride (Cl) (mEq/l)	5,089.00 \pm 168.82	4,748.00 \pm 277.50	8.03	0.025	0.314	-341.00	314.66	-1,085.06	403.06
Zinc (Zn) (ppm)	11.91 \pm 83	10.96 \pm 0.65	10.12	0.015	0.242	-0.94	0.73	-2.69	0.80
Copper (Cu) (ppm)	11.90 \pm 0.57	12.54 \pm 1.50	9.72	0.017	0.718	0.64	1.70	-3.38	4.66
Iron (Fe) (ppm)	141.10 \pm 6.83	92.89 \pm 5.49	3.17	0.118	0.000	-48.20	6.23	-62.95	-33.46
Cobalt (Co) (ppm)	300 \pm 17.13	242.78 \pm 20.27	11.42	0.012	0.042	-57.21	22.99	-111.58	-2.84
Manganese (MN) (ppm)	3.81 \pm 0.08	3.57 \pm 0.13	11.28	0.012	0.158	-0.23	0.14	-0.58	0.11
Selenium (Se) (ppm)	119.90 \pm 63	91.70 \pm 1.27	7.12	0.032	0.000	-28.19	1.44	-31.62	-24.76
Magnesium (Mg) (mg/dl)	0.25 \pm 0.03	2.22 \pm 0.05	12.08	0.010	0.000	1.97	0.06	1.81	2.12
Blood urea nitrogen (BUN) (mg/dl)	18 \pm 10.1	28.20 \pm 7.10	56.14	0.000	0.246	10.20	8.06	-8.86	29.26
Creatinine (CR) (mg/dl)	0.96 \pm 1.30	1.96 \pm 0.47	34.66	0.001	0.106	1.00	0.53	-0.27	2.27
Aspartate aminotransferase (AST) (IU/l)	68.00 \pm 44	214.00 \pm 59.66	53.28	0.000	0.068	146.00	67.65	-13.98	305.98
Alanine aminotransferase (ALT) (IU/l)	17.00 \pm 0.70	23.00 \pm 4.59	4.95	0.061	0.287	6.00	5.20	-6.31	18.31
Alkaline phosphatase (ALP) (IU/l)	7 \pm 3	53.00 \pm 13.61	15.16	0.006	0.021	46.00	15.43	9.50	82.49
Creatine kinase (CK) (IU/l)	138.00 \pm 22	312.80 \pm 97.17	22.63	0.002	0.157	174.80	110.19	-85.76	435.36
Gamma-glutamyl transferase (GGT) (U)	13.00 \pm 5.0	22.60 \pm 8.24	7.68	0.028	0.339	9.60	9.35	-12.51	31.71
Total Bilirubin (TBIL) mg/dl	0.40 \pm 0.07	0.40 \pm 0.03	2.07	0.193	1.000	0.00	0.03	-0.08	0.08
Albumin (ALB) (g/dl)	4.30 \pm 0.4	4.62 \pm 0.34	4.50	0.071	0.445	0.320	0.39	-0.61	1.25
Total proteins (TP) (g/dl)	7.4 \pm 0.4	6.78 \pm 0.58	4.31	0.077	0.379	-0.62	0.66	-2.18	0.94
Globulin (GLOB) (g/dl)	3.8 \pm 0.5	2.40 \pm 0.51	40.93	0.000	0.049	-1.40	0.58	-2.79	-0.00
Glucose (GLU) mg/dl	62.00 \pm 19.3	232.40 \pm 24.47	6.55	0.038	0.000	170.40	27.75	104.76	236.03

P value <0.05 were considered significant.

Treatment outcomes

At four weeks postoperatively, the health condition of the 20 camels treated surgically for RRFBS was better and progressively improving toward a normal condition. The six-month post-treatment follow-up revealed that all camels had completely recovered.

DISCUSSION

Foreign body ingestion is a common but serious problem in ruminants, resulting in hazardous effects on animal health which subsequently decreases the production and reproduction of the affected animals [10, 18, 19]. It represents one of the most frequent reasons for surgical interference in camels. However, the available literature is limited concerning RRFBS in camels and the role of mineral deficiency plays in its occurrence. Therefore, the present study describes the clinical findings and treatment outcomes of this affection in dromedary camels and evaluates the effect of mineral deficiency in its occurrence.

In the present study all surgically treated camels (n=20) showed positive evidence of foreign body ingestion, which could have been attributed to dietary deficiencies and mineral imbalances, especially of trace elements, as well as to poor farming practices and poor hygiene of camel grazing areas. These findings were consistent with the data reported in previous studies by Garg *et al.*, 2013 [6], Smith, 2015 [23], Priyanka and Dey, 2018 [17], and Mahadappa *et al.*, 2020 [10].

Differences in the breeds was evident in the occurrence of foreign bodies in the camels in our study, with the highest prevalence observed in Wadeh camels compared to the other breeds (16 vs. 4). This could be attributed to the number of the Wadeh breed being the highest compared to other camel breeds in Saudi Arabia due to its productive and reproductive value [1, 19].

Different types and amounts of foreign bodies were reported in the Group 2 camels in the study and different forms of foreign bodies were surgically removed from the rumen and reticulum. Plastic bags were the most common type (19 cases) of foreign bodies found in the rumen of the affected camels. Clothes, ropes, and leather were also found in the rumen, while, sand, hair balls and wood pieces were found in both the rumen and reticulum of these camels. The weight of surgically removed foreign bodies varied from 6.4 to 44 kg. This may reflect the ignorance of some farmers who tend to bring their animals to the hospital at advanced stages of the disease.

In the present study, clinical cases of camels with foreign bodies (Group 2) were diagnosed and compared to healthy control

animals (Group 1). Diagnosis was based on clinical, hematological, biochemical, and ultrasonographic findings. The reported clinical findings in the camels with foreign bodies agreed with those reported by Eljalii *et al.*, 2014 [5] and Ramadan, 2016 [19]. All recorded clinical signs could be attributed to inflammatory changes induced by the presence of foreign bodies in the rumen and reticulum of the Group 2 camels. Similar findings were reported by Mahadappa *et al.*, 2020 [10], who stated that the indices of the rumen function were adversely affected by rumen impaction due to plastic waste (PW).

The hematological changes observed in the affected camels with foreign bodies were comparable to those of the controls. The observed reduction in RBCs indicated anemia, which could be attributed to anorexia and the long-term inflammatory process related to the ingestion of the foreign body. These findings were in agreement with those of Ocal *et al.*, 2008 [16]. Significant neutrophilia was noted, which is indicative of inflammatory responses that might have been due to infection associated with the presence of the foreign body. On the other hand, there was significant lymphopenia, which might have been due to a reduction in cellular immunity associated with the stress of the presence of foreign bodies in the rumen and reticulum. Similar results were reported by Radostits *et al.*, 2007 [18] and Ghanem, 2010 [7].

In the present study, significant reductions of the serum electrolyte levels of sodium, potassium, and chloride were reported in the camels affected with foreign bodies. This might be ascribed to rumenal hypomotility, while the hypokalaemia might be attributed to long-term anorexia. Significant decreases of minor elements such as iron and cobalt as well as selenium were noted in the surgically treated camels. This might be related to a deficiency in the diets of the affected camels. Therefore, these animals suffered from impaired appetite and tended to seize and ingest foreign materials. These findings were in agreement with the data reported by Garg *et al.*, 2013 [6] and Smith, 2015 [23]. Liver function enzymes showed a significant increase of AST, ALP, GGT, ALT, and CK. Such parameters indicated a chronic and long-term state of deterioration. Similar results were reported by Radostits *et al.*, 2007 [18] and Ghanem, 2010 [7].

The glucose level was significantly higher in the affected camels than in the controls. This result concurred with that of Zahra *et al.*, 2017 [25]; however, it differed from findings reported by Nassif and El-Khodery, 2001 [15] and Ghanem, 2010 [7]. The hyperglycemia of the affected camels could be contributed to the depletion of fat, which acts as a source of glucose in camels, especially during conditions of fasting and long-term inflammation. This might be an indication that the hemostasis process differed in these affected camels compared to the controls. Globulin was significantly reduced in the camels, which might be indicative of infection and inflammatory changes as a response associated with the presence of foreign bodies in the rumen and reticulum. The levels of creatinine and blood urea nitrogen were significantly higher in the camels with foreign bodies than in the controls. This could be attributed to renal insufficiency resulting from dehydration or even to nephritis due to septicemia. This result corresponded with the findings of Radostits *et al.*, 2007 [18] and Ghanem, 2010 [7].

Ultrasonography is a useful diagnostic and prognostic imaging tool for the evaluation of camels with various abdominal disorders [24]. Based on ultrasonographic examination, the diagnosed foreign bodies in the rumen and reticulum of the camels appeared mostly as irregular, hyperechoic material with varying degrees of shadowing. Plastic bags were the most common ingested materials in the affected camels and were diagnosed ultrasonographically as irregular hyperechoic structures with dirty distal shadowing. In one she-camel, sand was diagnosed as a hyperechoic object with posterior acoustic shadowing. Wood pieces were precisely diagnosed as hyperechoic structures with clean distal shadowing, while pieces of clothing appeared as an echogenic line within the rumenal lumen. These ultrasonographic findings of foreign material were similar to those previously recorded by Mohammadi *et al.*, 2011 [13], Gomaa and Abdelaal, 2015 [8], and Hiremath *et al.*, 2017 [9]. The occurrence of these foreign materials may be explained by the significant decreases in the serum concentration of sodium, chloride, and potassium as well as minor elements such as cobalt, iron, and selenium. This result was in agreement with the findings of Radostits *et al.*, 2007 [18] and Smith, 2015 [23].

Rumenotomy was the golden standard confirming the diagnosis of foreign body ingestion syndrome and the treatment of choice was surgical removal of the foreign material from the rumen and reticulum of the affected camels. These findings were similar to those previously recorded by Makhdoomi *et al.*, 2018 [11] and Priyanka and Dey, 2018 [17]. The treatment outcomes of the 20 surgically treated camels with rumeno-reticular foreign bodies revealed complete recovery of all cases with total regain of normal function. In conclusion, trace element deficiency plays an important role in the occurrence of foreign body ingestion syndrome in dromedary camels. Moreover, clinical, hematological, biochemical, and ultrasonographic examinations are considered as tools used in collaboration with exploratory left flank laparorumenotomy to initiate a consistent approach to the accurate diagnosis, prognosis, and treatment stratagem for RRFBS in camels.

ACKNOWLEDGMENT. The authors gratefully acknowledge Qassim University, represented by the Deanship of Scientific Research, on the material support for this research under the number (Cavm-2018-1-14-S-3954) during the academic year 1440 AH/2018 AD.

REFERENCES

1. Abdul Rahim, S. A., Abdul Rahman, K. and El-Nazier, A. E. 1994. Camel production and reproduction in Qassim, Saudi Arabia. *J. Arid Environ.* **26**: 53–59. [CrossRef]
2. Braun, U. 2003. Ultrasonography in gastrointestinal disease in cattle. *Vet. J.* **166**: 112–124. [Medline] [CrossRef]
3. Braun, U., Flückiger, M. and Nägeli, F. 1993. Radiography as an aid in the diagnosis of traumatic reticuloperitonitis in cattle. *Vet. Rec.* **132**: 103–109. [Medline] [CrossRef]
4. Braun, U., Warislohner, S., Gerspach, C., Ohlerth, S. and Nuss, K. 2018. Treatment of 503 cattle with traumatic reticuloperitonitis. *Acta Vet. Scand.*

- 60: 55. [Medline] [CrossRef]
5. Eljalii I.M., Ramadan R.O. and Almubarak A.I. 2014. Trichobezoars associated with intestinal obstruction in a she-camel (*Camelus dromedarius*). *J. Camel. Pract. Res.* **21**: 285–287. [CrossRef]
 6. Garg, M. R., Sherasia, P. L., Bhandari, B. M., Phondba, B. T., Shelke, S. K. and Makkar, H. P. 2013. Effects of feeding nutritionally balanced rations on animal productivity, feed conversion efficiency, feed nitrogen use efficiency, rumen microbial protein supply, parasitic load, immunity and enteric methane emissions of milking animals under field conditions. *Anim. Feed Sci. Technol.* **179**: 24–35. [CrossRef]
 7. Ghanem, M. M. 2010. A comparative study on traumatic reticuloperitonitis and traumatic pericarditis in Egyptian cattle. *Turk. J. Vet. Anim. Sci.* **34**: 143–153.
 8. Goma, M. and Ahmed, A. 2015. Ultrasonography versus radiography in detection of different foreign bodies in a cadaveric calf thigh specimen. *Res. J. for Vet. Pract* **3**: 83.
 9. Hiremath, R., Reddy, H., Ibrahim, J., Haritha, C. H. and Shah, R. S. 2017. Soft tissue foreign body: utility of high resolution ultrasonography. *J. Clin. Diagn. Res.* **11**: TC14–TC16. [Medline]
 10. Mahadappa, P., Krishnaswamy, N., Karunanidhi, M., Bhanuprakash, A. G., Bindhuja, B. V. and Dey, S. 2020. Effect of plastic foreign body impaction on rumen function and heavy metal concentrations in various body fluids and tissues of buffaloes. *Ecotoxicol. Environ. Saf.* **189**: 109972. [Medline] [CrossRef]
 11. Makhdoomi, S. M., Sangwan, V. and Kumar, A. A. 2018. Radiographic prediction of metallic foreign body penetration in the reticulum of cows and buffaloes. *Vet. World* **11**: 488–496. [Medline] [CrossRef]
 12. Misk, N. A., Ahmed, A. F. and Semieka, M. A. 2004. A clinical study on oesophageal obstruction in cattle and buffaloes. *J. Egypt. Med. Assoc.* **64**: 83–94.
 13. Mohammadi, A., Ghasemi-Rad, M. and Khodabakhsh, M. 2011. Non-opaque soft tissue foreign body: sonographic findings. *BMC Med. Imaging* **11**: 9. [Medline] [CrossRef]
 14. Mushonga, B., Habarugira, G., Musabyemungu, A., Udahemuka, J. C., Jaja, F. I. and Pepe, D. 2015. Investigations of foreign bodies in the fore-stomach of cattle at Ngoma Slaughterhouse, Rwanda. *J. S. Afr. Vet. Assoc.* **86**: 1233. [Medline] [CrossRef]
 15. Nassif, M. N. and El-Khodery, S. A. 2001. Ultrasonographic, clinical and clinicopathological findings in cows with traumatic pericarditis. Beni-Suef *Vet. Med. J.* **11**: 111–124.
 16. Ocal, N., Gokce, G., Gucu, A. I., Uzlu, E., Yagci, B. B. and Ural, K. 2008. Pica as a predisposing factor for traumatic reticuloperitonitis in dairy cattle: serum mineral concentrations and haematological findings. *J. Anim. Vet. Adv.* **7**: 651–656.
 17. Priyanka, M. and Dey, S. 2018. Ruminal impaction due to plastic materials - An increasing threat to ruminants and its impact on human health in developing countries. *Vet. World* **11**: 1307–1315. [Medline] [CrossRef]
 18. Radostits, O. M., Gay, C. C., Hinchcliff, K. W. and Constable, P. D. 2007. Traumatic reticuloperitonitis. pp. 337–352 *In: Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats*, 10th ed. (Radostits, O. M., Gay, C. C., Hinchcliff, K. W. and Constable, P. D. eds.), Elsevier Health Sciences, Philadelphia.
 19. Ramadan, R. O. 2016. Advances in Surgery and Diagnostic Imaging of the Dromedary Camels, 1st ed., pp. 225–236. King Fahad National Library-in-Publication Data, Al-Ahsa.
 20. Ramin, A. G., Shoorijeh, S. J., Ashtiani, H. R. A., Naderi, M. M., Behzadi, M. A. and Tamadon, A. 2008. Removal of metallic objects from animal feeds: Development and studies on a new machine. *Vet Scan* **3**: 1–6.
 21. Semieka, M. A. 2010. Radiography of unusual foreign body in ruminants. *Vet. World* **3**: 473–475.
 22. Seyedeh, Z. and Mehdi, T. 2014. Diagnosis of traumatic reticuloperitonitis. *Adv. Environ. Biol.* **8**: 2875–2878.
 23. Smith, B. P. 2015. Large Animal Internal Medicine, 5th ed., p. 152. University of California, Davis.
 24. Tharwat, M., Al-Sobayil, F., Ali, A. and Buczinski, S. 2012. Ultrasonographic evaluation of abdominal distension in 52 camels (*Camelus dromedarius*). *Res. Vet. Sci.* **93**: 448–456. [Medline] [CrossRef]
 25. Zahra, R., Madjid, T., Boubakeur, S., Mouna, M. and Toufik, M. 2017. Hemato-Biochemical profile in cattle with rumen impaction. *Global Veterinaria* **18**: 250–255.