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Assessment of Clinicopathological Alterations in Barki Ewes With Foreign Body Syndrome in Rumen

Asmaa A. Darwish*

Animal and Poultry Health Department, Animal Production and Poultry Division,

Desert Research Center (DRC), Cairo, Egypt.

Abstract

FOREIGN body syndrome in sheep is a real threat. It causes several complications leading to economic loses. This work throws light on the most important clinicopathological alterations associated with foreign body syndrome in the sheep and proposes new biomarkers for its detection as well as its surgical intervention prognosis. Twenty apparently- healthy ewes were counted as the control group (CG), while the other twenty ewes endured symptoms, suggested presence of foreign body in their rumens confirmed by rumenotomy, and were considered as foreign body group (FG). Blood samples were collected before surgery, immunological and clinicopathological parameters were detected and statistically analyzed. FG compared to CG, showed a significant ($P<0.05$) increment in the pro-inflammatory cytokines, APPs, MMPs, free radicals, cortisol, GH, TSH, globulin, triglycerides, kidney function tests, hepatic enzymes, and a significant ($P<0.05$) decline anti-inflammatory cytokine, total antioxidant capacity, antioxidants, T3, T4, Insulin, Albumin, glucose, T/HDL/LDL-cholesterol, total lipids, minerals, electrolytes, trace elements. It also, displayed a significant ($P<0.05$) microcytic hypochromic anemia and hypoferemia with neutrophilic leukocytosis. Among the studied markers, TAC and SAA displayed the highest LR as markers for the disease diagnosis, while IL-1α, IL-6, TNF-α, and Cp had the best values for the rumenotomy prognosis. Conclusion: the combining between the supportive therapies alongside rumenotomy is important for managing ewes affected by foreign body syndrome. TAC and SAA are good indicator for foreign body syndrome in sheep, but IL-1α, IL-6, TNF-α, and Cp are better for guiding rumenotomy decisions.

Keywords: Foreign body syndrome, Sheep rumen, Immunological, Clinicopathological, Hormonal alterations, Rumenotomy.

Introduction

Foreign body syndrome in ruminants can cause significant health issues and even death if not promptly addressed. Ruminants, such as cattle, sheep, and goats, have a unique digestive system that includes a four-chambered stomach. The first chamber, the rumen, acts as a fermentation vat where microbes break down fibrous plant material. Foreign bodies can enter a ruminant's digestive system through accidental ingestion while grazing or consuming feed contaminated with objects like wire, nails, plastic, or other indigestible materials. These foreign bodies can cause various problems depending on their size, shape, and location within the digestive tract [1].

Foreign bodies can cause some potential issues in ruminants such as Impaction: Large or bulky foreign bodies may become lodged in the rumen or other parts of the digestive tract, causing impaction. This can lead to decreased feed intake, discomfort, and potentially life-threatening complications if not resolved [2]. Perforation: Sharp objects like wire or nails can puncture the walls of the digestive tract, leading to peritonitis (inflammation of the abdominal cavity) or abscess formation. Perforation is a severe complication that often requires surgical intervention. Rumenitis: Foreign bodies can irritate the lining of the rumen, leading to inflammation. This condition can impair rumen function and cause symptoms such as decreased appetite, decreased milk production (in dairy cattle), and weight loss [3]. Hardware disease: This term is often used to describe foreign body ingestion, particularly metal objects like nails or wire, which can lead to injury or inflammation of the reticulum (the second chamber of the stomach). It's called "hardware disease" because of its historical association with ingesting metal objects. Secondary infections: Foreign bodies can create sites for bacterial growth and infection within the digestive tract, leading to systemic illness if bacteria enter the bloodstream [4].

Treatment of foreign body ingestion in ruminants typically involves a combination of supportive care, such as fluid therapy and pain management, and sometimes

*Corresponding authors: Asmaa A. Darwish, asmaa_vet25@yahoo.com, Tel: 01148161026
ORCID: 0000-0002-8675-6313.
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surgical intervention to remove the offending object. Prevention is crucial and involves maintaining a clean feeding environment, using appropriate feeders to minimize the risk of foreign body ingestion, and monitoring animals for signs of illness or discomfort. Regular veterinary examinations can also help detect and address potential issues early [1-4].

Clinicopathological alterations are an assisting tool in the evaluation of the overall health status of diseased animals, determining the appropriate treatment approach, and monitoring treatment effectiveness [1-4]. This study throws light on the most important clinicopathological alterations associated with foreign bodies' presence in the sheep rumen with special reference to the value of pro-inflammatory cytokines, acute phase proteins, matrix metalloproteinases, and TAC in its diagnosis and its surgical treatment prognosis.

Material and Methods

After the ethical approval of the animal and poultry health department, animal production and poultry division, Desert Research Center (DRC), Cairo, Egypt, (code DRC-227-5-24), this research was executed on forty Barki ewes (with average 5 years age) gathered from different veterinary units of Matrouh governorate, twenty ewes were apparently-healthy (physiological ranges of temp, respiratory rate, pulse, bright shiny eyes, dry nostrils, normal appetite, normal body weights (50-55 kg)) and were theorized as the control group (CG), and other twenty ewes troubled with deterioration of the general condition, pain, grinding teeth, anemic mucous membrane, anorexia, abnormal fecal consistency (scanty hard, watery, pasty), sever emaciation (low bodyweights 35-40), and distended abdomen hard objects were detected in the rumen by palpation these symptoms suggested presence of foreign bodies in their rumens and were considered as foreign body group (FG). These ewes underwent a rumenotomy procedure, during which the presence of foreign bodies was confirmed using sterile surgical instruments under strict aseptic conditions. Following the surgery, the animals were monitored for a period of two weeks to ensure the administration of appropriate post-operative care. The follow-up also allowed for the classification of animals as surviving or deceased, facilitating a Receiver Operating Characteristic (ROC curve) analysis. This analysis primary aim was to assess the prognostic value of the studied biomarkers in guessing the post-rumenotomy outcomes.

Blood samples:

5 ml blood was obtained from the jugular vein of CG individuals as well as FG individuals (before the rumenotomy).

Each sample was separated into 3 parts. The first part was collected using Na_2EDTA and used for manual estimation of the hemogram (RBCs, Hb, PCV, MCV, MCH, MCHC) and leukogram (TLC, and DLC) parameters according to the method described by Feldman et al. [5]

The second part was collected on citrate to stop the coagulation process and centrifuged to obtain plasma at 3000 r.p.m for 20 min to measure Fb plasma levels using ELISA kits from IBL International Crop (Canada)®.

The third part was collected in a plain test tube, allowed to coagulate, and centrifuged at 3000 r.p.m. for 20 min to obtain serum for detection of various biochemical parameters spectrophotometrically using kits from Biodiagnostic Company®, as well as serum pro-inflammatory cytokines (IL-1α, IL-1β, IL-6, TNF-α), anti-inflammatory cytokine (IL-10) and hormones (Cortisol, GH, TSH, T3, T4, Insulin) levels by ELISA kits of MyBioSource company®, serum MMP-2 and MMP-9 concentrations by using Cloud- Clone Corp company® ELISA kits, serum amyloid A (SAA) and serum haptoglobin (Hp) using ELISA kits from IBL International Crop (Canada)®, Serum caeruloplasmin (Cp) and serum transferrin (Tf) by a turbidimetric method using Elabscience USA® kits, and serum ferritin by CLIA method using Abnova® (Taipei) kits. All manual instructions were carefully followed.

- Transferrin saturation percent (TF sat. %) = SI/TIBC*100.

- Unsaturated iron binding capacity (UIBC) = TIBC-SI.

Statistical analysis

Parameters mean values were compared between FG and CG by independent-sample T test using SPSS program version 26 according to [6]

A difference was considered significant at $P< 0.05$.

Graph pad prism version 8 program was used to evaluate the area under the curve (AUC), cut-off points, sensitivity, specificity, and likelihood ratio (LR) for the measured pro-inflammatory cytokines, APPs, MMPs, and TAC in FG compared to CG, and in dead group (DeG) compared to survive group (SG).

The positive predictive value (PPV), negative predictive value (NPV), and accuracy rate (AR) were calculated by dividing the true positive or true negative or sum of them on the total positive or total negative or total population respectively then multiplying the result in 100

Results

Immunological results: FG (compared to CG) demonstrated a significant ($P<0.05$) increment in the pro-inflammatory cytokines (IL-1α, IL-1β, IL-6, TNF-α), APPs (Fb, SAA, Hp, Cp), MMPs (MMP-2 and MMP-9), free radicals (NO, MDA), cortisol,

GH, TSH and a significant (P<0.05) decline in anti-inflammatory cytokine (IL-10), total antioxidant capacity (TAC), antioxidants (CAT, GPx, GR), T3, T4, Insulin (Table 1).

Biochemical results: FG compared to CG displayed a significant (P<0.05) elevation in TP, Glob, triglycerides, kidney function tests (urea, creatinine (Cr)), hepatic enzymes (ALT, AST, ALP), and a significant (P<0.05) reduction in Alb, A/G, glucose, T/HDL/LDL-cholesterol, total lipids, minerals (Ca, P, Mg), electrolytes (Na, K, Cl), trace elements (Cu, Zn) (Table 1).

Hematological and iron profile results: FG compared to CG displayed a significant (P<0.05) decline in red blood cell parameters and indices (RBCs, Hb, PCV, MCV, MCH, MCHC) and lymphocytes with a significant (P<0.05) neutrophilic leukocytosis (Table 2). While the iron profile of FG showed a significant (P<0.05) decrease in SI, Tf, Tf Sat. % and a significant (P<0.05) increase in ferritin, TIBC, and UIBC (Table 2).

Two weeks after the rumenotomy, ten ewes showed signs of recovery (restored their appetite, rumination process, and ability to move) (survive group, SG) and the other ten ewes were dead (dead group, DeG).

Concerning the value of pro-inflammatory cytokines, acute phase proteins, matrix metalloproteinases, and TAC in the foreign body syndrome diagnosis, all of them yielded high AUC (more than 0.7), sensitivity, and NPV = 100%, high specificity, PPV, and AR (more than 70%) except Fb (low sensitivity) and ferritin (low specificity), but TAC and SAA only displayed high LR as 20, and the rest markers had low to moderate LRs. They also revealed high AUC (more than 0.7), sensitivity, and NPV = 100%, high specificity, PPV, and AR (more than 70%) in the treatment monitoring except for transferrin, ferritin, MMP-2, and MMP-9 (low specificity), and all of them demonstrated low to moderate LR but the best LR was for IL-1α, IL-6, TNF-α, and Cp as 10 (Table 3).

Discussion

In agreement with previous research in ruminants, the current work cleared that the presence of foreign bodies in the rumen of sheep was characterized by prominent anorexia, depression, reduced feed, and water intake, abdominal distension, ruminal hypomotility, lack of rumination, and weight loss. Furthermore, some ewes may show dehydration and altered fecal characteristics (dry hard, pelleted feces, or loose pasty, or watery feces). Other clinical signs included grinding of teeth and arched back, recumbency, and death [1-5]. They cleared that the clinical symptoms severity depends on the degree of impaction, quantity, duration of foreign bodies in the rumen, and the animal age (more common in older ages). Tesfaye and Chanie [7] also noted that foreign body syndrome is more expected in animals with poor body conditions as the foreign bodies' presence in the rumen compromises the ruminal space, interferes with different nutrient absorption (volatile fatty acids), and hinders the normal fermentation and food mixing processes leading to poor body conditions. In addition, the indigestible foreign bodies` presence in the animal rumen irritates the ruminal mucosa causing several degenerative pathological changes such as shortening the ruminal papillae length, hyperplasia of the squamous epithelium, mononuclear infiltration in the subepithelial spaces, and triggers an inflammatory immune response [8-10].

The outstanding elevation of pro-inflammatory cytokines in FG in our data supported this assumption. Pro-inflammatory cytokines are inflammatory immune response central keys. Their activation reinforces and keeps the inflammatory immune response. They orchestrate various cells and organs to monitor, recognize, and clear any foreign body in the body (even if it has a therapeutic potential) [11-13]. Although their elevation was mild here (compared to infectious status), they were able to turn on the other inflammatory changes to a moderate degree [11]. Additionally, the mild decline in IL-10 serum levels in FG in the current work contributed somewhat to reducing their impact.

The pro-inflammatory cytokines up-regulated acute phase proteins (APPs) synthesis in the liver and release in the blood. APPs are golden health indicators in animals and humans [9, 14]. Their blood concentrations positively or negatively correlate with infections, inflammation, malignancies, and surgeries degree. According to this correlation, they are classified into two categories either positive APPs (augment) or negative APPs (diminish), during bacterial, viral, parasitic infections, malignancy, surgery ex…..[9, 14]. In the present work, a prominent acute phase response was observed in FG, represented by the increased Fb, SAA, Hp, Cp, ferritin (+ve APPs) and the declined transferrin and albumin (-ve APPs). Similar observations were noticed before in cows, buffaloes, and goats suffering from rumen foreign body complications [9, 11, 15-21]. They referred to their prognostic value in taking the rumenotomy decision and suggested them as surgical stress markers in diseased animals.

Another consequence of the activation of pro-inflammatory cytokines in FG is the increase in serum levels of MMP-2 and MMP-9. MMP-2 and MMP-9 are enzymes involved in the breakdown of extracellular matrix proteins, particularly collagen, which plays a crucial role in tissue remodeling and repair processes [22-24]. MMP-2 (Gelatinase A): MMP-2 is known as gelatinase A and is involved in the degradation of type IV collagen, a major

component of basement membranes. It is produced by various cell types, including fibroblasts, endothelial cells, and smooth muscle cells. MMP-2 is implicated in processes such as tissue remodeling, angiogenesis, wound healing, and cancer metastasis [22-24]. MMP-9 (Gelatinase B): MMP-9, also known as gelatinase B, shares structural and functional similarities with MMP-2 but has broader substrate specificity. It is capable of degrading a wide range of extracellular matrix proteins, including type IV, V, VII, and X collagens, as well as elastin. MMP-9 is produced by various cell types, including neutrophils, macrophages, and epithelial cells, and is involved in inflammatory responses, tissue repair, angiogenesis, and tumor invasion and metastasis [22-24]. Both MMP-2 and MMP-9 are tightly regulated at multiple levels, including transcriptional, post-transcriptional, and post-translational mechanisms. Dysregulation of MMP-2 and MMP-9 activity has been implicated in various pathological conditions, including cancer, cardiovascular diseases, neurodegenerative disorders, and inflammatory diseases. They also increased during infectious disease courses. Therefore, these enzymes are potential disease markers and therapeutic targets for the treatment of such conditions [22-24].

Activation of pro-inflammatory cytokines also leads to oxidative stress appearance in FG due to the imbalance between oxidants and antioxidants. These cytokines promote the release of free radicals from various immune cells. Free radicals are essential molecules involved in both physiological and pathological processes in animals [25]. They contribute significantly to the body's defense against bacteria, viruses, and parasites and regulate rumen and reticulum motility in ruminants. However, excessive free radicals can cause tissue damage, inflammation, and apoptosis. Antioxidants are supposed to control free radical activity and protect the body's systems from their hazardous effect [19, 26]. In the present study, FG experienced oxidative stress indicated by the obtained increase in the free radicals (NO, MDA) concentrations, and decreased TAC as well as antioxidants (CAT, GPx, GR) concentrations. Kirbas et al. [19] and Gomaa et al. [26] previously documented oxidative stress with a compensated antioxidant mechanism in cows affected by rumen foreign body complications. Additionally, Gomaa et al. [26] reported oxidative stress with a decompensated antioxidant mechanism in buffalo suffering from chronic rumen foreign body complications, which resulted in chronic damage and fibrosis.

Due to the absence of the compensated antioxidants mechanism in FG in our study, a marked increase in the liver and kidney function tests and anemia were depicted in FG. The accumulated free radicals' attack the RBCs, liver, and kidney cells and damage them. Similar results were recorded in cattle, buffalo, goat, and camel [18, 21, 27-32]. In contrast, Hussein et al. [33] and Otsyina et al. [3] didn`t observe any changes in the red blood cell parameters or liver and kidney function tests in ruminants with foreign body syndrome. Similarly, Akraiem and Abd Al-Galil [34] obtained normal RBCs and Hb and raised PCV values in cattle suffering from Rumen impaction due to plastic materials and Akinrinmade and Akinrinde [35] recorded decreased erythrocyte parameters with diminished urea and creatinine in cattle with foreign body syndrome. The variations observed could stem from factors such as the quantity of foreign body, the duration and severity of complications, and inherent differences between species.

Malnutrition and malabsorption are usually associated the foreign body syndrome in ruminants because of its physical presence in the rumen and injury of the rumen mucosa and papillae [8-10], also took a part in the outstanding anemia due to hypoferemia [15, 19, 28, 33]. Besides hypoferemia, malabsorption resulted in the noted decreased minerals, electrolytes, and trace elements levels, hypoglycemia, hypoalbuminemia, T/LDL/HDL-hypocholesterolemia with hypolipidemia in FG in our study. These findings resemble previous authors` findings in other ruminants with foreign body syndrome [28, 29, 30, 33]. Interestingly, Akinrinmade and Akinrinde [35] underscored the importance of a balanced diet for goats to prevent foreign body rumen impaction. Addressing deficiencies in iron, glucose, protein, minerals, electrolytes, and trace elements could indeed serve as a basis for formulating preventive measures. Ensuring goats receive proper nutrition is crucial for their health and well-being, as well as for preventing various health issues such as rumen impaction. Contrariwise, malnutrition, and subsequent negative energy balance (due to decreased available FAs to the body) led to enhanced body lipolysis and triglycerides accumulation in FG blood. Thus, marked hypertriglyceridemia was demonstrated in FG in the current data [7].

Regarding the protein profile of FG, it illustrated hyperglobulinemia and hypoalbuminemia. Hyperglobulinemia has been attributed to the prior increase noticed in different immune protein production in FG in the present research (cytokines, APPs, MMPs, ex…..). Several factors participated in hypoalbuminemia detected in FG such as anorexia, acute phase response (albumin is a negative reactant), oxidative stress (albumin is a potent antioxidant), and liver injury (albumin is a hepatic protein). These alterations in albumin and globulin in FG resulted in mild hyperproteinemia with a decreased A/G ratio. This data agreed with previous records obtained in different ruminants with foreign body syndrome [19, 21, 27, 33].

Beyond anorexia and oxidative stress, the depicted microcytic hypochromic anemia in FG here may be attributed to the invigoration of the pro-inflammatory cytokine. These pro-inflammatory cytokines reduce erythropoiesis in bone marrow via several mechanisms such as reducing erythropoietin secretion, interfering with iron absorption, increasing ferritin formation, enhancing hepcidin release, and decreasing circulating transferrin. Although these mechanisms are aimed at restricting iron availability to invading organisms to impede their growth, they inadvertently hinder iron delivery to the bone marrow, leading to the documented anemia in FG in the current study [15, 19, 28, 33]. The iron profile of FG in the present research supported this theory; it demonstrated hypoferemia, hypotransfereinemia, and hyperfereteinemia. The acute phase response documented in FG here is another possible reason for the hypotransferrinemia, and hyperfereteinemia recorded in FG. Whereas, transferrin is a negative acute phase reactant and ferritin is a positive acute phase reactant [9, 11, 15-21]. The elevated TIBC, UIBC values, and the diminished Tf Sat. % are rational consequences for the recorded hypoferemia in FG in this work.

On the contrary, the pro-inflammatory cytokines promote the granulopoiesis process in the bone marrow resulting in the neutrophilia and the subsequent leukocytosis observed in FG in the present work. Neutrophilia or leukocytosis or both are common findings in foreign body syndrome in different ruminants [28, 29, 32, 33, 34]. On the other hand, Lymphocytopenia was obtained in FG in our research, this pointed to their migration to the injury site and reflected the pain and stress status that the animal suffered from, which stimulated cortisol secretion. Cortisol may play a secondary role in this lymphocytopenia, it redistributes the recirculating lymphocytes due to the sequestration of lymphocytes in the lymphoid tissues rather than entering efferent lymph and blood [15, 18, 28, 29].

Concurrently with the described immunological and clinicopathological changes, the endocrine system activated to regulate the release of energy-rich substances (such as glucose, free fatty acids, and amino acids) and essential elements like calcium and phosphorus from storage reserves (such as fat tissue, muscle, liver, and bone) [36, 37]. These elements are crucial for sustaining an energy-demanding immune system during periods of restricted food and water intake, as observed in our cases. A predominance of energy expenditure pathways is initiated, resulting in characteristic hormonal shifts including increased release of cortisol and growth hormone (GH) [36, 37]. Cortisol facilitates the breakdown of liver glycogen, adipose tissue, and muscle protein, and promotes gluconeogenesis. Growth hormone exhibits glucogenic and lipolytic effects [36, 37]. Conversely, insulin, T3, and T4 levels decrease to mitigate energy consumption by body cells. Thus, FG in our work exhibited hypercortisolemia and elevated GH levels, accompanied by hypoinsulinemia and reduced levels of T3 and T4. The observed rise in TSH levels in FG may be attributed to the pituitary response to the detected hypothyroidism.

Our study clarified the importance of pro-inflammatory cytokines, acute phase proteins, matrix metalloproteinases, and TAC in diagnosing foreign body syndrome and predicting rumenotomy outcomes. The study strongly advocated for TAC and SAA as the most reliable biomarkers for the disease, while IL-1α, IL-6, TNF-α, and Cp as optimal indicators for making rumenotomy decisions. These findings align with earlier research emphasizing the utility of these markers in assessing overall health and diagnosing foreign body syndrome across different ruminant species, as well as predicting surgical outcomes. However, the study diverged from previous conclusions regarding the prioritization of these markers, which could be attributed to variations in species, duration, the severity of foreign body presence, and the overall health condition of the animals [21, 22, 25, 38].

Conclusion

The study emphasized that foreign body rumen syndrome in sheep is a multifaceted process influenced by various immunological, hematological, biochemical, and hormonal factors. It underscored the importance of combining supportive therapies with surgical intervention for managing ewes affected by foreign body syndrome. TAC and SAA emerged as reliable biomarkers for diagnosing the disease, while IL-1α, IL-6, TNF-α, and Cp were identified as potentially useful indicators for guiding rumenotomy decisions.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethical approval of the Animal and Poultry Health Department, Desert Research Center (DRC), Mataria, Cairo, Egypt, (code DRC-227-5-24).

List of abbreviations:

FG: forgein bodies group, CG: control group, IL-1α: interleukin 1 alpha, IL-1β: interleukin 1 beta , IL-6: interleukin 6 , TNF-α; tumor necrosis alpha, APPs;

acute phase proteins, Fb: fibrinogen, SAA: serum amyloid A, Hp: haptoglobin, Cp: caeruloplasmin, MMPs: matrix metalloproteinases, MMP-2: matrix metalloproteinase 2, MMP-9: matrix metalloproteinase 9, NO: nitric oxide, MDA: malondialdehyde, GH: growth hormone, TSH; thyroid stimulating hormone, IL-10: interleukin 10, TAC: total antioxidant capacity, CAT: catalase, GPx: glutathione peroxidase, GR: glutathione reductase, T3: triiodothyronine, T4: thyroxine, TP: total protein, Glob: globulin, Cr: creatinine, ALT; alanine transaminase, AST: aspartate transaminase, ALP: alkaline phosphatase, Alb: albumin, A/G: albumin/globulin, T/HDL/LDL-cholesterol: total/ high density lipoprotein/low density lipoprotein, RBCs: red blood cell counts, Hb: hemoglobin concentration, PCV: packed cell volume, MCV: mean corpuscular volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration, SI: serum iron, Tf: transferrin , Tf Sat. %: transferrin saturation %, TIBC: total iron binding capacity, UIBC: unsaturated iron binding capacity, SG: survive group, DeG: dead group, AUC; area under the curve, NPV: negative predictive value, PPV: positive predictive value, AR: accuracy rate, LR: likelihood ratio.

TABLE 1. The immunological and biochemical parameters of the foreign body group (FG) compared to the control group (CG). Value=mean±SD

Parameter	CG	FG
IL-1α (Pg/ml)	25.55±3.53	45.46±3.19*
IL-1β (Pg/ml)	32.60±2.31	45.77±5.85*
IL-6 (Pg/ml)	24.35±3.40	36.86±3.59*
TNF-α (Pg/ml)	25.66±1.59	35.86±1.83*
IL-10 (Pg/ml)	98.72±3.92	82.17±4.55*
Fb (mg/dl)	116.01±10.34	129.50±8.26*
Cp (mg/dl)	2.02±0.91	3.48±0.14*
Hp (g/dl)	0.15±0.02	0.29±0.05*
SAA (mg/L)	2.46±0.19	2.95±0.02*
MMP-2 (ng/ml)	16.83±1.73	27.50±2.17*
MMP-9 (ng/ml)	23.13±1.28	43.40±2.47*
MDA (nmol/ml)	12.76±1.19	27.96±2.05*
NO (μmol/L)	26.75±1.17	37.60±1.70*
TAC (Mm/L)	1.23±0.11	0.48±0.02*
CAT (U/L)	405.01±11.47	218.51±19.81*
GPx (mU/L)	950.05±25.54	425.60±3.53*
GSH (ng/ml)	22.25±1.61	12.14±1.76*
AST (U/L)	24.65±0.15	37.45±2.31*
ALT (U/L)	32.69±0.12	45.06±1.76*
ALP (U/L)	26.92±1.81	36.92±1.81*
Blood urea (mg/dl)	24.86±0.07	41.79±2.32*
Cr (mg/dl)	0.64±0.04	1.65±0.04*
Glucose (mg/dl)	93.30±3.45	52.60±3.56*
Total lipids (mg/dl)	348.19±8.76	319.61±9.24*
Triglycerides (mg/dl)	72.49±2.30	93.91±3.78*
Phospholipids (mg/dl)	156.03±4.16	156.03±4.16
T-cholesterol (mg/dl)	119.67±4.84	69.67±4.84*
HDL-cholesterol(mg/dl)	85.89±2.31	45.89±2.31
LDL-cholesterol (mg/dl)	33.79±2.54	23.79±2.54*
Ca (mg/dl)	9.55±0.47	4.92±0.04*
P (mg/dl)	5.79±0.98	2.45±0.22*
Cl (mmol/L)	99.67±1.35	79.67±1.35*
Na (mmol/L)	133.70±3.96	93.70±3.96*
K (mmol/L)	3.60±0.19	1.58±0.20*
Mg (mg/dl)	3.51±0.18	1.63±0.14*
Cu (μmol/L)	21.71±0.90	11.71±0.90*
Zn (μg/dl)	153.80±5.88	105.15±3.00*
Total protein (g/dl)	6.54±0.73	6.86±0.02*
Albumin (g/dl)	3.96±0.03	1.90±0.08*
Globulin (g/dl)	2.58±0.14	4.96±0.06*
A\G	1.58±0.22	0.38±0.02*

Significant between the two groups indicated by (*), when P<0.05.

TABLE 2. Erthyrogram, iron profile parameters, leukogram, serum hormones of the foreign body group (FG) compared to the control group (CG). Value=mean±SD.

Parameter	CG	FG
RBCs ($\times10^6$/µl)	12.71±0.27	9.47±0.16*
Hb (g/dl)	14.45±0.30	8.41±0.29*
PCV (%)	33.46±0.79	22.60±0.15*
MCV (fl)	26.33±0.90	23.88±0.24*
MCH (pg)	11.37±0.28	8.88±0.31*
MCHC (%)	43.22±1.72	37.21±1.25*
SI (µg/dl)	104.94±3.65	78.64±5.28*
TIBC (µg/dl)	332.14±1.68	346.31±3.96*
UIBC (µg/dl)	227.20±4.27	267.67±6.49*
Transferrin(mg/dl)	110.55±9.13	92.85±5.64*
Tf sat. %	31.60±1.14	22.71±1.54*
Ferritin (ng/ml)	12.85±1.14	21.00±2.29*
TLC ($\times10^3$/µl)	7.09±0.13	7.56±0.43*
Neutrophils ($\times10^3$/µl)	2.13±0.05	4.60±0.41*
Lymphocytes($\times10^3$/µl)	3.96±0.03	1.96±0.03*
Monocytes ($\times10^3$/µl)	0.54±0.08	0.54±0.08
Eosinophils ($\times10^3$/µl)	0.42±0.06	0.42±0.06
Basophils ($\times10^3$/µl)	0.04±0.05	0.04±0.05
Cortisol (µg/dl)	1.57±0.37	5.49±1.10*
Insulin (µIU/ml)	9.74±0.05	6.01±0.87*
T3(ng/ml)	1.74±0.15	1.53±0.09*
T4 (µg/ml)	0.85±0.08	0.67±0.03*
TSH (µIU/ml)	0.001±0.002	0.02±0.003*
GH (ng/dl)	11.55±1.24	15.75±1.83*

Significant between the two groups indicated by (*), when P<0.05.

TABLE 3. Cut off points, sensitivity%, specificity%, LR, PPV%, NPV%, and accuracy rate% of the suggested markers in FG (compared to CG) and in DeG (compared to SG)

Marker	Group	Cut off	Sensitivity%	Specificity%	LR	PPV%	NPV%	AR
TAC (Mm/L)	FG	1.05	100%	95%	20	95.24%	100%	97.50%
	DeG	0.48	100%	80%	5	83.33%	100%	90%
IL-1α (Pg/ml)	FG	29.70	100%	85%	6.67	86.96%	100%	92.5%
	DeG	45.66	100%	90%	10	90.91%	100%	95%
IL-1β (Pg/ml)	FG	36	100%	90%	10	90.91%	100%	95%
	DeG	43.87	100%	80%	5	83.33%	100%	90%
IL-6 (Pg/ml)	FG	28.60	100%	90%	10	90.91%	100%	95%
	DeG	36.44	100%	90%	10	90.91%	100%	95%
TNF-α (Pg/ml)	FG	26.70	100%	90%	10	90.91%	100%	95%
	DeG	36.57	100%	90%	10	90.91%	100%	95%
Fb (mg/dl)	FG	127.5	65%	85%	4.33	81.25%	70.83%	75%
	DeG	125	100%	70%	3.33	76.92%	100%	85%
Cp (mg/dl)	FG	3.21	100%	90%	10	90.91%	100%	95%
	DeG	3.45	100%	90%	10	90.91%	100%	95%
Hp (g/dl)	FG	0.19	100%	90%	10	90.91%	100%	95%
	DeG	0.27	100%	80%	5	83.33%	100%	90%
SAA (mg/L)	FG	2.65	100%	95%	20	95.24%	100%	97.50%
	DeG	2.93	100%	50%	2	66.67%	100%	75%
Transferrin(mg/dl)	FG	101.5	100%	90%	10	90.91%	100%	95%
	DeG	97.50	100%	60%	2.5	71.43%	100%	80%
Ferritin (ng/ml)	FG	13.50	100%	60%	2.5	71.43%	100%	80%
	DeG	19.00	100%	50%	2	66.67%	100%	75%
MMP-2 (ng/ml)	FG	18.71	100%	80%	5	83.33%	100%	90%
	DeG	25.67	100%	50%	2	66.67%	100%	75%
MMP-9 (ng/ml)	FG	24.23	100%	75%	4	80%	100%	87.5%
	DeG	41.24	100%	50%	2	66.67%	100%	75%

LR= 0.5-5: low; LR=5-10: moderate; LR>10: high.

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تقييم التغيرات المرضية الإكلينيكية في الأغنام ذات الأجسام الغريبة في الكرش

أسماء عبدالله رجب درويش

قسم صحة الحيوان، شعبة الانتاج الحيوانى والدواجن، مركز بحوث الصحراء، القاهرة، مصر.

الملخص

متلازمة الأجسام الغريبة في الأغنام تشكل تهديدا حقيقيا. يسبب العديد من المضاعفات التي تؤدي إلى خسائر اقتصادية. يلقي هذا العمل الضوء على أهم التغيرات المرضية الإكلينيكية المرتبطة بمتلازمة الأجسام الغريبة في الأغنام ويقترح مؤشرات جديدة لتشخيصها والتنبؤ بنتائج بالتدخل الجراحي لها.عشرين نعجة سليمة ظاهريًا اعتبرت المجموعة الضابطة (CG)، بينما عانت عشرين نعجة أخرى من أعراض، تشيرإلى وجود أجسام غريبة في الكرش تم تأكيدها عن طريق فتح الكرش، واعتبرت مجموعة الأجسام الغريبة (FG). تم جمع عينات الدم قبل الجراحة، وتم الكشف عن المعاملات المناعية والسريرية المرضية وتحليلها إحصائيا. أظهر FG مقارنة بـ CG زيادة كبيرة ($P < 0.05$) في السيتوكينات المؤيدة للالتهابات، APPs، MMPs، الجذور الحرة، الكورتيزول، GH، TSH، الجلوبيولين، الدهون الثلاثية، اختبارات وظائف الكلى، الإنزيمات الكبدية، وانخفاض معنوي (P) < 0.05 في مستوى السيتوكينات المضادة للالتهابات، إجمالي قدرة مضادات الأكسدة، مضادات الأكسدة، T3، T4، الأنسولين، الألبومين، الجلوكوز، T/HDL/LDL-الكوليسترول، الدهون الكلية، المعادن، الشوارد، العناصر النزرة. كما أظهرت أيضًا انخفاضًا معنويا ملحوظًا ($P < 0.05$) في فقر الدم الناقص الصباغ صغير الخلايا ونقص في الدم مع زيادة عدد الكريات البيضاء المتعادلة. من بين العلامات التي تمت دراستها، عرض TAC وSAA أعلى LR كعلامات لتشخيص المرض، في حين كان لدى IL-1α وIL-6 وTNF-α وCp أفضل القيم لتشخيص بضع الكرش. الاستنتاج: إن الجمع بين العلاجات الداعمة إلى جانب شق الكرش مهم لرعاية النعاج المصابة بمتلازمة الأجسام الغريبة. يعد TAC وSAA مؤشرًا جيدًا لتشخيص متلازمة الأجسام الغريبة في الأغنام، لكن IL-1α وIL-6 وTNF-α وCp أفضل لتوجيه قرارات بضع الكرش.

الكلمات الدالة: الأجسام الغريبة في الأغنام، المتغيرات المناعية، الإكلينيكية المرضية، الهرمونات، بضع الكرش.