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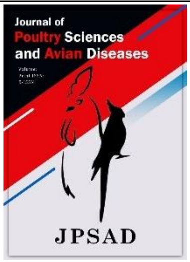

The effective treatment of hepatic lipidosis and lipemia in an ornamental hen: a case report

Mahdi Khalilzadeh Houjaqan[1], Ali Salavati[1], Iman Shojaei[2], Ali Mousavi[3], Seyed Mostafa Peighambari[1*]

[1] Department of Avian Diseases, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
[2] Department of Clinical Pathology, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran
[3] Department of Radiology, Science and Research Branch, Islamic Azad University, Tehran, Iran

*** Corresponding author email address**: mpeigham@ut.ac.ir

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ABSTRACT

This study discusses the significant role of lipids in liver functional disorders, emphasizing their impact on metabolic processes and the evaluation of organism and cell function. Hepatic lipidosis, observed across various species, including birds, results from an imbalance in fatty acid metabolism. The study focuses on a case presentation of a laying hen with severe respiratory symptoms and abdominal distension, diagnosed with hepatic lipidosis due to an inappropriate high-fat diet. Diagnostic methods include clinical examinations, blood tests, radiology, and ultrasonography. Treatment involves atorvastatin, furosemide, and dietary adjustments, resulting in a complete recovery. The discussion highlights the metabolic aspects of hepatic lipidosis in laying hens and the challenges in diagnosing pet birds, suggesting biochemical tests and ultrasonography. Additionally, the article explores the application of atorvastatin in treating hyperlipidemia in birds and emphasizes the importance of maintaining a healthy liver in actively egg-laying birds. Our study and experiences have shown that, alongside chemical compounds, herbal compounds can also be utilized for optimal liver health.

Keywords: *Hepatic Lipidosis, Backyard Poultry, Metabolic Disorders, Atorvastatin*

1 Introduction

Lipids play a crucial role in functional disorders of the liver. It is due to their involvement in the body's metabolic processes and their metabolic characteristics in determining the functional status of the organism, individual cells, and intracellular elements, as well as in assessing the quality of products obtained from poultry (1).

Hepatic lipidosis has been reported in humans, cattle, horses, dogs, cats (2), and various bird species, including galliformes (3), passeriformes (4, 5), falconiforms (6), and psittacines (7). In mammals, the normal liver contains about

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5% fat in triglycerides, fatty acids, phospholipids, cholesterol, and cholesterol esters. The liver stores lipids derived from the diet mobilizes fatty acids from lipid reserves and synthesizes fatty acids within hepatocytes. Under normal conditions, albumin transports circulating fatty acids to the liver, where they are oxidized for energy or incorporated into triglycerides. If the rate of fatty acid delivery to the liver exceeds the liver's capacity for metabolism or re-secretion of fatty acids into circulation, triglyceride accumulation leads to hepatic lipidosis (8). Processes leading to hepatic lipidosis include increased delivery of fatty acids to the liver (from the diet or related to environmental lipolysis), reduced oxidation of fatty acids, and decreased liver capacity to re-secrete processed fatty acids into circulation (9).

One of the main factors leading to hepatic lipidosis in overweight birds is an inappropriate high-fat diet, resulting in hypercholesterolemia and ovarian disorders. Secondary septicemia may subsequently occur (10). History and clinical signs, clinical pathology, diagnostic imaging, and hepatic biopsy are some methods for diagnosis in live birds. Post-mortem gross lesions in the liver and sampling for histopathology can make a definitive diagnosis (11). The most common clinical manifestation is anorexia with calm behavior, although other signs of hepatic dysfunction may be present. Complete blood count and serum biochemistry aid in diagnosis and direct treatment. Serum, even in a fasting state, is often highly lipemic. Increased white blood cell count is frequently observed. Serum chemistry may be within normal ranges or indicate elevated levels of bilirubin, AST, LDH, cholesterol, and triglycerides. Caloric needs in birds with hepatic lipidosis are 2 to 3 times higher than normal. Very low-fat diets may fail to provide sufficient calories. It is crucial to modify the bird's diet gradually. Additional supportive care includes fluid therapy, metabolic aids (lactulose, silymarin), and antibiotics if necessary. Improving nutritional status is essential for complete recovery and preventing relapse (10, 12).

The keeping of backyard poultry is increasingly prevalent in urban and suburban families. The rising popularity of backyard chicken flocks has spurred several cross-sectional studies to describe the health and biosecurity of non-commercial flocks, as well as the characteristics, attitudes, and performance of owners of this type of poultry (13, 14). A nationwide survey of flock owners indicated that owners often express the need for veterinary care, particularly for treating non-commercial poultry (14). Euthanasia and necropsy are fundamental for disease diagnosis in commercial poultry. However, owners of native poultry, who often consider their chicks as household pets (14), may find it challenging to sacrifice 1 or 2 birds for disease diagnosis. Therefore, equipped veterinarians must conduct diagnostic tests, such as biochemical profiles, before death to provide demographic information about native chicken populations (15). Reference ranges for biochemical values in native chicks are limited. Published reference values for *Gallus gallus domesticus* can be found in some reference books (16, 17), but the origin of these values cannot be traced. Therefore, more information is needed about the characteristics of the reference and whether the intervals can capture the clinical spectrum of healthy chickens in a backyard flock.

Valuable diagnostic information, such as the rough size of the liver, can be achieved using radiographic evaluation. However, it cannot diagnose the parenchymatous changes and the severity of hepatic lesions (18, 19). Radiographically, the margins of the liver should not extend past the sternum on the lateral view. With enlargement, there will be a dorsal deflection of the proventriculus and caudodorsal displacement of the ventriculus (to the level of the acetabulum). The hourglass cardiac hepatic silhouette is lost on the dorsoventral view, and the liver will extend beyond an imaginary line drawn from the scapula to the acetabulum (4). Ultrasonography (US) can help us define these changes in the liver parenchyma, but the exact etiologic diagnosis is often only possible with additional cytological or histopathological examinations (11, 19). Avian hepatic parenchyma has the same ultrasonographic (US) appearance as mammalian species (Nordberg et al., 2000). As any diffuse changes in normal echogenicity or echotexture could indicate diffuse hepatic disorders, US examination is routinely used to diagnose fatty liver in humans and other mammals (20, 21). The application of a new US elastography technique, acoustic radiation force impulse (ARFI) imaging, has been promising in diagnosing hepatic lipidosis in chickens in an experimental design (22).

2 Case presentation

On April 7, 2023, a laying hen with severe respiratory symptoms, such as gasping, presented to the Avian Clinic of the Veterinary Teaching Hospital, University of Tehran. No typical signs of respiratory infections were observed, such as fever or discharge from the eyes, nose, or mouth. Clinical examinations revealed distension in the abdominal area, and the bird experienced difficulty breathing and panting during increased activity or stress (the color of the comb Changed to blue). Upon obtaining the bird owner's history, it was revealed that the bird's diet contained high amounts of simple sugars and fats. However, daily egg-laying was proceeding without any apparent issues.

In order to conduct further examinations, blood was drawn from the bird following international standards (23), and the samples were sent to the laboratory for analysis. Furthermore, radiology and ultrasonography were employed to investigate hepatic lesions and examine other body organs for diagnostic purposes.

The results of hematology and biochemistry at different time intervals are shown in Table 1. In the radiology images, an accurate liver size assessment was impossible due to the presence of eggs. On ultrasound examination, increased echogenicity of the liver tissue was likely observed due to lipid changes (Figure 1 and Figure 2). Additionally, free fluids were detected in the abdominal cavity on ultrasound examination.

After treatment with atorvastatin (10 mg/kg PO q12h), furosemide (3 mg/kg PO q24h), and Hepacarnithol® According to the manufacturer's recommended dose for two weeks, simultaneously with the medication prescription, the diet was also balanced. After two weeks of treatment and dietary adjustment, respiratory signs and abdominal distention reduced significantly, and the bird returned to normal activity.

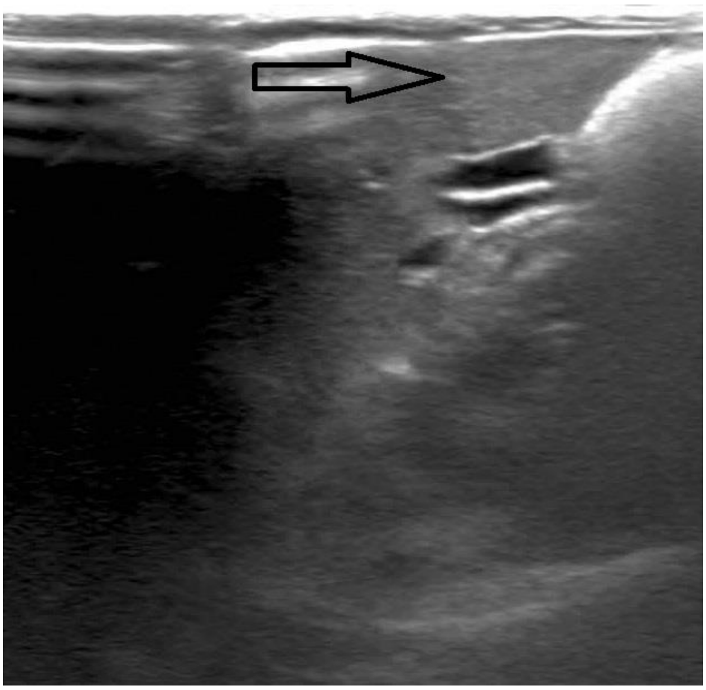

Figure 1. The arrow showed the liver tissue. The echogenicity of the tissue has increased due to mild fatty change.

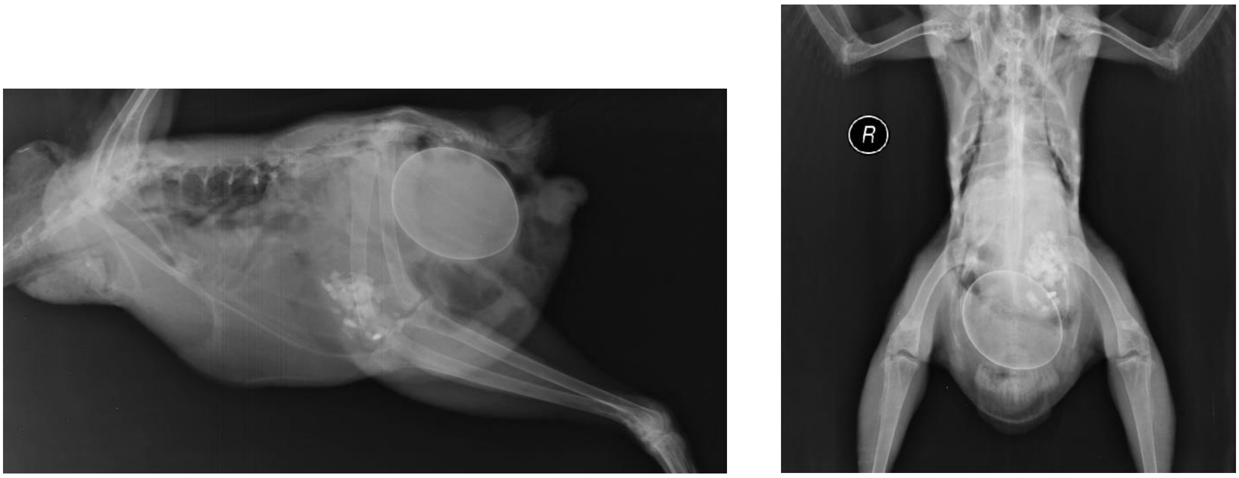

Figure 2. Left: Lateral view. Right: Dorso-ventral view. With the bird in the laying phase, it was challenging to assess the size of the organs accurately.

After two weeks of treatment cessation, dietary modifications continued. After two months, despite the resolution of all symptoms, a follow-up blood test was performed. To ensure the absence of recurrent symptoms, another blood analysis was conducted after six months, showing complete improvement in the bird's condition.

Table 1. Hematological and Biochemical Test Results at Different Time Intervals

Parameters	Before Treatment	Two weeks after treatment	Six months after treatment	Nine months after treatment	Normal Range (Reference)
WBC' 10^3	11	14	-	-	9-32(17)
Heterophils (%)	64	63	-	-	30-60(17)
Immature Heterophils (%)	6	2	-	-	-
Lymphocytes (%)	27	28	-	-	29-84(17)
Monocytes (%)	3	7	-	-	0.1-7(17)
HCT (%)	27	34	-	-	22-55(17)
Total protein (g/dl)	5.75	3.88	4.3	3.9	3.3-5.5(17)
Triglycerides (mg/dl)	1912	533	627	568	64.8-655.2 (16)
Cholesterol (mg/dl)	649	79	101	76	86-211
AST (u/l)	204	247	248	276	82-311 (15) 130-270 (16)
Uric acid (mg/dl)	7.9	1.7	1.4	3.3	2.5-8.1(17)

3 Discussion

In laying hens, the liver plays a significant role in the synthesis and metabolism of fat. Fats metabolized in the liver are derived from three main sources: dietary fat, depot fat, and de novo fatty acid synthesis (from feed carbohydrates) (24). Hepatic lipidosis is often referred to as Fatty liver. The etiology of this syndrome has been proposed to be nutritional and observed practically in response to force-feeding high-energy diets (25). Studies show that carbohydrates and fats increase the fat content of the liver, and triglycerides are the main fat deposited in the liver (26, 27). Fatty liver syndrome is generally a metabolic disorder in the poultry industry, especially in hens in cage farming systems. Birds kept in cages cannot move enough to burn the calories they are taking (28). The case under our investigation was sedentary because it was kept as a pet at home and had an improper diet that included a large amount of fats and simple sugars, such as soft drinks, which probably caused destructive effects on the liver and increased blood lipids (cholesterol and triglycerides).

The diagnosis of hepatic lipidosis in live birds can be based on the history, clinical symptoms, clinical pathology, diagnostic imaging, and biopsy. Macroscopic liver lesions in necropsy and the preparation of histopathological samples can be used for a definitive diagnosis by assessing damages (11). However, we acknowledge that definitive methods cannot be applied to a pet bird, and procedures suitable for live birds must be employed. Additionally, due to active ovaries and complete eggs inside the abdomen, organs may be displaced by eggs, causing the liver to deviate from its normal position. Therefore, the use of radiology is not feasible. For this reason, history, hematological and biochemical tests, and ultrasonography are the only tools available for diagnosis.

Atorvastatin is considered the primary treatment for hyperlipidemia and atherosclerosis in humans. Prescribing atorvastatin in humans (with a maximum recommended dose of 80 milligrams per day) leads to rapid absorption after oral intake, reaching peak plasma concentration within 1 to 2 hours and an elimination half-life of approximately 14 hours. At higher doses, atorvastatin reduces blood cholesterol and low-density lipoprotein cholesterol (LDL-C) by up to 50%, making it one of the most potent lipid-lowering and anti-atherosclerotic drugs on the market. Statins act as hepatic 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors, reducing cholesterol production by blocking the initial enzymes of the mevalonate pathway necessary for hepatic cholesterol synthesis. There needs to be more scientific literature regarding the treatment with statins and pharmacology in birds. Prescription of atorvastatin at a dose of 3 milligrams per kilogram per day, along with a standard diet, was associated with reduced hepatic cell damage and steatosis, along with improvement in hyperlipidemia-related renal disease in chickens (29, 30). Initial data obtained by researchers from controlled trials on combined atorvastatin in Amazon parrots (10 milligrams per kilogram PO q24h for 30 days) (31) and atorvastatin (10 milligrams/kilogram PO q12h and q24h, and 20 mg/kg PO q12h, each for 14 days) (32) and rosuvastatin (10 milligrams/kilogram PO q12-24 hours for 14 days) in Quaker parrots, equivalent to 10 to 20 times the human dose, did not statistically show a significant lipid-lowering effect on cholesterol, triglycerides, and plasma lipoproteins, and other lipids. A study conducted on Amazon parrots to investigate the pharmacokinetics of atorvastatin demonstrated that the drug is safe at higher doses (20 mg/kg PO q24h) and exhibits a favorable plasma concentration compared to humans (33). Hypothetically, a dietary supplement containing atorvastatin should facilitate the oxidation of fatty acids, consequently reducing the esterification and storage of triacylglycerol in adipose tissue. In another study examining the combined effects of atorvastatin and L-carnitine on poultry production and carcass traits, findings indicate that dietary supplements of atorvastatin and L-carnitine in combination affect the redistribution of lipids, intramuscular fat, carcass traits, and blood parameters in broilers, thereby improving carcass quality (34).

In order to maintain a healthy bird, the liver should be kept in excellent condition. A better understanding of the metabolic functions and the factors that can cause disruptions in the liver is essential for the body's regular function. This matter is fundamental in birds actively producing eggs, as their liver constantly produces fats for yolk formation. Since the dietary regimen in pet birds may be inappropriate, it is recommended that a thorough assessment of metabolic issues not be based solely on clinical observations and biochemical tests should be used for timely diagnosis and treatment confirmation. Additionally, based on the authors' experiences in this bird category, herbal compounds such as milk thistle alongside chemical compounds are suggested to enhance liver health.

Conflict of Interest

The authors declared no conflicts of interest.

Author Contributions

All authors contributed to the original idea and study design.

Data Availability Statement

Data are available from the corresponding author upon reasonable request.

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