RESEARCH ARTICLE

Hepatorenal Syndrome in Dogs with Experimental Extrahepatic Cholestasis

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Abstract

Hepatorenal syndrome (HRS) is a unique form of functional and potentially reversible renal failure secondary to liver diseases. It occurs typically in kidneys that are histologically normal. In this study, the hepatorenal syndrome was observed in a model of extrahepatic biliary stasis. Seven mature male mongrel dogs were subjected to complete surgical ligation of common bile duct at the duodenal region Clinical, ultrasonographic, histopathological examinations along with biochemical analysis for liver enzymes and urinalysis were performed before and throughout the experimental periods. Clinical observations post-surgery revealed icteric mucosa, abdominal pain, weight loss, dehydration, orange-colored urine, bilirubinuria, and clay feces. Biochemical analysis showed an abrupt increase in the mean values of serum blood urea nitrogen and creatinine from the 3rd day till reaching the peak at the 2nd week post-surgery. A strong positive correlation was detected between BUN and creatinine, and serum total and direct bilirubin. Ultrasonographic findings of liver revealed a progressive dilatation of gallbladder and the common bile duct from the 3rd day post-ligation, with an increase in the echogenicity of the liver, whereas, the kidneys demonstrate normal renal parenchyma and dimensions. Histopathological examination of the kidney revealed hemorrhage, vacuolation, hyaline droplet were observed in renal tubules and edema and yellowish-brown granules were seen in the interstitial tissue, but the significant renal changes that refer to renal failure weren’t detected. In conclusion, the dogs are considered a suitable model for studying hepatorenal syndrome and also there is an association between obstructive jaundice and renal failure.

Keywords: Hepatorenal syndrome, Obstructive jaundice, Dog, Biochemical analysis Pathological features.

Introduction

Hepatorenal syndrome (HRS) is a form of functional and potentially reversible renal failure which occurs in kidneys secondary to liver disease, especially with cirrhosis and ascites, due to the absence of recognized biomarkers, the diagnosis of HRS relies on a combination of clinical and laboratory criteria [1,2]. HRS in human is a life-threatening condition that needs to be diagnosed and treated rapidly in order to improve the clinical outcome [3] There are two clinical types of HRS, type I and type II based on the severity of the condition. Type I HRS is the type develops rapidly with poor prognosis, showing a doubling of the serum creatinine level within two weeks, whereas type II HRS has slower
rising renal retention parameters. Type I HRS patients have a mortality percent of 50% two weeks after diagnosis, approaching up to 100% within months [4, 5]. The diagnosis of HRS depends upon the presence of hepatic failure; high levels of serum creatinine and the absence of other causes of renal failure such as bacterial infection, shock, and the use of drugs that are toxic to the kidneys with no evidence of renal parenchyma diseases [6].

Patients with obstructive jaundice developed renal failure; similar clinical and pathological features were consistent with those found in HRS. The association of obstructive jaundice and acute renal failure in human has been recognized well since 1843 when a patient with fulminating ascending cholangitis became oliguric and died [7, 8]. The risk of renal failure is increased in obstructive jaundice patients with decreased intravascular volume; the presence of severe hepatic decompensation leads to splanchnic and systemic vasodilatation and decreased effective arterial blood volume to the kidneys. These changes lead to increase renal vasoconstriction and progressive oliguric renal failure [9]. The deeper jaundice the greater the risk of acute renal failure [10].

The major causes of extrahepatic biliary obstruction in dogs are pancreatitis, neoplasia, biliary mucoceles, cholangitis, and cholelithiasis [11]. Cholestatic liver diseases are defined as an accumulation of bile acids in the liver that causes an inflammatory process and liver injury [12]. The most clinical signs of biliary tract diseases in dogs are jaundice, abdominal pain, and ascites [13]

In complete common bile duct obstruction, patients showed pale feces and dark urine. Depending on the development of complications such as gallbladder rupture with leakage of sterile or septic bile the patients can show more severe signs such as fever, acute abdominal pain, and septic shock [14].

The present study aimed to throw the light on the association between obstructive jaundice and renal failure in the absence of significant renal changes in a model of extrahepatic biliary stasis in dogs.

Materials and Methods

The protocol of this study was approved by the Animal Experimentation Ethics Committee of Zagazig University (ZU–IACUC), protocol number ZU – IACUC/2/F/59/2019.

Seven mature male mongrel dogs aging from 6-11 months and weighting (20-25 kg) were included in this study. They were housed indoors in individual cages labeled with dog identifying. They were kept under uniform nutritional regimen, fed ad libitum on non-commercial diet (chicken and meat extract) and had free access to water. Dogs were dewormed and vaccinated against viral diseases according to the regulation of veterinary authorities during the one month acclimatization period. After acclimatization periods, all dogs underwent the surgical common bile duct ligation to induce extrahepatic obstructive cholestasis.

Experimental procedures

A more updated protocol for ligating the common bile duct at the duodenal region was applied (Figure. 1A) according to Kakabadze et al. [15]. After the surgery, follow-up and postoperative treatment were applied: Meloxicam ampoules (non-steroidal anti-inflammatory) produced by AMRIYA PHARM. IND.- Alexandria – Egypt in a dose 0.2 mg/kg/24 hours IM for 3-5 days and cefotax as Cefotaxime Sodium (antibiotics) produced by Egyptian Pharmaceutical Company (EPICO) in a dose 20 mg/kg/24 hours IM for 5 days, together with daily disinfection of the wound with Betadine 10%. Animals were kept on soft bedding. Closed observation to all examined dogs was done at regular intervals (3rd day, 1st, 2nd, 3rd, 5th and 8th week post-surgery).
Clinical examination

Clinical examination was thoughtfully performed before and during different experimental periods (0 day, 3rd day, 1st, 2nd, 3rd, 5th and 8th week post-surgery). The preliminary general examination was applied; general appearance, behavior, state of appetite, skin tent test, sunken eyes, urine, and fecal characters were noted and body weight was recorded. Special attention was paid to visible mucous membranes (conjunctival and oral mucosa) and sclera. The examination of mucous membrane was applied in good day light, in some cases, artificial light was used. Closed observation of all cases during the experimental period was done and any clinical alterations were recorded [16].

Ultrasonographic examination

Abdominal ultrasound (liver parenchyma, gall bladder, common bile duct and kidneys) was performed using a high definition ultrasound system equipped with 5 MHz micro convex and 9 MHz linear transducer Sonoscape Ultrasound (A5V, China) during different experimental periods.

Biochemical analysis

Five ml of blood was collected via cephalic vein puncture into a clean dry centrifuge tube without anticoagulant for serum separation at zero day, and during the different experimental periods; 3rd day, 1st, 2nd, 3rd, 5th and 8th week post-surgery. Serum liver enzymes were determined according to the methods described by Reitman and Frankel [17] for Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), and Tietz [18] for serum gamma glutamyl transferase (GGT) levels. Serum total protein and albumin were estimated according to the method described by Doumas et al. [19] and Henary et al. [20] respectively. Serum total and direct bilirubin levels were estimated according to Malloy and Evelyn [21]. Serum blood urea nitrogen (BUN) and creatinine were estimated by kinetic method using test kits according to the method described by Patton and Crouch [22] and Houot [23] respectively.

Urinalysis was applied at zero day, and during the experimental period; 3rd day, 1st, 2nd, 3rd, 5th and 8th week post-surgery. Samples were obtained by spontaneous urination or by catheterization. Physical examination of urine samples including color, volume, transparency, sediment, and odor was applied. Comburg multiple test strips (Boehringer Monnheim, Germany) were used for rapid urinalysis.

Postmortem and histopathological examinations

Postmortem examinations were performed for all dogs (dead or euthanized). The different lesions were recorded and samples were collected. Tissue specimens (liver and kidney) were taken and fixed in 10% buffered formalin. The histopathological slides were prepared and reviewed according to Jorge et al. [24].
Statistical analysis

Data were statistically evaluated by a software program (SPSS, version 16) using One-way ANOVA to compare between the findings during the experimental periods and at 0 day. Results were considered statistically significant at $P<0.05$ [25]. The correlation coefficient and significance of the correlation between liver and kidney function tests were evaluated by Pearson correlation analysis according to Feldman, et al. [26].

Results

Clinical examination

Table 1 and Figure 1 (B, C, D, E and F) summarize the observed symptoms and their onset of appearance post-surgery. No postoperative complications were recorded, all dogs showed jaundice, orange colored urine and clay feces from the 3rd day post-surgery. The normal color of fecal samples restored gradually from the 3rd week and the feces were normal by the 8th week. Abdominal pain, excessive emaciation, dehydration, and reduced appetite were also recorded. It is worthy to mention that 2 of 7 cases showed depression, recumbency, and they become oliguric at the 9th day post-surgery and death follow in the 2nd week, one of them showed severe ascites. All dogs showed a significant ($p<0.05$) decrease in their body weight from the 1st week post-surgery (17.20 ± 1.16 kg) till the 3rd week (16.67 ± 1.76 kg), after that an improvement in their weight was recorded from the 4th week (18 ± 1.53 kg).

Table (1): Clinical findings according to the onset of appearance after complete surgical ligation of common bile duct in mongrel dogs.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Onset of appearance</th>
<th>Onset of disappearance</th>
<th>No. of affected /total.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icteric m.m</td>
<td>3rd - 5th day</td>
<td>4th - 6th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Yellowish skin</td>
<td>3rd - 5th day</td>
<td>4th - 6th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Orange color urine</td>
<td>3rd - 7th day</td>
<td>3rd - 5th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Clay feces</td>
<td>3rd - 7th day</td>
<td>3rd - 5th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>4th day</td>
<td>3rd week</td>
<td>1 of 7</td>
<td>14</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>5th day</td>
<td>2nd - 6th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Polyphagia</td>
<td>6th day</td>
<td>Euthanasia (8th week)</td>
<td>1 of 7</td>
<td>14</td>
</tr>
<tr>
<td>weight loss and reduced activity</td>
<td>7th day</td>
<td>3rd - 6th week</td>
<td>7 of 7</td>
<td>100</td>
</tr>
<tr>
<td>Dehydration</td>
<td>7th day</td>
<td>Death (2nd week)</td>
<td>2 of 7</td>
<td>28</td>
</tr>
<tr>
<td>Ascites</td>
<td>7th day</td>
<td>Death (2nd week)</td>
<td>1 of 7</td>
<td>14</td>
</tr>
<tr>
<td>Reduced appetite</td>
<td>9th day</td>
<td>3rd - 6th week</td>
<td>6 of 7</td>
<td>86</td>
</tr>
<tr>
<td>Depression and recumbency</td>
<td>9th day</td>
<td>Death (2nd week)</td>
<td>2 of 7</td>
<td>28</td>
</tr>
<tr>
<td>Death</td>
<td>2nd week</td>
<td>2nd week</td>
<td>2 of 7</td>
<td>28</td>
</tr>
</tbody>
</table>

Ultrasonographic findings

The cystic, hepatic, lobar and interlobular ducts could not be identified on pre-surgical scans. While normal gallbladder was seen as anechoic, round structure lies in the right paracostal region between right medial and quadrate lobes. The normal bile duct was small 2-3 mm in diameter. Progressive distension of gallbladder and common bile duct started from the 3rd day post-surgery reaching the peak at the 2nd week, and a slight reduction was recorded after there with some increase in echogenicity of the liver (Figure 1 G to I). Ultrasonography of the kidneys before and during experimental periods revealed a normal picture, that renal medulla is the least echogenicity, followed by the renal cortex, and then the renal sinus with normal dimensions in different periods (Figure 1 J and K).

Biochemical analysis

Biochemical findings were illustrated in (Figure 2); regarding the liver function tests, a significant increase in serum liver enzymes AST, ALT, and GGT, and total and direct bilirubin started from the 3rd day post-surgery till reaching the peak at the 2nd week. While, their levels began to decline from the 3rd week post-surgery and the lowest levels were recorded at the 8th week. Meanwhile, a significant reduction in serum total protein and albumin were recorded from the 3rd day until the end of the study without significant changes in serum globulin. Regarding to kidney function tests, there was a significant
increase ($p<0.05$) in the mean value of serum BUN and creatinine starting from the 3$^{\text{rd}}$ day post-surgery (47.67±6.40 and 1.09±0.11 mg/dL, respectively), 55.25±7.17 and 1.25±0.05 mg/dL at 1$^{\text{st}}$ week, till reaching the peak at the 2$^{\text{nd}}$ week post-surgery (60.99±0.99 and 1.33±0.01 mg/dL), then their levels showed gradual reduction from the 3$^{\text{rd}}$ week (49.02±1.17 and 1.17±0.15 mg/dL), 42.39±3.04 and 0.75±0.10 mg/dL at 5$^{\text{th}}$ till reaching the lowest level at the 8$^{\text{th}}$ week (36.14±1.05 and 0.72±0.02 mg/dL) (Figure 2 D and E).

As presented in Table (2) there was correlation between kidney function tests including BUN and serum creatinine and liver function tests as ALT, AST, GGT, total bilirubin and direct bilirubin. BUN were significantly correlated in a positive mode with serum ALT ($r=0.89$, $p<0.01$), AST ($r=0.94$, $p<0.002$), GGT ($r=0.91$, $p<0.003$), total bilirubin ($r=0.92$, $p<0.001$) and direct bilirubin ($r=0.95$, $p<0.001$). Also, strong positive correlation were recorded between serum creatinine and serum ALT ($r=0.87$, $p<0.01$), AST ($r=0.88$, $p<0.01$), GGT ($r=0.95$, $p<0.001$), total bilirubin ($r=0.97$, $p<0.001$) and direct bilirubin ($r=0.95$, $p<0.003$).

<table>
<thead>
<tr>
<th>Table (2): Pearson correlation coefficients between liver and kidney function tests after complete surgical ligation of bile duct in mongrel dogs.</th>
</tr>
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<tbody>
<tr>
<td><strong>ALT</strong></td>
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<td>---------</td>
</tr>
<tr>
<td>ALT</td>
</tr>
<tr>
<td>GGT</td>
</tr>
<tr>
<td>Total protein</td>
</tr>
<tr>
<td>Albumin</td>
</tr>
<tr>
<td>Globulin</td>
</tr>
<tr>
<td>Total bilirubin</td>
</tr>
<tr>
<td>Direct bilirubin</td>
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<tr>
<td>BUN</td>
</tr>
<tr>
<td>Creatinine</td>
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</tbody>
</table>

Correlation is significant at *$p<0.05$, and **$p<0.01$. ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, GGT: gamma glutamyl transferase and BUN: Blood urea nitrogen.
Urinalysis revealed orange colored urine by the 3rd day till the 2nd week post-surgery, then the intensity of color regress and appeared nearly similar to the normal color by the 3rd week. Reduction in the volume of the voided urine was observed from 9th day till 2nd week post-surgery. All samples were clear and neither sediment nor abnormal odor was observed at different times of examination. Bilirubinuria (7 of 7 dogs) were recorded from the 3rd day post-surgery and their levels increased gradually till reaching the maximum by the 2nd week, then regress gradually from the 3rd week. Proteinuria was recorded in 3 of 7 dogs.

Post-mortem examination

Postmortem examination was applied in 2 dogs that died at the 2nd week post-surgery, after that euthanasia was applied to 3 dogs at the 5th week and to 2 dogs at 8th week post-surgery. Out of seven dogs, four were severely emaciated, 6 dogs had icteric mucous membranes and 5 had yellowish staining ribs, intestine and mesentery. Intra-abdominal fluid effusion (about 10 L) was recorded within the abdominal cavity (1 of 7 dogs) with fibrinous peritonitis that covering liver and kidney (Figure 3 A and B), enlarged gallbladder, common and hepatic bile ducts (6 of 7 dogs). Paleness of the kidney was observed in 2 of 7 dogs that died in the 2nd week post-surgery (Figure 3 C).

Figure 3: A) Liver of dog suffered from ascites and peritonitis. B) Kidney of the same dog. C) Kidney of dog with acute renal failure in the 2nd week showed paleness. D) The portal area of liver showing congestion of portal vein and cirrhosis characterized by proliferation of fibrous tissue replaced bile duct (arrow head) with congestion of hepatic sinusoids (arrow) (H&E, 300X). E) The kidney showing interstitial lymphocytic infiltrations and mild fibrous proliferation (arrow head) with hemorrhages (blue arrow) and dilated blood vessels (black arrow) in the interstitial tissue, some renal tubules showing hydronephrosis (white arrow) (H&E,300X). F): the kidney showing hemorrhage and vacuolation in the epithelium of some renal tubules (arrow) (H&E,1200X). G) The kidney showing congestion of blood vessels with thickening and hyalinization in its wall and perivascular proliferation of fibrous tissue (arrow head) with epithelial cast inside lumen of some renal tubules (black arrow) and hemorrhage inside the glomeruli (white arrow, H&E,300X). H): the kidney showing edema (arrow head) and yellowish brown granules of bile pigment (arrow) in the interstitial tissue (H&E, 1200X). I): the kidney showing interstitial lymphocytic infiltrations (arrow) with yellowish brown granules of bile pigment (arrow head) (H&E, 1200X).
**Histopathological Findings**

Liver showed congestion of central vein with vacuolation in some hepatocytes and yellowish-brown granules of bile pigment in hepatocytes were also detected. The portal area of liver showing congestion of portal vein and cirrhosis characterized by proliferation of fibrous tissue replaced bile duct with congestion of hepatic sinusoids (Figure 3 D). The kidneys showed hemorrhage, vacuolation in the epithelial cells of the glomeruli, hyaline droplet in the lining epithelium of some renal tubules, edema and yellowish-brown granules of bile pigment were seen in the interstitial tissue (Figure 3 E to I). Such findings in the kidney were clear in 1 dog that died in the 2\textsuperscript{nd} week and 2 dogs that euthanized in 5\textsuperscript{th} week post-surgery and less clear in the remaining dogs.

**Discussion**

In this study, the severity of the condition is often evidenced by the degree of jaundice. All dogs showed jaundice from the 3\textsuperscript{rd} day post-surgery. Jaundice was attributed to the increase in the concentration of bilirubin in the blood owing to impairment of bile flow after common bile duct ligation and, the deposition of such substance on tissues mainly skin and mucous membranes. These results are similar to those obtained by Wang and Wei-Feng [27]. Abdominal pain, excessive emaciation and reduced appetite recorded in this study could be attributed to impaired bile flow in the extrahepatic biliary tree and the retention of bile salts in the liver with severe damage of hepatocytes and hepatic dysfunction occurred, these findings agreed with other studies [28-30].

Ascites was recorded in one dog might be owed to excessive accumulation of unconjugated bile acids in the blood. Unconjugated bile acids are cytotoxic and induce tissue inflammation and alter the permeability of vascular structures within the peritoneum leading to transudation of fluid into the peritoneal cavity, this results were previously mentioned by Owens et al. [31].

Orange colored urine and bilirubinuria could be attributed mainly to the blockage of enterohepatic circulation of bilirubin after common bile duct ligation. So the kidney becomes the main route for its elimination leading to impairment of kidney function [32, 33].

Increase serum creatinine levels with no or minimal proteinuria and decreased urine volume are characteristic to HRS. Clay-colored feces could be attributed to biliary obstruction, so bilirubin cannot be discharged or discharged in a small amount into the intestines, consequently fecal pigment reduced and clay-colored feces observed. This result is inconsistent with the findings of previous studies [33, 34]. As recorded by Utkan et al. [35] the reduction in body weight was attributed to hepatocellular dysfunction secondary to the impaired enterohepatic circulation of bile, which results in insufficient protein synthesis and gluconeogenesis, malabsorption of fats and steatorrhea and poorly absorbed fat-soluble vitamins..

In the present study, ultrasonography plays an important role in the early diagnosis of extrahepatic cholestasis. In contrast, it is of low value in diagnosing HRS. While, Duplex-Doppler ultrasound of intralobar arteries is a simple, non-invasive and effective method that enables the early detection of renal hemodynamic disturbances before renal dysfunction becomes clinically evident [36].

The main laboratory finding of HRS is an acutely elevated serum BUN and creatinine after ligation from the 3\textsuperscript{rd} day and reaching the peak in the 2\textsuperscript{nd} week post-surgery. It is worthy to mention that about 3 and 4 folds increase in serum BUN and creatinine were recorded in 2 of 7 dogs that died in the 2\textsuperscript{nd} week.

There are no specific clinical findings in diagnosing of HRS, the more important aid is the biochemical findings. Significant increase in the level of serum BUN and creatinine which parallel with the marked increase in the level of serum total and direct bilirubin post-surgery from the 3\textsuperscript{rd} day and the peak was at the 2\textsuperscript{nd} week, then decrement began from the 3\textsuperscript{rd} week. Our results coincided with Heinrich et al. [37] who recorded that complete common bile duct ligation in mice resulted in an immediate increase in bilirubin which remained constant during 14 days after ligation. Also, Crema et al. [38] recorded that
common bile duct ligation in dog resulted in an increase in serum total bilirubin concentration one week post-operative. Serum bilirubin rises in this study secondary to biliary tract obstruction. Bile is eliminated in the gastrointestinal tract but when the normal elimination is impaired, the serum concentration of bilirubin will elevate and hyperbilirubinemia occurs.

In cholestasis, the hepatic ability for metabolizing and excreting toxic substances is lost, causing renal overload. Therefore, the kidneys become the major route for elimination of toxic metabolites in the body, leading to increased exposure to nephrotoxic substances and disorders as kidney failure and hepatorenal syndrome [39, 40]. Hyperbilirubinemia has additionally been shown to attenuate the development of angiotensin II and induced arterial hypertension by reducing the production of superoxide and sodium reabsorption in the thick ascending loop of Henle [41].

The histopathological examination revealed loss of the normal histological architecture of the hepatic tissue after common bile duct ligation. This change was attributed to retention of the bile in hepatocytes with subsequent liver damage after biliary stasis. Awad et al [42], Aller et al [43], Panqueva [44] recorded similar consequences. Intrahepatic biliary obstruction includes the presence of bile within hepatocytes and canalicular spaces, and bile duct proliferation that may progress to cellular death and hepatic cirrhosis [45, 46, 47]. Also, hemorrhage and vacuolation in the epithelial cells of the glomuléri and yellowish-brown granules of bile pigment that were seen in the interstitial tissue could be attributed to the toxic effect of bilirubin on renal tissue. Van Slambrouck et al. [48] reported similar findings. It is worthy to mention that histopathological alteration of the renal tissue was not grave enough to cause such retention of urea and creatinine.

Finally, a fundamental question remains to be answered; why a considerable improvement occurs after the 2nd week post-surgery? We are currently unsure of the exact answers, so, there is an unmet need to understand such mechanism. In this study, the complete common bile duct ligation was performed surgically using Vicryl (polyglactin 910) suture material- Ethicon. The suture material holds its tensile strength approximately for two to three weeks in the tissue and is completely absorbed by hydrolysis within 56 to 70 days (8-10 weeks). So all biochemical parameters reached the peak in the 2nd week post-surgery and declined from the 3rd week with slight improvement in all dogs. All parameters reached the lowest level in the 8th week.

We can assume that the two dogs that died in the 2nd week might be suffered from HRS type that is highly fatal. Meanwhile, 5 of 7 cases showed clinical improvement parallel to the reduction in total and direct bilirubin.

Conclusion
The dog is considered a suitable model for studying HRS. In addition, obstructive jaundice and high total and direct bilirubin are the contributing factors for HRS.

Conflict of interest
None of the authors have any conflict of interest to declare.

Acknowledgments
The authors thank the Department of Animal Medicine and the Department of Veterinary Surgery Anesthesiology and Radiology for their support.

References


الملخص العربي

المتلازمة الكبدي الكلونية في الكلاب عقب جراحة توقف مسار الدهون الصفراوية

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تعرف المتلازمة الكبدية الكلونية بأنها نوع فريد من أشكال الفشل الكلوي الوظيفي نتيجة أمراض الكبد ويحدث عادة في الكلي التي تفقد وظائفها مع بقاء النسيج محتفظًا بشكله الطبيعي. وفي هذه الدراسة تم ملاحظة متلازمة الكبدية الكلونية في نموذج تجريبي لوفح مسار الدهون الصفراوية بعد الكبد حيث خضع سبع ذكور من الكلاب عدة تجارب لإنتاج الكبد الكامل للعظام الماريا والموجات فوق الصوتية (من النبض والدورة.GRAPES) والموجات فوق الصوتية للمريض المجسم.

и

درس عدد من الفروقات في فضلات الدهون الصفراوية بعد توقف مسار الدهون الصفراوية في نموذج تجريبي في هيئة الطبي، وموجات فوق الصوتية (من النبض والدورة.GRAPES) وفي نموذج تجريبي في هيئة الطبي، وموجات فوق الصوتية (من النبض والدورة.GRAPES) وفي نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في


الملخص العربي

المتلازمة الكبدية الكلونية في الكلاب عقب جراحة توقف مسار الدهون الصفراوية

ياسمين حسن بومياب، إسماعيل متولي عامر، الامام محمد النجار، وفاء محمود عبد الرؤف، نورا هند السداوي، محمد جمعه

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2 المستشفى البيطري، كلية الطب البيطري، جامعة الزقاق - مصر.
3 قسم التشريحي، كلية الطب البيطري، جامعة الزقاق - مصر.
4 قسم التشريحي، كلية الطب البيطري، جامعة الزقاق - مصر.

تعرف المتلازمة الكبدية الكلونية بأنها نوع فريد من أشكال الفشل الكلوي الوظيفي نتيجة أمراض الكبد ويحدث عادة في الكلي التي تفقد وظائفها مع بقاء النسيج محتفظًا بشكله الطبيعي. وفي هذه الدراسة تم ملاحظة متلازمة الكبدية الكلونية في نموذج تجريبي لوفح مسار الدهون الصفراوية بعد الكبد حيث خضع سبع ذكور من الكلاب عدة تجارب لإنتاج الكبد الكامل للعظام الماريا والموجات فوق الصوتية (من النبض والدورة.GRAPES) والموجات فوق الصوتية للمريض المجسم.

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درس عدد من الفروقات في فضلات الدهون الصفراوية بعد توقف مسار الدهون الصفراوية في نموذج تجريبي في هيئة الطبي، وموجات فوق الصوتية (من النبض والدورة.GRAPES) وفي نموذج تجريبي في هيئة الطبي، وموجات فوق الصوتية (من النبض والدورة.GRAPES) وفي نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في نموذج تجريبي في


