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HEMATOLOGICAL AND BIOCHEMICAL EFFECTS OF PARTIAL AND COMPLETE SPLENECTOMY IN DOGS

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ABSTRACT

The purpose of the current study was to describe the effect of surgical splenectomy technique either partial or complete on some biochemical and hematological parameters. Six male mature mongrel dogs were subdivided into two groups (complete and partial splenectomy), and six immature mongrel dogs were subdivided into two groups (complete and partial splenectomy). Blood samples were taken before (base line), 10, 30, and 60 days post-operative. The results showed a significant reduction in serum albumin and iron levels 10 days after partial and complete splenectomy in both immature and mature dogs. However, serum gamma globulin fraction, ferritin, transferrin, and ceruloplasmin concentrations were significantly increased at the same period following surgical operation. There was a perturbation in serum activity of transaminases, bilirubin, and urea levels. The levels of WBCs, neutrophils, lymphocytes, MCH, MCHC, and platelets in completely splenectomized immature and mature dogs were increased. While, the RBCs and Hb concentrations were significantly decreased following complete splenectomy in immature and mature dogs. These results concluded that splenectomy in dogs may induce anemia, thrombosis, and inflammatory conditions but also increase cellular and humeral immunity as a compensatory mechanism.

Key words: Splenectomy, transferrin, platelets, ceruloplasmin, dogs

INTRODUCTION

The spleen, one of the most vascularized organs of the body and consider as a part of the mononuclear phagocyte system which is located between the portal and systemic circulations. Its blood supply comes from the splenic artery and from a rich arterial collateral network, mainly splenogastric, while its venous drainage flows to the splenic vein and a small part to the splenogastric veins. The splenic vein joins the superior mesenteric vein to form the portal vein (Petroianu, 2003). The spleen plays important functions, including hematopoiesis, cell purification and reservoir of blood elements (Sipka *et al.*, 2006).

The available information concerning the results of splenectomy in the veterinary field is not well-identified and most of the knowledge in this consideration has originated from human provenance (Chaudhry *et al.*, 1997). The indications for total splenectomy include tumors, benign splenic lesions, splenic torsion, traumatism and hematological immune-mediated diseases not responsive to treatments with drugs (Harari, 1999). Hemangiosarcoma (HSA) is the most common tumor of the canine spleen (Tillson, 2003). Partial splenectomy is indicated in animals with traumatic or focal lesions of the spleen to preserve splenic function. Complete removal of the spleen may lead to undesirable effect such as post-operative infections and sepsis, due to the reduce production of antibodies and phagocytes or may lead to thrombosis, due to rose of platelet count in blood (Khan *et al.*, 2009).

Despite the extensive literature on the effects splenectomy in human with different illness such as thalassemia, liver injuries, HCV infection and others on hematological and biochemical parameters, there is a few data about the hematological and biochemical alterations following splenectomy in animals specifically dogs. The aim of this study is to investigate the effects of total and partial splenectomy in apparently healthy adult and young dogs on complete blood count, liver functions (ALT, AST, albumin, and bilirubin), urea, and iron balance (iron, ferritin, ceruloplasmin, and transferrin) levels.

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MATERIALS AND METHODS

1. Animals and experimental design

Twelve apparently healthy female stray dogs, Six puppies aging from (3-4 month), weighting (4-6 kg) and others aging from (3-4 years) and weighting (20-25 kg) were used in the present study which approved by Institutional Animal Use and Care Committee of Faculty of Veterinary Medicine, Alexandria University. The local ethics committee for the use of laboratory animals approved all experimental procedures. Before experiment the animals were clinically and ultrasonoghraphically examined to ensure that they are apparently healthy. Animals were randomly divided into four groups according to age 2 mature groups and 2 immature groups (n=3 in each): group **A**, mature with complete splenectomy, group **B**, mature with partial splenectomy, group **C,** immature with complete splenectomy, group **D**, immature with partial splenectomy. The animal experiments were carried out in accordance with the National Institutes of Health (NIH) Guidelines for the Care and Use of Laboratory Animals, and the study protocol was approved by ethics committee, Faculty of Veterinary Medicine, Alexandria University.

2. Surgical operation

Food was withheld from all the dogs 12 h and water 2 h before the experiment. The dogs were pre-medicated pre-operatively by intramuscular administration of xylazine HCl as sedation 1mg/kg (Xyla-ject®, Adwia Pharmaceuticals Co., Egypt). Fifteen minutes after pre-medication, induction of general anesthesia was induced and maintained with 5 mg/kg b.wt Ketamine HCl (Ketamine®10%, Alfasan Pharmaceuticals, Holland) injected intramuscular.

The ventral abdomen prepared for aseptic surgery, a ventral midline abdominal incision from the xiphoid, extending caudal to the umbilicus were made in premature dogs, Otherwise in adult animals left sub-costal approach were made. After exposure of the spleen and isolated extra abdominal and place moistened abdominal laparotomy pads around the incision under the spleen, for total splenectomy proximal vessels of the hilum were isolated. Double ligate and transect all vessels at the splenic hilus with absorbable suture material polyglactin 910 (Vicryl®).

3. Blood samples

Two blood samples of each dog were taken from the cephalic vein just before surgery and on the 10^{th} day, 1 month and 2 month postoperatively. First sample was collected into the Voma Med® tubes containing K_3EDTA anticoagulant to obtaining whole blood for hematological examination including red blood cell count (RBC), white blood cell count (WBC), hemoglobin concentration (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count (PLT), neutrophils and lymphocyte counts were determined using automated blood analyzer (SERONO-9120 Baker System). Second blood sample was taken in plain Voma Med® tubes without anticoagulant for obtaining serum for measurement of ALT, AST, bilirubin, urea, iron, ferritin, ceruloplasmin, transferrin, and serum protein electrophoresis.

4. Biochemical analysis

Serum liver marker enzymes (ALT, AST), bilirubin, and urea concentration determined using Biodiagnostic kits according to the manufacturer's instructions. Serum ceruloplasmin forms a precipitate with a specific antiserum which was determined using immunoturbidimetric assay (Wolf, 1982). Serum transferrin was immunoturbidimetric determined (Lizana and Hellsing, 1974). Ferritin level was estimated according to (Finch *et al.,* 1986). Electrophoretic pattern of serum protein was evaluated according to (Kaplan and Savory, 1965).

5. Statistical analysis

Data were analyzed using the SPSS package (SPSS Inc., Chicago, IL). Results are expressed as mean± SE with the experiment repeated at least three times. Statistical evaluations were done using one-way analysis of variance (ANOVA). A p value of < 0.05 was considered significant.

RESULTS

1. Surgical operation

The ventral midline celiotomy was standard access for splenectomy in premature dogs; the spleen was easily and directly located. However a left paracostal approach in mature dogs was found to be superior to midline approaches for removal of the spleen. The paracostal abdominal approach provides excellent exposure, ease for manipulation, reduced anesthetic time, and fewer related problems such as postoperative pain with minimal need for analgesic and rapid return to normal function.

2. Serum protein fractionation

There was a significant reduction of serum albumin level 10 days after partial and complete splenectomy in young and adult dogs ($P < 0.05$), which tend to be increased to reach normal level at 60 days in young dogs while still below normal level in adult dogs. The change in albumin concentration was corresponding to the difference in serum total protein level (table 1). On the other hand, serum gamma globulin level tends to be increased 30, 60 days after partial and complete splenectomy in young and adult dogs at $P < 0.05$ (table 1).

3. Iron, ferritin, transferrin, and ceruloplasmin concentrations

The level of serum iron was significantly decreased following partial or complete splenectomy and gradually increased to reach its level at 0 day in both young and adult dogs ($P < 0.05$). However, serum ferritin, transferrin, and ceruloplasmin concentrations were significantly increased 10 days after both operation and tend to be decreased to reach the normal levels at 60 day (table 2).

4. Liver and kidneys functions

The data represented in table (3) showed that serum activities of ALT, AST were significantly increased following partial or complete splenectomy without change in serum bilirubin level. However, serum urea concentration was significantly increased 30, and 60 days post-operative technique in young and adult dogs.

3. Hematological parameters

The levels of WBCs, neutrophils, lymphocytes, and platelets in completely splenectomized young and adult dogs were significantly increased soon after operation followed by gradual decrease toward the normal values at the end of experiment (table 5). While in partially splenectomized small and large dogs, their levels significantly increase after operation and reach to normal levels at two month.

The MCV, and MCHC in all groups significantly increase after operation followed by gradual decrease toward normal, except in partially splenectomized adult dogs have no significant changes. While MCH in completely splenectomized young and large dogs showed significant increase along the experiment period, while, partially splenectomized dogs showed non-significant changes.

RBCs and Hb significantly decrease in completely splenectomized small and large dogs and start increasing toward normal levels at the end of experiment. While in partially splenectomized dogs, they slightly decrease after experiment and rapidly returned to normal values (table 4).

Table 1: Serum protein fractionation after partial and complete splenectomy in young and adult dogs

		Period of operation (days)	T. protein (g/dl)	Albumin (g/dl)	Alpha1 (g/dl)	Alpha2 (g/dl)	Beta (g/dl)	Gamma (g/dl)
Young dogs	Complete splenoctomy	0	5.37±0.15^{b}	3.35±0.05^{a}	0.18±0.00^{c}	0.87±0.06^{b}	0.76±0.04^{a}	0.22±0.01^{b}
		10	5.30±0.12^{b}	3.32±0.05^{a}	0.21±0.00^{b}	0.83±0.04^{b}	0.71±0.04^{a}	0.22±0.00^{b}
		30	5.20±0.17^{b}	3.00±0.06^{b}	0.17±0.00^{c}	1.08±0.05^{a}	0.72±0.06^{a}	0.23±0.00^{b}
		60	6.00±0.17^{a}	3.47±0.06^{a}	0.23±0.01^{a}	1.23±0.06^{a}	0.81±0.05^{a}	0.26±0.01^{a}
	Partial splenoctomy	0	6.20±0.12^{a}	3.72±0.06^{a}	0.28±0.00^{a}	1.00±0.01^{a}	0.85±0.05^{a}	0.35±0.01^{b}
		10	5.60±0.23^{bc}	3.21±0.06^{b}	0.19±0.00^{c}	0.98±0.06^{a}	0.83±0.05^{a}	0.36±0.04^{b}
		30	5.50±0.12^{c}	3.17±0.05^{b}	0.24±0.00^{b}	0.83±0.03^{b}	0.79±0.01^{a}	0.44±0.01^{a}
		60	6.10±0.17^{ab}	3.79±0.07^{a}	0.23±0.01^{b}	0.93±0.05^{ab}	0.84±0.06^{a}	0.30±0.01^{b}
Adult dogs	Complete splenoctomy	0	7.20±0.12^{a}	4.15±0.04^{a}	0.26±0.00^{a}	1.26±0.05^{ab}	1.22±0.00^{a}	0.28±0.01^{d}
		10	6.80±0.17^{b}	3.52±0.06^{b}	0.26±0.01^{a}	1.38±0.06^{a}	1.37±0.09^{a}	0.34±0.01^{c}
		30	5.80±0.12^{c}	2.78±0.05^{d}	0.23±0.00^{b}	1.06±0.01^{c}	1.22±0.06^{a}	0.51±0.01^{a}
		60	6.50±0.06^{b}	3.26±0.05^{c}	0.22±0.00^{b}	1.18±0.01^{bc}	1.41±0.01^{a}	0.42±0.01^{b}
	Partial splenoctomy	0	5.90±0.06^{ab}	3.28±0.05^{a}	0.15±0.00^{c}	0.93±0.01^{b}	1.01±0.00^{b}	0.54±0.00^{d}
		10	6.10±0.12^{a}	2.69±0.06^{b}	0.30±0.01^{a}	1.12±0.00^{a}	1.26±0.06^{a}	0.74±0.00^{a}
		30	5.60±0.17^{b}	2.32±0.06^{c}	0.27±0.01^{b}	1.14±0.06^{a}	1.16±0.05^{a}	0.71±0.00^{b}
		60	5.50±0.12^{b}	2.82±0.05^{b}	0.14±0.00^{c}	0.96±0.06^{b}	0.97±0.01^{b}	0.62±0.01^{c}

Values are expressed as mean ± SE.

The values with different superscript letters within the same column significantly differ at $p < 0.05$.

Table 2: Serum iron, ferritin, transferrin, and ceruloplasmin levels after partial and complete splenectomy in young and adult dogs.

		Period of operation (days)	Iron (µg/dl)	Ferritin (ng/ml)	Ceruloplasmin (ng/ml)	Transferrin (ng/ml)
Young dogs	Complete splenoctomy	0	163.67±4.26^{a}	97.17±6.81^{c}	19.10±1.22^{c}	182.33±1.79^{d}
		10	107.80±2.25^{b}	117.67±3.52^{b}	29.40±1.21^{a}	219.47±1.08^{b}
		30	62.97±4.49^{d}	145.30±2.59^{a}	23.77±0.75^{b}	206.07±2.22^{a}
		60	75.90±3.23^{c}	158.53±3.95^{a}	19.33±0.43^{c}	195.67±2.34^{c}
	Partial splenoctomy	0	171.27±3.03^{b}	178.97±3.61^{a}	17.80±1.44^{c}	197.73±2.69^{b}
		10	89.80±2.21^{c}	187.90±4.31^{a}	35.47±1.65^{a}	229.23±3.26^{a}
		30	134.90±6.33^{a}	166.90±3.10^{b}	27.60±1.12^{b}	208.20±1.97^{b}
		60	170.43±2.05^{a}	95.67±3.32^{c}	19.80±0.89^{c}	198.50±4.50^{b}
Adult dogs	Complete splenoctomy	0	169.37±1.41^{a}	112.33±5.41^{c}	21.03±0.74^{c}	198.13±1.33^{b}
		10	94.77±1.02^{d}	228.53±9.79^{a}	37.20±1.45^{a}	201.60±1.13^{b}
		30	107.27±1.19^{c}	137.73±3.49^{b}	28.43±0.55^{b}	215.60±1.10^{a}
		60	124.03±1.83^{b}	139.13±5.09^{b}	22.07±0.90^{c}	199.87±2.30^{b}
	Partial splenoctomy	0	132.67±2.89^{a}	142.37±3.15^{c}	20.10±1.23^{c}	188.73±3.39^{d}
		10	90.83±1.84^{d}	186.10±6.12^{a}	33.47±1.04^{a}	234.17±2.43^{a}
		30	105.77±2.49^{c}	163.20±4.40^{b}	23.60±1.10^{b}	219.03±1.47^{b}
		60	120.17±1.82^{b}	168.80±3.70^{b}	20.50±0.61b^{c}	209.13±1.46^{c}

Values are expressed as mean ± SE.
The values with different superscript letters within the same column significantly differ at $p < 0.05$.

Table 3: Liver and kidney functions after splenectomy after partial and complete splenectomy in young and adult dogs

		Period of operation (days)	ALT (U/L)	AST (U/L)	Bilirubin (mg/dl)	Urea (mg/dl)
Young dogs	Complete splenoctomy	0	20.43±0.69^{a}	14.73±0.55^{b}	0.90±0.03^{a}	17.23±1.78^{c}
		10	11.23±0.48^{c}	20.70±0.38^{a}	0.71±0.01^{b}	26.43±1.62^{b}
		30	16.43±1.21^{b}	21.33±0.58^{a}	0.56±0.03^{c}	35.00±1.99^{a}
		60	11.50±1.65^{c}	20.60±0.69^{a}	0.74±0.03^{b}	13.70±0.59^{c}
	Partial splenoctomy	0	8.13±1.00^{c}	8.70±0.46^{b}	0.91±0.04^{c}	17.67±1.79^{c}
		10	26.27±2.22^{a}	11.20±0.40^{a}	0.56±0.03^{b}	17.90±2.20^{c}
		30	12.93±1.65^{bc}	11.53±0.38^{a}	0.74±0.03^{a}	26.47±2.48^{b}
		60	17.57±1.07^{b}	11.73±0.38^{a}	0.85±0.03^{a}	44.27±3.32^{a}
Adult dogs	Complete splenoctomy	0	15.13±0.38^{a}	15.30±0.53^{ab}	0.88±0.02^{a}	15.67±1.04^{b}
		10	5.80±0.46^{b}	17.70±1.27^{a}	0.68±0.02^{b}	15.07±1.37^{b}
		30	3.53±0.22^{c}	10.77±0.41^{c}	0.68±0.05^{b}	22.90±2.47^{a}
		60	5.53±0.28^{b}	13.60±0.64^{b}	0.82±0.02^{a}	24.67±2.03^{a}
	Partial splenoctomy	0	11.27±1.24^{a}	18.40±1.04^{b}	0.93±0.04^{a}	20.47±1.79^{a}
		10	7.97±0.78^{bc}	22.40±0.84^{a}	0.68±0.05^{c}	19.03±1.56^{a}
		30	10.10±0.46^{ab}	13.73±0.41^{c}	0.77±0.02^{bc}	20.53±0.67^{a}
		60	5.73±0.09^{c}	12.57±1.24^{c}	0.88±0.02^{ab}	14.23±0.96^{b}

Values are expressed as mean ± SE.
The values with different superscript letters within the same column significantly differ at $p < 0.05$.

Table 4: Hemoglobin and blood indices after after partial and complete splenectomy in young and adult dogs

		Period of operation (days)	RBCs (10^6/µl)	Hb (g/dl)	MCV (fl)	MCH (pg)	MCHC (%)
Young dogs	Complete splenoctomy	0	5.49±0.17^{a}	12.10±0.15^{a}	62.37±0.52^{b}	21.03±0.38^{c}	34.23±0.52^{ab}
		10	4.28±0.18^{b}	11.07±0.24^{ab}	64.17±0.59^{ab}	22.93±0.13^{b}	35.57±0.44^{a}
		30	3.98±0.02^{b}	10.33±0.42^{b}	65.07±0.58^{a}	23.67±0.15^{b}	31.90±1.04^{b}
		60	4.06±0.08^{b}	10.77±0.38^{b}	62.37±0.44^{b}	25.70±0.21^{a}	33.43±0.62^{ab}
	Partial splenoctomy	0	4.90±0.12^{a}	9.77±0.20^{a}	65.67±0.76^{b}	21.50±0.87^{a}	31.13±0.55^{c}
		10	4.47±0.22^{ab}	9.27±0.19^{ab}	72.03±0.46^{a}	22.27±0.61^{a}	32.83±0.68^{b}
		30	4.20±0.15^{ab}	9.00±0.12^{b}	61.67±0.95^{c}	22.83±0.49^{a}	35.97±0.26^{a}
		60	4.50±0.15^{b}	9.73±0.12^{a}	65.90±0.17^{b}	22.53±0.35^{a}	33.60±0.29^{b}
Adult dogs	Complete splenoctomy	0	7.17±0.18^{a}	12.33±0.32^{a}	62.50±0.35^{c}	18.57±0.58^{b}	29.33±0.41^{b}
		10	5.33±0.15^{c}	10.17±0.18^{b}	60.23±0.24^{d}	20.73±0.79^{a}	30.77±0.49^{ab}
		30	5.83±0.15^{bc}	11.63±0.38^{a}	67.20±0.62^{a}	21.80±0.56^{a}	31.57±0.44^{a}
		60	5.97±0.18^{b}	12.00±0.26^{a}	64.17±0.18^{b}	21.60±0.45^{a}	30.43±0.46^{ab}
	Partial splenoctomy	0	6.90±0.25^{a}	13.23±0.39^{a}	72.67±0.88^{a}	23.13±0.99^{a}	31.83±0.79^{a}
		10	5.53±0.22^{b}	11.50±0.23^{b}	70.53±0.47^{b}	24.73±1.34^{a}	31.53±0.64^{a}
		30	6.23±0.15^{a}	12.23±0.41^{ab}	73.53±0.35^{a}	22.77±0.93^{a}	32.13±0.23^{a}
		60	6.77±0.20^{a}	12.87±0.47^{a}	71.80±0.42^{ab}	22.83±1.00^{a}	31.83±0.60^{a}

Values are expressed as mean ± SE.
The values with different superscript letters within the same column significantly differ at $p < 0.05$.

Table 5: White blood cells and platelets count after after partial and complete splenectomy in young and adult dogs

			WBCs	Lymph	Neutrophil	Platelets
Young dogs	Complete splenoctomy	0 day	8.83±0.18d	2.90±0.12d	6.73±0.33d	210.33±4.98c
		10 day	13.87±0.46b	5.10±0.15b	11.47±0.50b	358.33±10.93a
		30 day	17.83±0.15a	6.73±0.23a	16.10±0.23a	300.00±5.77c
		60 day	11.17±0.15c	4.10±0.06c	9.93±0.43c	230.00±8.66b
	Partial splenoctomy	0 day	7.90±0.12c	3.23±0.12c	7.83±0.18b	235.67±8.09b
		10 day	9.03±0.09a	4.27±0.12b	9.40±0.23a	316.67±12.02a
		30 day	8.63±0.12b	5.40±0.23a	10.03±0.29a	295.00±2.89a
		60 day	7.07±0.09d	2.97±0.07c	7.47±0.23b	210.00±5.77b
Adult dogs	Complete splenoctomy	0 day	13.27±0.45d	3.67±0.22d	9.63±0.30c	403.67±8.76c
		10 day	16.90±0.12b	4.77±0.13c	12.13±0.18b	576.67±14.53b
		30 day	22.03±0.32a	6.73±0.18a	17.00±0.53a	658.33±19.22a
		60 day	15.47±0.37c	5.53±0.12b	12.27±0.58b	576.67±14.53b
	Partial splenoctomy	0 day	12.60±0.32b	3.60±0.26c	9.30±0.32c	221.67±9.28c
		10 day	16.27±0.46a	5.60±0.15a	11.47±0.18a	332.33±15.84b
		30 day	15.50±0.26a	4.93±0.26ab	10.43±0.18b	429.67±15.50a
		60 day	13.33±0.24b	4.13±0.34bc	9.77±0.43bc	338.33±19.22b

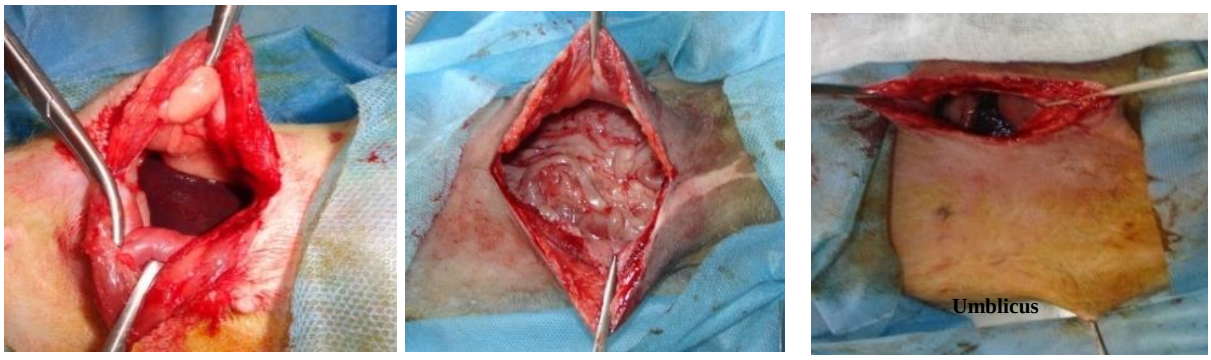

Fig.1: Abdominal incision for located spleen:

Fig.1-a: Midline abdominal incision in young dog located spleen

Fig.1-b: Midline abdominal incision in adult dog spleen was not located for its lateral position

Fig.1-c: Left sub-costal abdominal incision in adult dog located spleen

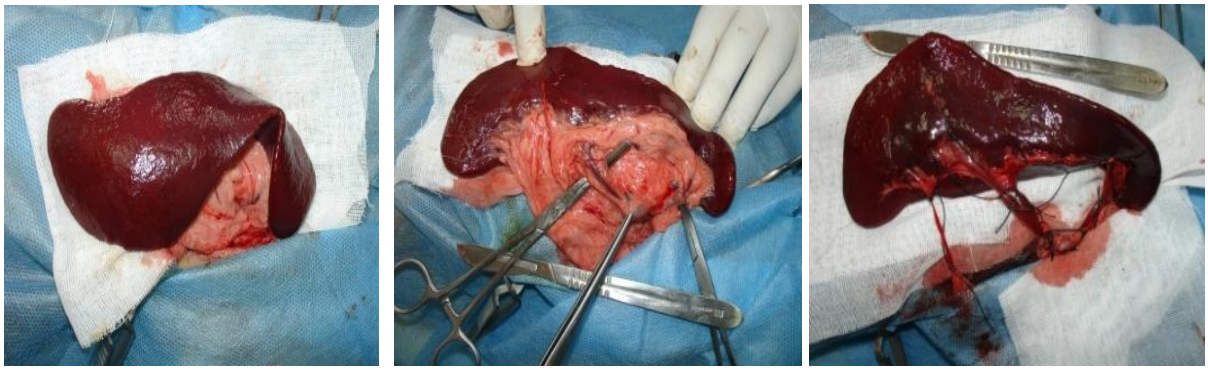

Fig.2: Isolation of the spleen extra abdominal for complete splenectomy:

Fig.2-a: The abdominal incision was covered with moisted laparatomy sponges after isolate the spleen

Fig.2-b: Identify and isolation of the splenic artery and vein and short gastric vessles

Fig.2-c: Individual ligation to vessels 1-2cm from their entrance into splenic parenchyma

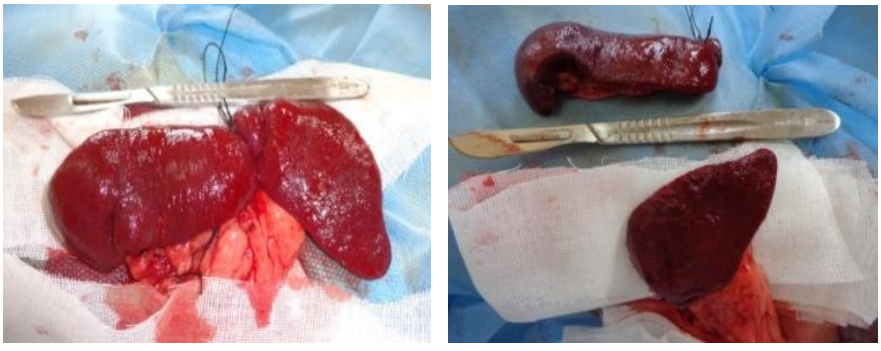

Fig.3: partial splenectomy

Fig.3-a: Double ligation to splenic parenchyma after detecting to resected part and closure to its vesseles

Fig.3-b: The spleen was incised between two ligation to ensures complete hemostasis

DISCUSSION

The effect of splenectomy either partial or complete on some biochemical parameters was studied. The reduction of serum albumin post operation (data presented in table 1) was as part of the systemic response to surgical trauma which was agreed with previous studies. There was a reduction of albumin in the postoperative peripheral blood relative to its values in the splenic vein and preoperative peripheral blood in schistosomal patients undergoing splenectomy (Petroianu *et al.,* 2004). Concerning iron balance, serum iron concentration was decreased with significant increase in serum ferritin, transferring, and ceruloplasmin in dogs under both types of splenectomy (table 2). These results were in accordance with Kolnagou *et al.* (2013) who found that total body iron storage capacity is reduced, whereas serum ferritin and iron concentration in other organs appears to be increased in thalassemia major patients following splenectomy. Serum ferritin was increased when iron level was low; this exploration was parallel to that of De Domenico *et al.* (2011) who showed that ferritin secretion results when cellular ferritin synthesis occurs in the relative absence of free cytosolic iron. A compensatory increase in the serum level of transferring and ceruloplasmin is due to increased hepatic synthesis of both proteins following decreased serum iron level.

Concerning hepatic functions, splenectomy can regenerates the hepatic functions assessed by low enzymatic activity (ALT, AST) and bilirubin level (Table 3). These results came in agreement with Elsebae and Abu-Zekri, (2008) who stated that the activities of ALT, AST, and ALP and level of albumin were significantly decreased while serum bilirubin increased following splenectomy in patients with chronic hepatitis C viral infections. The present study showed significant decrease in RBCs and Hb in completely splenectomized dogs in contrary partially dogs these results coincides with results observed by Chaudhry *et al.* (1997). Complete splenectomy cause decrease in red blood cell values, even below physiological values (Jain, 1993). MCV and MCHC significantly increase after operation, these results agreed with results obtained by Knežević *et al.* (2002). The aging of erythrocyte lead to change in its plasma membrane causing retention of fluids inside the cell, so aged RBCs have higher mean corpuscular volume values. Total splenectomy lead to increased number of circulating old red blood cells, this combined with sever reticulocytosis, led to high mean corpuscular volume values in pigs (Poljičak-Milas *et al.,* 2012). Platelets count showed significant increase in completely splenectomized small and large dogs soon after operation, these results also obtained by Karagülle *et al.* (2007). As about one third of total platelets are sequestered in spleen, also spleen is the site of platelet destruction, so after removal of splenectomy, thrombocytosis will develop. Ichikawa *et al.* (1998) indicated that, gradual increase in thrombopoietin, IL-1 and erythropoietin levels in splenectomized patients followed by increase in platelets number. It has been stated that splenectomy causes changes in the number of white blood cells with later leukocytosis The Peripheral WBC counts in animals following partial splenectomy were significantly different from those found in animals subjected to total splenectomy at the same time periods (Bessler *et al.,* 2004). There are several mechanisms participate in the excess of WBCs after splenectomy, decrease in apoptotic cell death rate following splenectomy (Djaldetti *et al.,* 2003). Additional mechanism is cell migration; small lymphocytes migrate from peripheral blood into lymphoid tissues and into the spleen and are released back to the blood (Rannie and Donald, 1977). We concluded that partial splenectomy is preferred over total splenectomy when possible because it preserves splenic function. The spleen normally contains a reservoir of red blood cells (RBCs), has hematopoietic capabilities, has important phagocytic functions, and is helpful in maintaining immunocompetence; total splenectomy eliminates these beneficial actions.

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التأثيرات الكيميائية الحيوية والدموية لاستئصال الطحال الجزئى والكلى فى الكلاب

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تهدف الدراسة الى توصيف تاثير الاستئصال الجزئى أو الكلى على بعض المعاملات الكيميائية الحيوية والدموية. تم استخدام عدد ٦ من الكلاب البالغة قسمت الى مجموعتين تعرضت الاولى الى جراحة استئصال جزئى للطحال والثانية تعرضت الى جراحة استئصال كلى للطحال. وأيضا استخدام عدد ٦ من الكلاب الغير بالغة قسمت الى مجموعتين خضعت الاولى الى جراحة استئصال جزئى للطحال والثانية خضعت الى جراحة استئصال كلى للطحال. تم تجميع عينات الدم قبل اجراء الجراحة و بعدها ب ١٠، ٣٠، و ٦٠ يوم. أظهرت النتائج انخفاض معنوى فى مستوى الزلال والحديد بعد ١٠ ايام من اجراء الجراحة بينما ازداد نسب الجلوبيولين والترانسفرين والفريتين والسريولوبلازمين خلال نفس المده. كما أدى استئصال الطحال الى خلل فى وظائف الكبد والكلى. أيضا نسبة الهيموجلوبين وعدد خلايا الدم الحمراء انخفضت معنويا بعد اجراء العملية فى الكلاب البالغه والغير بالغة نتيجة استئصال الطحال الجزئى والكلى بينما ارتفعت عدد الخلايا البيضاء والصفائح الدموية. نستخلص من الدراسة أن استئصال الطحال كلياً أو جزئياً ممكن أن يؤدى الى حدوث الانيميا والجلطات وحالات التهابية ولكن يزيد من المناعه الخلوية كطريقة تعويضية.