

**LIVER RESTORATION FOLLOWING PARTIAL HEPATECTOMY AND  
CHOLECYSTILOECTOMY IN DOG**

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**Köpeklerde Kısmi Hepatectomy ve Cholecystilobectomy'yi Takiben Karaciğerin  
Yeniden Onarımı**

**Özet:** Bu çalışma klinik bakımdan sağlıklı erkek ve dişi toplam 28 olgun köpek üzerinde yürütülmüştür. Köpekler 4 eşit gruba ayrılmıştır. Birinci ve 3. gruptaki köpeklere % 30 ve % 40'lık olmak üzere sırasıyla sol lateral lob ve yine sol lateral ile sol central loblara eksizyonla kısmi hepatectomy uygulanmıştır. İkinci ve 4. gruptaki köpeklere de sırasıyla % 30 ve 40'lık olmak üzere cholecystilobectomy yapılmıştır.

Tüm gruptardaki köpeklerin rejenerasyon yeteneği, rejenerasyon yüzdesi hesabı ile saptanmıştır. Rejenerasyon yetenekleri sırasıyla 1. 2. 3. ve 4. gruplarda % 31.1, % 36.0, % 42.76 ve % 45.40 olarak hesaplanmıştır. Cholecystilobectomy uygulanan gruptardaki rejenerasyon yüzdesi, karşıtı olan kısmi hepatectomy uygulamalarına kıyasla yüksek olmasına karşın, bu iki ayrı uygulama sonucunda elde edilen rejenerasyon yüzdeleri arasındaki farkların önemli derecede olmadığı saptanmıştır.

**Summary:** The present study was carried out on 28 clinically healthy adult dogs of both sexes. They were divided into four equal groups. Dogs of the first and third groups were subjected to 30 % and % 40 partial hepatectomy by the excision of left lateral lobe and left lateral as well as left central lobes respectively. Dogs of the second and fourth groups were subjected to 30 % and 40 % cholecystilobectomy respectively.

Regeneration capability was estimated in all groups by calculation of regeneration percentage. It was 31.10, 36.00, 42.76 and 45.40 % in the 1st, 2nd, 3rd and the 4th groups respectively. In spite of the regeneration percentage in case of cholecystilobectomy groups were higher than those of corresponding partial hepatectomy ones, there was no significant difference between the cholecystilobectomy and partial hepatectomy in regeneration percentage.

### Introduction

Hepatic resection or partial hepatectomy is indicated in many conditions such as traumatic fracture of hepatic parenchyma (14, 16), hepatic abscessation (6, 19), primary or secondary tumors of hepatic and biliary ducts (9) and in cases of liver hydatid cyst (5, 23). Hepatic lobectomy is carried out nowadays to obtain a liver graft for a non auxiliary liver transplantation (9).

Different techniques for lobectomy were described by several authors. The partial hepatectomy was described in dogs (17, 18, 22). The technique consisted of isolation of the structures in the hepatic bed with individual closure and division of bile ducts and blood vessels. Finger-fracture technique was applied for partial hepatic resection (7,8). Mass ligation at the base of resected lobe including hepatic vessels and ducts was used (11) in partial hepatectomy by using a clamp (15). Comparison between the partial hepatectomy by the aid of laser knife and diathermy cut instrument was studied (21).

In dogs and rats, when they were subjected to partial hepatectomy, the remaining liver tissues increased in bulk. This behaviour of liver tissue was not true regeneration (4,15,22).

The aim of the present experimental study is to describe the technique for cholecystilobectomy and partial hepatectomy in dogs and estimation of the liver restoration following them.

### Material and Methods

The present study was performed on 28 clinically healthy mongrel dogs of both sexes. The animals were weighing from 7 to 21 kg.

*Animals were classified into four groups (Fig., 1) :*

- I - 30 % partial hepatectomy (7 dogs).
- II - 30 % cholecystilobectomy (7 dogs).
- III - 40 % partial hepatectomy (7 dogs).
- IV - % 40 cholecystilobectomy (7 dogs).

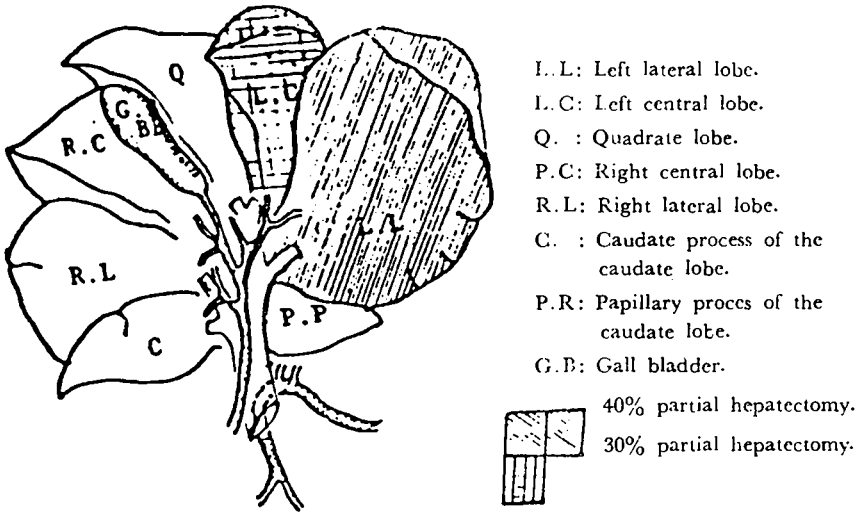


Fig. 1: Diagram for hepatic lobes, 30 % and 40 % partial hepatectomies.

Fig. 1: Karaciğer Loblarının diyagramı, % 30 ve % 40 parsiyal hepatektomi.

#### *Animal preparation and preanesthetic medication :*

Animals were starved for about 12 hours before the operation. They were sedated by I/M injection of chlorpromazine HCl (1 mg/kg bw.) Clipping and shaving of the ventral abdominal wall from the xyphoid to the pubis. The operative field was prepared for till aseptic surgery by disinfection of tincture of iodine 3 %.

Anaesthesia was induced by intravenous injection of thiopental sod 5 % (Biochemic G mb H, Vienna) until all reflex actions were abolished. Dogs were positioned in dorsal recumbency and chest raised upward to facilitate the exposure of the liver.

#### *Surgical procedures :*

**Group I: 30 % partial hepatectomy.**

An incision was made through the skin and abdominal muscles on the midline from the xyphoid process downward to the post umbilical region. The abdominal sheath together with the peritoneum were cut along the wound. The wound edges were drawn wide by applying a self-retaining wound dilator. The pylorus of stomach and the duodenum were grasped downward with a moist sterile drape (Fig. 2).



Fig. 2: Exposure of the liver; the pylorus and duodenum were grasped downward with a moist sterile drape.

Fig. 2: Karaciğerin açımı; pilorus ve duodenum ıslak steril bez ile tutuluşu.

The triangular coronary and hepatogastric ligaments were transected to free the left lateral lobe from its attachment. The intended lobe was gently lifted and grasped downward and medially. The pedicle of the lobe was exposed and encircled with a crushing ligature (silk NO. 2) using Deschamb's needle (Fig. 3). The ligation included the vascular and biliary pedicle. By the use of diathermy knife electrode, the excision of the lobe was made about 0.5 cm distal to the ligature (Fig. 4). Any blood oozing from the pedical stump could be controlled individually by a dry guaze swab. Abdominal cavity had been dried carefully from any remained blood. Abdominal wound was closed as usual. A covering suture was applied to the skin wound.

*Group II:* 30 % cholecystilobectomy.

After the same exposure to the liver as described in group I, the gall bladder was exposed by pulling the duodenum downward and over hanging of the central mass of the liver (quadrate lobe medially and right central laterally). Gentle pressure was done to evacuate the bladder contents in the duodenum. The wall of the bladder was clamped by a Houpntner clamp (Fig. 5). The gall bladder was bluntly dissected from the liver bed by closely snipping off its wall till rearing its upper part of the neck (Fig. 6). Bleeding occurred during



Fig. 3: The pedicle of the lobe was encircled with a crushing ligature using Deschamb's needle.

Fig. 3: Lob bağlantısının Deschamb iğnesi kullanarak baskı ligatürü ile çevrimi.



Fig. 4: Excision of the lobe by diathermy knife electrode 1/2 cm. distal to the ligature.

Fig. 4: Lobun ligatürün 0.5 cm distalinde diatermik elektrod ile oksizyonu.



Fig. 5: Clamping of the fundus of the gall bladder by a hauptner clamp after gentle evacuation.

Fig. 5: Hassas olarak boşaltıldıktan sonra safra kesesi fundusunun bir hauptner birleştiricisi ile sabitlemesi.

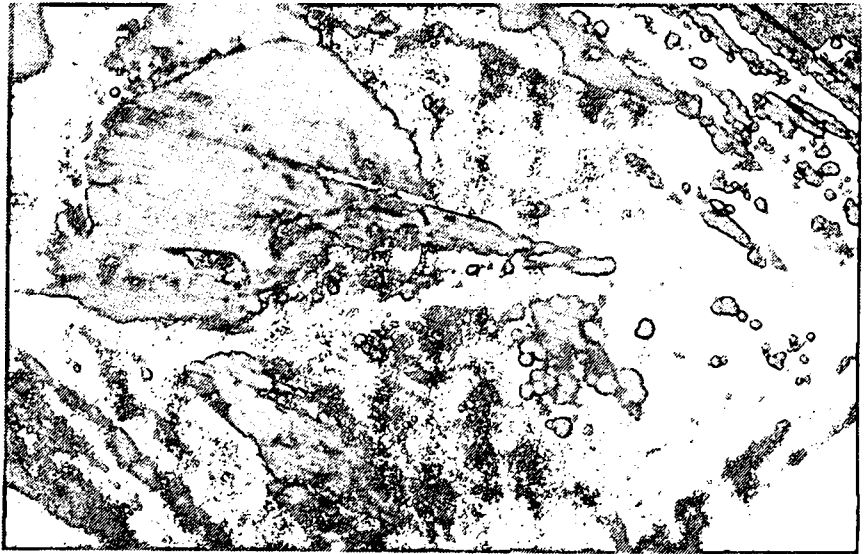


Fig. 6: The dissection of the gall bladder from the liver bed and ligation of the cystic duct.

Fig. 6: Safra kesesinin karaciğerden ayrılması ve sistik kanalın ligatürü.

the separation of the gall bladder from the liver bed could be controlled by pressure of hot moist pack or by light coagulation with diathermy round coautery electrode. The cystic duct was dissected bluntly from its surrounding tissues. The junction between the cystic and hepatic ducts was doubly ligated with Silk No. 1. Cutting in between the two ligatures and then the gall bladder was excised. The same technique of 30 % partial hepatectomy was performed as in group, I. A part of omentum was placed in-between the quadrate and right central lobes. Abdominal wall was closed as usual manner.

*Group III: 40 % partial hepatectomy.*

The left lateral lobe was excised as described in group, I. The left central lobe was easily and clearly exposed (Fig. 7). It was grasped medially to manipulate its pedicle by applying a double crushing ligature with silk No. 2 using Desham's needle. The ligature crushed the hepatic parenchyma and closed the hepatic vessels and ducts.

The left central lobe was excised about 0.5 cm distally to the embedded ligature (Fig. 8). Abdominal wall was closed in the usual manner.

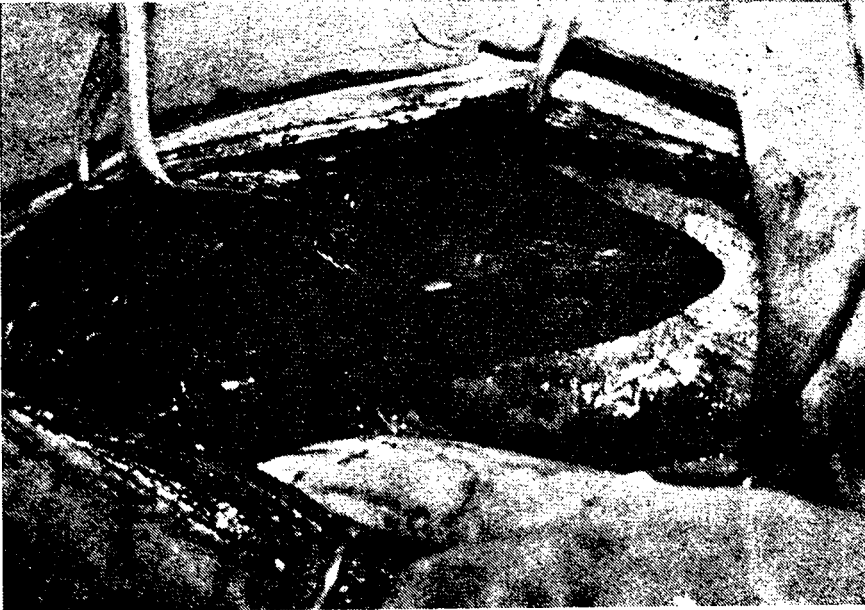


Fig. 7: Exposure of the left central lobe.

Fig. 7: Sol merkezi lobun açılması.

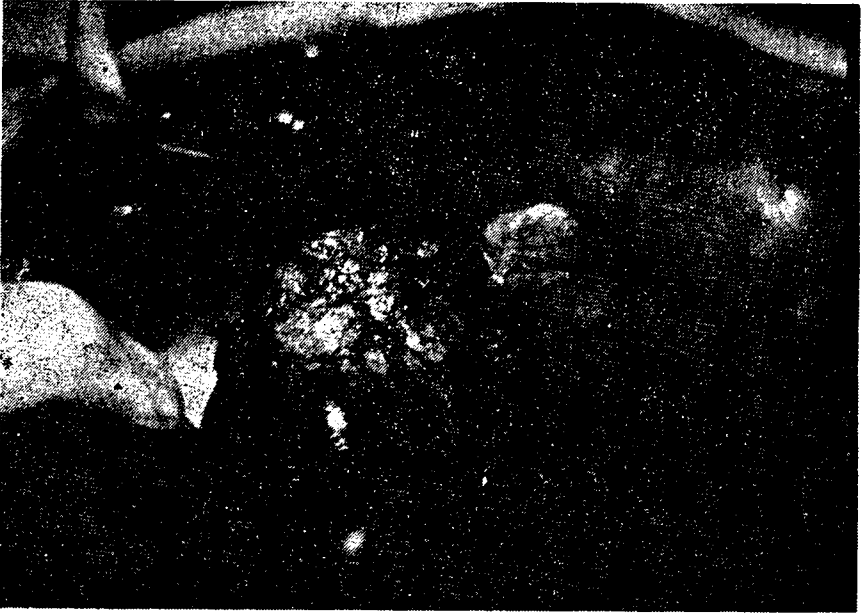


Fig. 8: The stump of the left central lobe after complete excision.

Fig. 8: Tam eksizyondan sonra merkezi lobun kalıntısı.

*Group IV*: 40 % cholecystilobectomy.

In this group the left central and left lateral lobes as well as the gall bladder were resected as described before.

*Post-operative care*:

The animals of all groups were subjected to fluid therapy which consists of replacement of extracellular fluid losses with dextrose 5 % and normal saline 500 ml of each for 2 successive days. Parenteral administration of broad spectrum antibiotic ampicillin vials with the dose 250 mg/daily for 5 successive days.

*Determination of regeneration rate*:

Total liver weight could be estimated as it forms about 3.5 % of total body weight(22). Remnant liver weights were obtained by subtraction of the resected lobes from the total liver weights. Two months post-operatively, animals were sacrificed. All liver masses were removed from attachments and adhesions. In case of partial hepatectomy only, the gall bladders were removed away leaving the



common bile duct at the same level of ligation in case of cholecystectomy. Total liver masses were weighed. Liver gain weights were calculated by subtraction of the remnant liver weights after operation from the liver weights at the time of euthanasia. Regeneration rates were calculated (4) from the formula:

$$\text{Regeneration rate} = \frac{\text{Liver gain weight}}{\text{Removed weight}} \times 100$$

## Results

### *Clinical Observations:*

Animals recovered from anaesthesia and were ambulant two hours after completion of the operation without any complications. Convalescence was unremarkable. They were off food on the second day depending upon fluid therapy only. By the third day, animals were in normal general healthy condition, ate their own offered food and water. Skin stitches were removed 10 days after operation. Only two cases showed small stitch abscesses resulting from cutting the stitch through the whole thickness of the skin by biting the animal himself. The abscesses needed only three successive days dressing. A clean healing was achieved. All animals remained alert, active without any signs of illness. Animals of all groups survived up to the terminal point of all the experiment.

### *Liver regeneration percentage:*

The animal body weight, estimated liver weight, the resected lobes weight, the remnant liver weight, the liver weight at sacrificing and the liver gain weight were shown in (Table, 1). From these data, regeneration percentage were (24.66–42.85 %), (22.79–46.63 %), (30.27–64.28 %) and (25.82–82.14 %) with the means overall of  $31.1 \pm 3.9$  %,  $36.0 \pm 3.97$  %, and  $42.76 \pm 5.90$  % in the groups, I, II, III and IV respectively. A non significant increase was observed in both cholecystilobectomized groups comparing with corresponding hepatic lobectomized ones.

## Discussion

The results of this study confirmed that the mass ligation technique was the simplest and accurate for a complete hepatic lobectomy.

Table 1. Mean values and standar error of regeneration percentage in pre and post-hepatic lobectomy and cholecystilobectomy in dogs.

Animal weight (kg).	Group, I 9.20 ± 0.86 (7-12)	Group, II 12.00 ± 1.51 (8-17)	Group, III 13.60 ± 2.00 (9-21)	Group, IV 10.40 ± 0.92 (8-13)
Est. liver weight (gm).	322.00 ± 30.10 (245-420)	420.00 ± 53.08 (280-595)	476.00 ± 73.08 (315-735)	364.00 ± 32.45 (280-455)
Resected lobe weight (gm).	96.40 ± 9.10 (73-126)	125.80 ± 15.82 (48-178)	190.40 ± 29.23 (126-294)	145.60 ± 12.98 (112-182)
Remenant liver weight (gm).	225.60 ± 21.00 (172-294)	288.80 ± 41.01 (196-417)	285.60 ± 43.84 (189-441)	218.40 ± 19.47 (168-273)
Liver weight at sacrificing (gm).	256.00 ± 24.81 (190-330)	358.00 ± 48.92 (230-500)	362.00 ± 47.47 (270-530)	280.00 ± 14.14 (240-320)
Liver gain weight weight (gm).	30.40 ± 4.69 (18-45)	45.80 9.64 ± (31-83)	76.40 ± 5.60 (59-89)	61.60 ± 8.67 (47-92)
Regeneration percentage.	31.10 ± 3.10 (24.66-42.85)	36.00 ± 3.97 (22.79-46.63)	42.76 ± 5.90 (30.27-64.28)	45.40 ± 10.15 (25.82-82.14)

Group I = 30 % partial hepatectomy.

Group II = 30 % cholecystilobectomy.

Group III = 40 % partial hepatectomy.

Group IV = 40 % cholecystilobectomy.

The use of Deschamb's needle for application of an encircling ligature at the most proximal part of the lobe pedicles made insurance of accurate complete lobectomy. Placing the ligature and tying the knot, the thread cut out through the parenchymatous tissue and tied together with hepatic vessels (10, 11). The cut parenchymal tissue prevent the ligature from slipping. The hepatic and biliary vessels were included inside the encircling ligature. In the present study the Mass ligation technique overcomes the vascular and biliary anatomical variations, whereas these lobar structures were included inside the encircling ligature.

The most common complications of hepatic lobectomy was the haemorrhage (1, 2). Neither minor nor major hepatic haemorrhage occurred in any of the dogs in the present study. Cut of parenchymal stump by means of diathermy knife electrode was more effective in achieving haemostasis.

Simply, chromic catgut ligature was placed around the root of the pedicles of the lobe to be resected (10,11). The ligature cut through the parenchyma, gathered and constricted the blood vessels and biliary ducts. Cut of the stump was done by means of surgical scalpel. This

technique had the advantage of avoiding the difficult and dangerous dissection of the tissues and hepatic blood vessels. In the present study, silk was used for pedicle ligation of the resected lobe. This nonabsorbable material had the advantages of its ability to retain strength in vivo and its low tissues reactivity.

Biliary decompression was preferred prior to the dissection as it has some advantages(3). The gall bladder becomes smaller and occupies a less surgical field and less danger exists of spillage of bile during operative dissection which results in biliary peritonitis. The author had injected sterile saline solution subserosally where the gall bladder and the liver adhere. This technique allowed serosa to be attached to the liver bed and prevented a raw liver surface. In the present study, biliary decompression was done when gentle pressure to the fundus of the bladder and emptying its content into the duodenum. Subserosal injection of saline was not performed in the present procedures to avoid the risk of injuring the hepatic parenchyma or puncture of the gall bladder neck as it has a very thin wall.

The results of regeneration percentage in the present study were 30.1 % and 42.76 % in 30 % and 40 % partial hepatic lobectomy after eight weeks and 36% and 45.4 % in case of 30 and 40 % cholecystilobectomy after the same time respectively. These results were supported by other researchers (4,12,13,17,18) who concluded that the regeneration response was influenced by the amount of liver removed at operation. The present study concluded that there was no significant differences in regeneration percentage between partial hepatectomy and corresponding cholecystilobectomy.

Complete hepatic regeneration required 8-10 weeks (20) as they resulted in 99.2% hepatic regeneration percentage after 10 weeks post 42 % partial hepatectomy. Increase and enlargement in hepatocytes which was true hepatic restoration or restitution was more evident in 70 % than 40 % partial hepatectomy (24, 25). A complete regeneration in a shorter time (6 weeks after surgery ) was gained when 95 % hepatectomy and the remnant papillary process of the caudate lobe 5 % reconstituted the original liver mass (26).

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