Dept. of Vet. Surg.,
Fac. Vet. Med., Assiut University
Head of Dept. Prof. Dr. M.T. Nassef.

LIVER RESTORATION FOLLOWING PARTIAL HEPATECTOMY AND CHOLECYSTILOBECTOMY IN DOG

(With one Table and 8 Figuers)

By

M.T. NASSEF, M.A. ALI, A.S. SALEH and M.M. ABD EL-HAFEEZ*

(Received at 15/2/1993)

تجديد الأنسجه الكبديه المصاحب للإستئصال الجزئى للكبد والحوصله المراريه فى الكلاب

محمود طنطاوى ، عادل محمد ، أحمد صالح ، محمد عبد الحفيظ

أجرى هذا البحث على عدد ٢٨ كلباً بالغاً من كلا الجنسيين. وكانت هذه الحيوانات تتراوح ما بين ٨ إلى ٢١ كيلو جرام. قسمت هذه الكلاب إلى أربع مجموعات متساويه وخصصت المجموعتان الأولى والثالثه إلى إستئصال جزئى للكبد بنسبة ٣٠ ٪ ، ٤٠ ٪ وذلك بإستئصال الفص الأيسر الخارجى فى المجموعه الأولى (٣٠ ٪) وإستئصال الفصين الأيسر الخارجى والأيسر المركزى فى المجموعه الثالثه (٤٠ ٪). وفى المجموعتين الثانيه والرابعه تم الإستئصال الجزئى للكبد كما فى المجموعتين الأولى والثالثه. بالإضافه إلى إستئصال الحويصله المراريه. ولقد تم الإستئصال بطريقة الربط المكثف حول قاعدة الفص. وتم قطع تحت منطقة الربط باستخدام المشرط الكهربى. بعد ثمانية أسابيع تم إعدام الحيوانات لقياس معدلى التجديد فى خلايا الكبد المستأصل وذلك بالمعادله التاليه:-

نسبة معدلى التجديد فى خلايا الكبد = وزن الزياده فى الكبد بعد الالتئام X ١٠٠

وزن الفص أو الفصوص المستأصلة

وقد لوحظ أنها كانت ٣١ر١ ٪ ، ٣٦ ٪ ، ٧٦ر٤٢ ٪ ، ٤٥ر٤ ٪ فى المجموعات الأولى والثانيه والثالثه والرابعه على التوالى. ولقد لوحظ أنه ليس هناك فروقاً معنويه بين المجموعتين المستأصل فيها الحوصله المراريه بالإضافه إلى فصوص الكبد بالمقارنه بالمجموعتين المستأصل فيها فصوص من الكبد فقط.

*: Animal Health Research Laboratory, Assiut.

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% & 40% partial hepatectomy by the excision of the 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 higher regenertion percentage in case of cholecystilobectomy groups than those of corresponding partial hepatectomy ones, there was no significant difference between the cholectystilobectomy and partial hepatectomy in regeneration percentage.

INTRODUCTION

Hepatic resection or partial hepatectomy is indicated in many condition such as traumatic fracture of hepatic parenchyma *(LUCAS & WALT, 1970 and KIRK & BISTNER, 1975)*, hepatic abscessation *(De-BAKEY & JORDAN, 1977 and MARTIN, 1981)*. Primary or secondary tumors of hepatic and biliary ducts *(DRAZNER, 1985)* and in cases of liver hydatid cyst *(COPPA & RANSON, 1985 and SINGH, 1987)*. Hepatic lobectomy is carried out nowadays to obtain a liver graft for a non auxilliary liver transplantation *(DRAZNER, 1985)*.

Different techniques for lobectomy were described by several authors. *SIGEL (1963) and MACKENZIE et al. (1975 & 1977)* described the partial hepatectomy in dogs. The technique consisted of isolation of the structures in the hepatic bed with individual closure and division of bile ducts and blood veseels. *De BOER et al. (1970) and DINGWALL et al. (1970)* applied finger-fracture technique for partial hepatic resection. *EL-GUINDI and MOTTELIB (1974)* used mass ligation at the base of resected lobe including the hepatic vessels and ducts. *LOPUKHIN (1976)* applied partial hepatectomy by using a clamp. *ORDA et al. (1977)* compared between the partial hepatectomy by the aid of laser knife and diathermy cutting instrument.

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 (*CHILD et al., 1963; SIGEL, 1963 and LOPUKHIN, 1976*)

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 perfomed 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).

Animal preparation and preanesthetic medication:

Animals were starved for about 12 hours before the operation. They were sedated by 1/M injection of chlorpromazine HCI with the dose of 1 mg/kg b.w. Clipping and shaving of the ventral abdominal wall from the xyphoid t ill the pubis. The operative field was prepared for aseptic surgery by disinfection with tincture of iodine 3%.

Anaesthesia was induced by intravenous injection of thiopental sod. 5% (Biochemie GmbH, Vienna) until all reflexes 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 downard to the post umbilical region. The abdominal sheath togehter with the peritoneum were cut along the wound. The wound edges were drown 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). The triangular coronary and hepatogastric ligaments were transected to free the left lateral lobe from its attachment. The intended lobe was gently lefted and grasped downward and medially. The pedicle of the lobe was exposed and encircled with a crushing ligature (silk No.2) using Deshamb'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 pedicle stump could be controlled individually by a dry 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). Gentile pressure was done to evacuate the bladder contents in the duodenum. The wall of the bladder was clamped by a Hauptner clamp (Fig. 5). The gall bladder was bluntly dissected from the liver bed by closely snipping off its wall till reach its upper part of the neck (Fig. 6). Bleeding occurs during the separation of the gall bladder from the liver bed could be controlled by pressure with a hot moist pack or by light coagulation with diathermy round cautery 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 goup I. A part of omentum was placed in-between the quadrate and right central lobes. Abdominal wall was closed as usual.

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 ligatures around its pedicle with silk No. 2 using Deshamb'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 distal to the embedded ligature (Fig. 8). Abdominal wall was closed in the usual manner.

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 in a dose rate of 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 *(SIGEL, 1963)*. 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 cholecystilobectomy. 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 sacrifice. Regeneration rates were calculated from formula stated by *CHILD et al. (1963)*.

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

RESULTS

Clinical Observations:

Animals recovered from anaesthesia and were ambulant two hours after completion of the operation without any complication. 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. These abscesses needed only three successive days dressing. A clean healing was achieved. All animals remained alert, active without any sign 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±3.1%, 36.00±3.97%, and 42.76±5.90% in groups, I, II, III and IV respectively. A non significant increase 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. The use of Deshamb's needle for application of an encircling ligature at the most proximal part of the lobe pedicles made insurance of accurate complete lobectomy. *EL-AMROUSI* et al. *(1971) and EL-GUINDI & MOTTELIB (1974)* recorded that placing the ligature and tying the knot, the thread cut out through the parenchymatous tissue and tied together with hepatic vessels. 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 complication of hepatic lobectomy was the haemorrhage *(BJORLING* et al., *1985 and BLASS & SEIM, 1985).* 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; *EL-AMROUSI* et al. *(1971) and EL-GHINDI & MOTTELIB (1974)* placed a chromic catgut ligature around the root of the pedicles of the lobe to be resected. 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.

BREZNOCK (1983) prefered biliary decompression prior to the dissection as it has some advantages. The gall bladder becomes smaller and occupies a less surgical field and less danger exists of spilage 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 row liver surface. In the present study, biliary decompression was done when gentile pressure to the fundus of the bladder and emptying its content into the dudenum. 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% & 42.76% in 30% and 40% partial hepatic lobectomy after eight weeks and 36% & 45.4% in cases of 30% and 40% cholecystilobectomy after the same time respectively. These results were supported by *CHILD et al. (1963); MACKENZIE et al. (1975 & 1977) and FRANCAVILLA et al. (1978 & 1987)* 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.

MIZUMOTO et al. (1979) stated that complete hepatic regeneration required 8-10 weeks as they resulted in 99.2% hepatic regeneration percentage after 10 weeks post 42% partial hepatectomy. *STARZEL et al. (1979 & 1980)* proved that the increase and enlargement in hepatocytes which was true hepatic restoration or restitution was more evident in 70% than 40% partial hepatectomy. A complete regeneration in a shorter time was gained by *SZAWLOWSKI et al. (1982)* when they adopted major hepatectomy (95%) and the remnant papillary process of the caudate lobe (5%) reconstituted the original liver mass 6 weeks after surgery.

REFERENCES

Bjorling, D.E.; Prasse, K.W. and Holmes, R.A. (1985): Partial hepatectomy in dogs. Compend cont Educ. Pract. Vet. 7: 257-263.

Blass, C.E. and Seim, G.H. (1985): Surgical technique for the liver and biliary tract. Vet. Clin. North Am. (small animal practic). 15: 257-275.

Breznock, E.M. (1983): Surgery of hepatic parenchymal and biliary tissues. In: Bojrab M.J.,. Current Techniques in Samll Animal Surgery 2nd Ed. Philadelphia Lea & Febiger. pp. 212-22.

Child, C.G.; Barr, D.; Holswade, G.R. and Harrison, G.S. (1963): Liver regeneration following portocaval transposition in dogs. Annals of Surgery 138: 600-608.

Coppa, G.F. and Ranson, J.H.C. (1985): Hepatic resection for metastastic colon and rectal cancer. Ann Surg. 202-203.

De Bakey, M.E. and Jordan, G.L. (1977): Hepatic abscesses, both intra and extra hepatic. Surg. Clin. North Am. 57(2) 430-433.

De Boer, J.; Downie, H.G. and Archibald, J. (1970): Intra hepatic bilio digestive anastomosis in dogs. Surgery 68: 646-652.

Dingwall, J.S.; De Boer, J. and Archibald, J. (1970): A new technique for liver resection in the dog. J. Small Animal Practice 7: 429-437.

Drazner, J. (1985): The liver and biliary tract. In Gourley, I.M. and Vassear, P.B. General Small Animal Surgery. 1st Ed Lippicott Company Philadelphia London, Mixico City, New York, Sydney.

El-Amrousi, S.; El-Guindi, M.; El-Monzaly, M. and Mottelib, A. (1971): Experimental studies on partial hepatectomy in dogs. 1- Surgical procedures and alteration in serum transaminases. U.A.R. J. Vet. Sci., 8, No. 1: 17-24.

El-Guindi, M.H. and Mottelib, A.A. (1974): The effect of partial hepatectomy on some blood constituents in dogs. Assiut Vet. Med., J. Vol. 1 No. 1&2 139-145.

Francavilla, A.; Ove, P.; Polimeno, L.; Coetzee, M.; Makowka, L.; Rose, J.; Van Thiel, D.H. and Strazel, T.E. (1987): Extraction and partial purification of hepatic stimulatory substance in rats, mice and dogs. Cancer Res. Nov. 1 47(21): 5600-5605.

Francavilla, A.; Porter, K.; Benichou, J.; Jones, A. and Starzel, T. E. (197 8): Liver regeneration in dogs: Morphological and chemical changes. Journal of Surgical Research 25, 409-419.

Kirk, R.W. and Bistner, S.I. (1975): Hand Book of Veterinary Procedures and Emergency Treatment. 2nd Ed. W.B. Saunders Company, Philadelphia, London, Toronto.

Lopukhin, Yu. M. (1976): Experimental Surgery. 1st Ed. Mir Publishers, Moscow.

Lucas, C.E. and walt, A.J. (1970): Critical decisions in liver trauma. Arch. Surg. 101: 207-212.

Mackenzie, R.J.; Francival, C.M.; Wood, C.B.; Maureen, A.; O'Keane, M. and Blumgart, L.H. (1977): The effect of prologed hepatic ischaemia before 70 percent partial hepatectomy in the dog. Br. J. Surg. Vol. 64: 66-69.

Mackenzie, R.J.; Furnival, C.M. and O'Keane, M. (1975): The effect of hepatic ischaemia on liver function and the restoration of liver mass after 70% hepatectomy in the dog. Br. J. Surgery, 62: 431-437.

Martin, E.C. (1981): Percutaneous drainage in the management of hepatic abscess. Sur. Clin. North Am. 61(1): 157-169.

Mizumoto, R.; Kawarada, Y.; Yamiawaki, T.; Noguchi, T. and Nishida, S. (1979): Resectability and Functional Reserve of the liver with obstructive jaundice in dogs. Am. J. of Surg. 137(6): 768-778.

Orda, R.; Wiznitzer, T.; Goldwasser, B.; Bubis, J.; Levene, S. and Kaye, R. (1977): Partial hepatectomies with a hand-held lasser knife: An experimental study. Br. J. Surg. Vol. 64: 857-861.

Sigel, B. (1963): Parial hepatectomy in the dog. Arch. Surg. Vol. 87, 11: 788-791.

Singh, H. (1987): Hepatectomy simplified with the use of water scalpel. Indian J. Gastroenterology, Vol. 6 No.(3) 151-152.

Starzel, T.E.; Porter, K.A.; Hayashide, N.; Schechter, P. and Terblanche, J. (1980): Further studies on hepatic stimulatory substance (SS.) after partial hepatectomy. J. of Surg. Res. 29: 471-474.

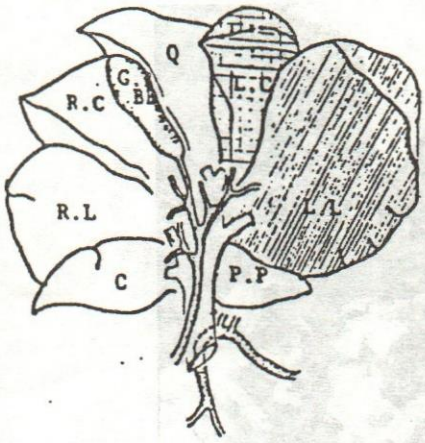
Starzel, T.E.; Terblanche, J.; Porter, K.A.; Jones, A.F.; Usui, S. and Mazzoni, G. (1979): Growth stimulating factor in the regenerating canine liver. Lancet, 1: 127-131.

Szawlowski, A.W.; Saint-Aubert, B. Qouttebel, M.C.; Astre, C. and Joyeux, H. (1982): Experimental model of extended repeated partial hepatectomy in the dog. Eur. Surg. Res. (Switzerland) 19(6): 375-380.

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

	Group, I	Group, II	Group, III	Group, IV
Animal weight (kg).	9.20±0.86 (7-12)	12.00±1.51 (8-17)	13.60±2.00 (9-21)	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.



L.L: Left lateral lobe.
L.C: Left central lobe.
Q. : Quadrate lobe.
P.C: Right central lobe.
R.L: Right lateral lobe.
C. : Caudate process of the caudate lobe.
P.P: Papillary process of the caudate lobe.
G.B: Gall bladder.

40% partial hepatectomy.
30% partial hepatectomy.

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

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

Fig.(3): The pedicle of the lobe was encircled with a crushing ligature using deschamb s needle.

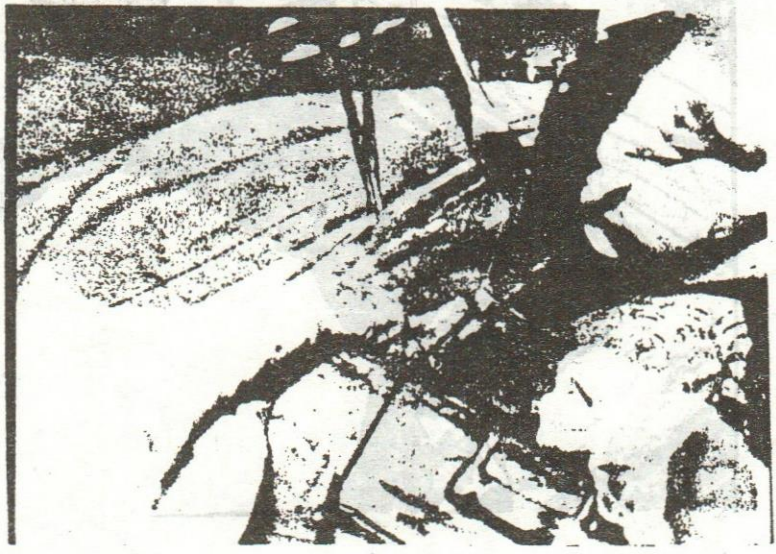


Fig.(4): Excision of the lobe by diathermy knife electrode 1/2 cm. distal to the ligature.

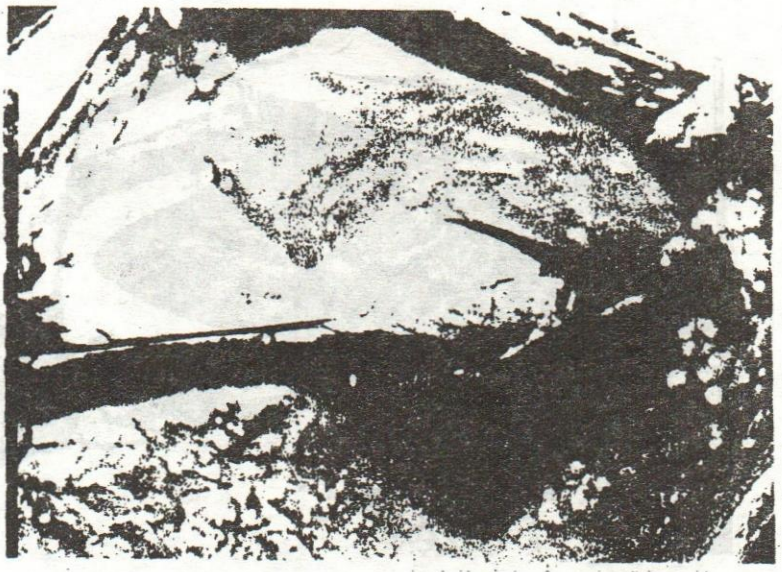


Fig.(5): Clamping of the fundus of the gall bladdar by a hauptner clamp after gentle evacuation.

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

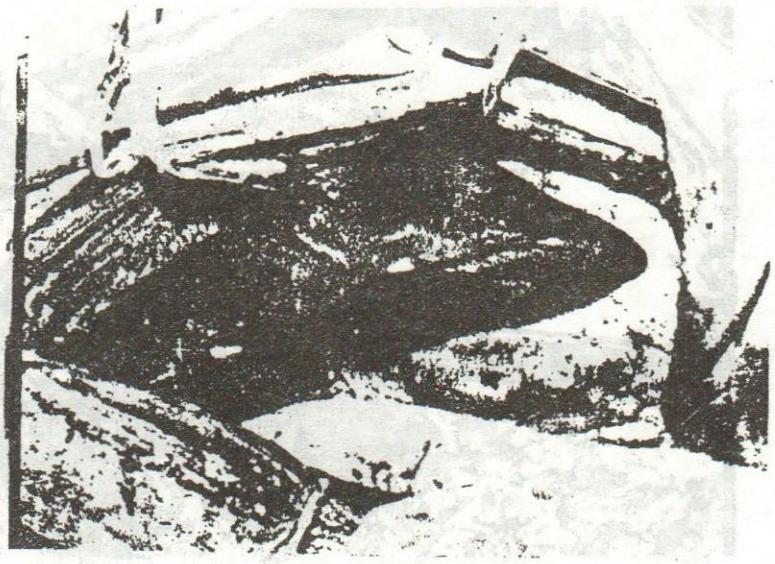


Fig.(7): Exposure of the left central lobe.

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