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Liver Resection for Primary Hepatic Neoplasms *)**)

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Schlüsselwörter: Primäre maligne Lebertumoren - gutartige Lebertumoren - Lebermetastasen - Leberresektion - Technik der Leberresektion - Ergebnisse der Leberresektion.

Summary: Subtotal hepatic resection was performed in 356 patients; 87 had primary hepatic malignancies, 108 had metastatic tumors, and 161 had benign lesions including 8 traumatic injuries. The global mortality was 4.2%. The experience has elucidated the role of subtotal hepatic resection both for benign and malignant neoplasms.

Leberresektion bei primären malignen Lebertumoren

Zusammenfassung: Bei 356 Patienten wurde eine subtotale Leberresektion durchgeführt. Indikation zur Leberresektion bildeten primäre bösartige Lebertumoren (87 Patienten), Lebermetastasen (108 Patienten), gutartige Lebererkrankungen und Leberverletzungen (161 Patienten). Die globale postoperative Letalität betrug 4,2%. Die operativen Techniken anatomischer Leberresektionen werden erläutert, und der Stellenwert der subtotalen Leberresektion sowohl für gutartige als auch bösartige Lebertumoren wird aufgezeigt.

The period from 1960 to now will be viewed someday as the golden age of surgical hepatology. During this time, remarkable and previously inaccessible information was obtained about hormonal influences on liver structure and function, the metabolic effects of portacaval shunt, mechanisms of hepatic regeneration after subtotal hepatic resection, and the most effective ways to perform these resections. In the background or foreground of all these advances can be seen the brooding presence of liver transplantation. However, it is our assignment here to review a small corner of this very large room, namely the treatment of primary hepatic tumors by partial hepatectomy. In so doing, we will also refer to our total experience with liver resections.

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Original descriptions of anatomic resections

The first right hepatic lobectomy (anterior and posterior segment) was done by *Wendel* in 1911 (1), the first left lobectomy (medial and lateral segment) was performed by *Abel* (2), and right trisegmentectomy (right lobe plus medial segment of left lobe) was described by *Lortat-Jacob* and *Robert* (3) at about the same time as this operation was mentioned by *Wangensteen* (4). Although removal of the lateral segment of the left lobe undoubtedly was performed long before, *Raven* (5) described hilar dissection preparatory to removal of the lateral segment of the left lobe as late as 1949. These achievements were all the more remarkable considering that the segmental anatomy of the liver (Fig. 1) was not well understood until years later, with the reports of *Couinaud* (6), and *Goldsmith* and *Woodburne* (7). In 1983, we described the operation of left trisegmentectomy (left lobe plus anterior segment of right lobe) (8). These 5 resections are the only anatomical ones which we perform. All others are considered local excisions, even if a huge bulk of tumor is removed.

Technical refinements

A surgeon who is not able to perform all of the 5 resections should not undertake any of the so-called easier hepatectomies. Many referrals to us are spoiled cases in which an un-

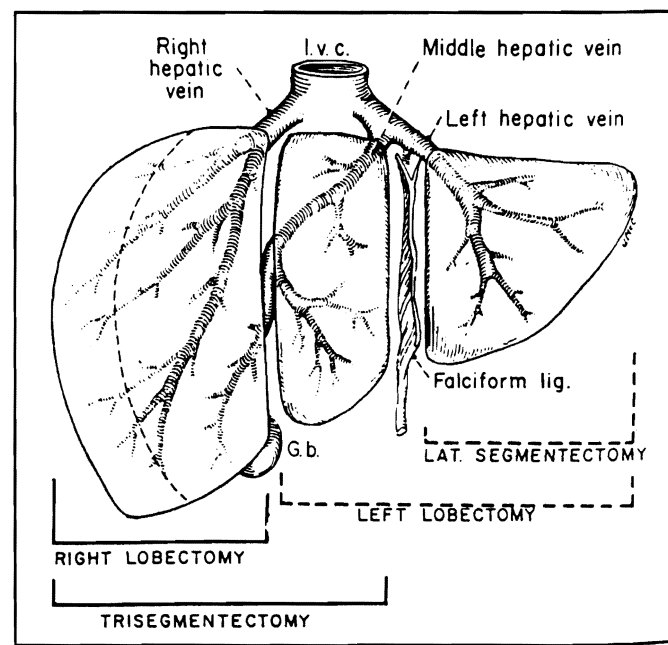


Fig. 1. The 4 most commonly used kinds of partial hepatectomy. By permission of *Surg. Gynecol. Obstet.* (9).

Fig. 2. Right trisegmentectomy at the moment of parenchymal transection. Note ligation of the middle hepatic vein. By permission of Surg. Gynecol. Obstet. (9).

prepared surgeon has had to back out after conceding his (or her) unpreparedness. The index procedures are right and left trisegmentectomy. If these operations can be performed skillfully, all other anatomic resections are easy since the preparation for each is an integral step toward accomplishment of a trisegmentectomy. All of the anatomic resections are based insofar as possible upon dissection and control of all of the major structures entering the specimen to be removed and upon early control of the veins leaving it.

Right trisegmentectomy

Deaths after all of the anatomical resections were frequent until 20 years ago. The operative mortality following right trisegmentectomy ranged from 40 to 60% until 12 years ago when this previously seldom used and purportedly difficult operation was described in detail shown (9). The features of the completed operation are demonstrated in Figure 2. Suffice it to say that accurate hilar dissection and correct identification of the intersegmental plane are cardinal technical requirements. The first steps are identical to those with simple right lobectomy. It is the management of the medial segment which gives the operation its specificity.

Left trisegmentectomy

Left trisegmentectomy is not a mirror image version of right trisegmentectomy. The first left trisegmentectomy was performed at the Colorado General Hospital, Denver, on June

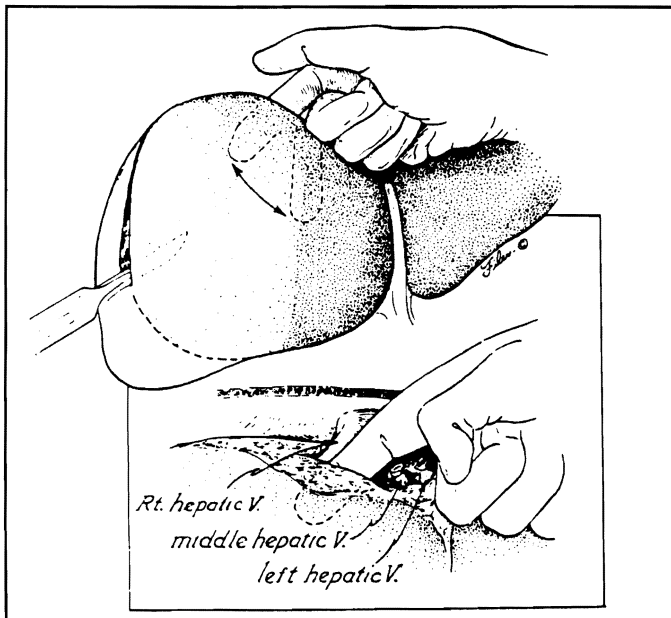
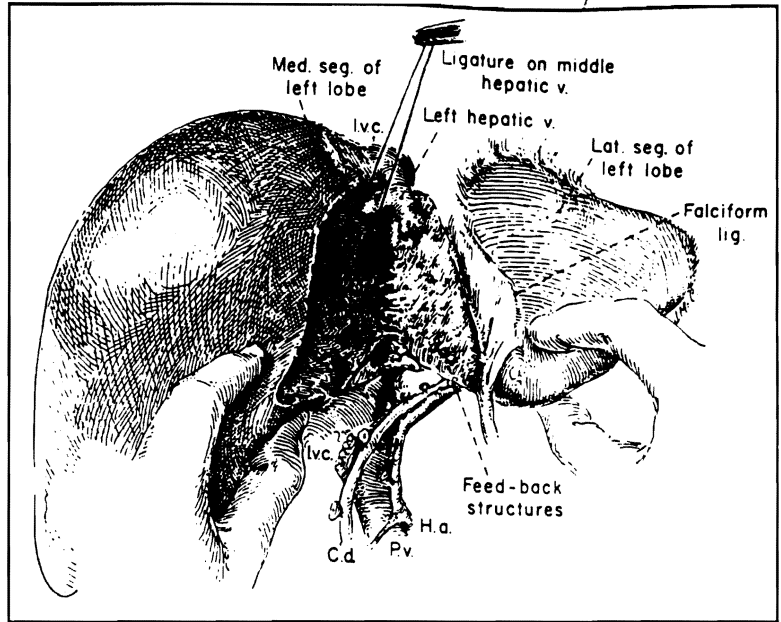


Fig. 3. The principle of left trisegmentectomy. The left portal triad structures have already been divided, causing a colored demarcation at the junction of the true right and left lobes. To perform a left trisegmentectomy, the anterior segment of the right lobe is scalped off in the coronal plane. By permission of Surg. Gynecol. Obstet. (8).

15, 1980 (8). The first steps are those of a standard left lobectomy with dissection, ligation, and division of the left portal vein, hepatic artery and hepatic duct.

The unique steps of left trisegmentectomy involve what follows namely scalping off the anterior segment of the right lobe just anterior to the right hepatic vein. The coronal plane of intersegmental transections is approximately 90 degrees from the gall bladder bed (Fig. 3).

After left trisegmentectomy is completed, the raw surface of the remaining posterior segment of the right lobe faces directly at the surgeon. The posterior segmental bile duct is usually quite exposed and numerous tributary ducts are encountered at or near the anterior segmental plane. Distortion of the main segmental duct can occur so easily that a T-tube should be placed with its upper arm negotiating the posterior curve into the liver substance.

Case material

Between 1970 and April of 1987, 356 patients underwent partial hepatic resection on the liver transplantation service at the University of Colorado, Denver, or the University of Pittsburgh (Tab. 1). 161 of the lesions removed were benign, 87 were primary malignancies and 108 were metastases (Tab. 2).

Tab. 1. Subtotal hepatic resections.

1970 - 1980 University of Colorado	----	104 patients
1981 - 1987 University of Pittsburgh (April)	----	252 patients
		TOTAL ---- 356 patients

Tab. 2. Benign/malignant distribution in 356 patients.

Histologically Benign Disease	-----	161 patients
Histologically Malignant Disease	-----	195 patients
Primary	-----	87
Metastatic	-----	108
		TOTAL ---- 356 patients

Benign tumors

The most common benign tumor by a factor of 4 was the cavernous hemangioma of which there were 88 examples (Tab. 3). All exceeded the 4 cm diameter used by *Adam*, *Huvos*, and *Fortner* (10) to designate "giant hemangiomas", and some occupied most of the liver. Almost every patient had symptoms. Pain and a sensation of pressure were the most common. Several patients had pain so severe that they had become addicted to narcotics. These hemangiomas had extensive areas of organized thrombosis, and after operation the need for pain medication disappeared.

Tab. 3. The benign diseases for which resections were performed.

Diagnosis	Number Patients
Cavernous Hemangioma -----	88
Adenoma -----	21
Congenital Cyst(s) -----	16
Focal Nodular Hyperplasia -----	15
Trauma -----	8
Hydatid Cyst(s) -----	4
Abscess -----	2
Caroli's Disease -----	2
Fibroma -----	1
Leiomyoma -----	1
Cystic Hamartoma -----	1
Regenerative Nodule -----	1
Organized Hematoma -----	1
TOTAL -----	161

The second most common benign tumors were adenomas, totaling 21 (Tab. 3). 2 of the patients had adenomas in all four hepatic segments. 1 of these patients eventually required a liver transplantation 13 months after right trisegmentectomy when robust growth of residual adenomas in the remaining lateral segment caused life threatening external compression of the portal vein and inferior vena cava in the same way as before the partial hepatectomy. 1 of the patients with a single giant adenoma had a 90% hepatic resection, 1 of the most extensive resections, if not the most, ever recorded. In this case, regeneration was not complete, the patient developed alopecia and nail growth arrest, and the course was complicated by

Tab. 4. Resections used to treat benign disease.

	RTS	LTS	RL	LL	LLS	LOCAL	TOTAL
Hemangioma	10	1	23	3	5	46	88
Adenoma	8	1	8	3	0	1	21
Cong. Cyst(s)	3	0	7	2	0	4	16
FNH	2	0	3	1	1	8	15
Others	6	0	7	2	2	4	21

RTS --- Right Trisegmentectomy LL --- Left Lobectomy
 LTS --- Left Trisegmentectomy LLS --- Left Lateral Segmentectomy
 RL --- Right Lobectomy

Tab. 5. Operative deaths after resection for benign diseases. Abbreviations as in Tab. 4.

	RTS	LTS	RL	LT	LLS	Local	Total
Number:	29	2	48	11	8	63	161
OP Death:	3	0	1	0	0	0	4
(0%):	(10%)	-	(2%)	-	-	--	2.5%

2: RTS for Trauma
 1: RTS for Liver Abscesses
 1: RL for Regenerative Node in Cirrhosis

Tab. 6. Partial hepatic resection for malignant disease.

Primary -----	87
Metastatic -----	108
Colorectal Cancer -----	76
Other Epithelial primary ---	22
Sarcomas -----	10

Tab. 7. Primary hepatic malignancies treated with partial hepatic resection.

Diagnosis	Number Patients
Hepatocellular Carcinoma (HCC) -----	47
Fibrolamellar HCC -----	13
Cholangiocarcinoma -----	6
Mixed Cholangio-Hepatocellular Carcinoma ---	4
Cyst-wall Carcinoma -----	4
Leiomyosarcoma -----	3
Rhabdomyosarcoma -----	2
Hepatoblastoma -----	2
Angiosarcoma -----	1
Malignant Paraganglioma -----	1
Malignant Endocrine Tumor -----	1
Sarcoma of Undetermined Cell Type -----	1
Malignant Tumor of Undetermined Cell Type --	1
Gall-bladder Cancer -----	1
TOTAL -----	87

Tab. 8. Mortality after resection for primary malignancy. Abbreviations as in Tab. 4.

	RTS	LTS	RL	LL	LLS	LOCAL	TOTAL
No:	42	8	13	13	2	9	87
Op Death	6	2	2	0	0	1	11
(0%):	(14%)	(25%)	(15%)	-	-	(11%)	(12.5%)

4 of 11 Patients had Cirrhosis
 4 of 11 Patients Were Older than 60 Years Old

prolonged ascites (12). However, clinical recovery was complete, and she is well 18 years later.

Other benign lesions are listed in Table 3. With the single cysts, it could not be determined in advance if these contained tumors, and in 4 instances listed in one of the later tables, malignant neoplasms were found in the cyst wall. The rest of the benign lesions included some tumors rarely seen in the liver including a fibroma and a leiomyoma (Tab. 3).

The resections used for the benign lesions are listed in Table 4. 90 of the 161 resections were of a lobe or more including 31 right or left trisegmentectomies. There were 63 "local excisions" but some of these so-called non-anatomical resections were anything but minor.

Operative mortality included all deaths in the hospital or in the first 30 days. For benign lesions, the resections had a mortality of 2.5%. The 4 deaths were after resection for trauma (2 examples), a liver abscess caused by an opportunistic microorganism, and a regenerative nodule. This last death was of a 27 years old female whose cirrhotic liver contained a giant regenerative nodule which was diagnosed mistakenly as a hepatoma. She bled to death after an ill advised right lobectomy.

Primary hepatic malignancies

The frequency of hepatic resection for primary hepatic malignancies was actually lower than hepatectomy for localized hepatic metastases. During the 17 years period, 108 patients had hepatic resection for metastatic disease, commonly from colorectal primaries (Tab. 6). During the same time, there were only 87 resections for malignant primary neoplasms (Tab. 6).

The histopathologic diagnoses in the 87 cases are summarized in Table 7. Hepatomas led the list totaling 60. 13 of the hepatomas were of the fibrolamellar variety which have been described as having a less aggressive natural history (13, 14, 15). There were 10 cholangiocarcinomas in pure form or mixed with hepatocellular components (Tab. 7). A variety of sarcomas and even more rare tumors completed the list (Tab. 7). There were 4 examples of malignancies which developed in hepatic cysts apparently in nests of hyperplasia. In 3 of these 4 cases, the tragic error had been made at earlier operations of marsupializing the cysts or of draining them into defunctionalized Roux limbs of jejunum.

Of the 87 resections, 50 were right or left trisegmentectomies, and 26 more were of the

Tab. 9. Operative mortality after resection for liver metastases. Abbreviations as in Tab. 4.

	RTS	LTS	RL	LL	LLS	Local	Total
Number:	37	4	36	13	11	7	108
Op Death:	0	0	0	0	0	0	0

Tab. 10. Total operative deaths during total experience with 356 resections. Abbreviations as in Tab. 4.

	RTS	LTS	RL	LL	LLS	Local	Total
Number:	108	14	97	37	21	79	356
Op Death:	9	2	3	0	0	1	15
(%)	(8%)	(14%)	(3%)	(0%)	(0%)	(1%)	4.2%

lateral segmentectomies and 9 local excisions (Tab. 8). The operative mortality was 12.6% (11 patients). In 4 of these cases, the liver had underlying cirrhosis, and in 4 more, the patients were more than 60 years old. Technical problems at operation or subsequent hepatic failure were the usual lethal factors in patients with cirrhosis. The mortality with the different kinds of resections is summarized in Table 8.

The operative mortality in cases of primary hepatic malignancy (Tab. 8) was greater than the 2.5% figure after resection for benign disease (Tab. 5) and the 0% mortality after resection for hepatic metastases (Tab. 9). The 108 metastatic cases included 41 trisegmentectomies and 49 lobectomies. The

Tab. 11. Notations about 15 operative deaths after 356 hepatic resections.

Case	Age/Sex	Diagnosis	Type Resection	Days Death Postop	Explanation of Death
1	51/F	Cirrhosis (thorotrast) Angiosarcoma	RTS	58	Hepatic failure; metastases
2	64/F	Mixed CHC-HCC	RTS	20	Hepatic failure, celiac axis thrombosis
3	27/F	Cirrhosis; Regenerative nodule	RL	4	Hepatic failure, hemorrhage
4	50/M	Cirrhosis; HCC	RL	0	Unrecognized perforation of central vein catheter into the mediastinum
5	59/M	Abscesses	RTS	32	Hepatic failure, stress ulcer bleeding
6	54/M	HCC	RTS	45	Hepatic failure, stress ulcer bleeding
7	63/M	Cirrhosis; hemochromatosis; HCC	RTS	7	Hepatic failure
8	77/M	Cirrhosis; HCC	Local	0	Intraoperative myocardial infarction
9	28/M	Trauma	RTS	0	Intraoperative hemorrhage
10	68/M	HCC	RTS	32	Hepatic failure
11	55/F	CHC	LTS	0	Intraoperative hemorrhage
12	73/M	HCC	RL	32	Hepatic failure
13	45/M	FL-HCC; liver transplant	RTS	17*	Hepatic failure, transplant failure
14	31/M	Trauma	RTS	0	Sudden death in ICU, pulmonary emboli
15	52/F	Neuroendocrine tumor	RTS	0	Residual lateral segment drainage blocked by tumor

*Died after transplantation

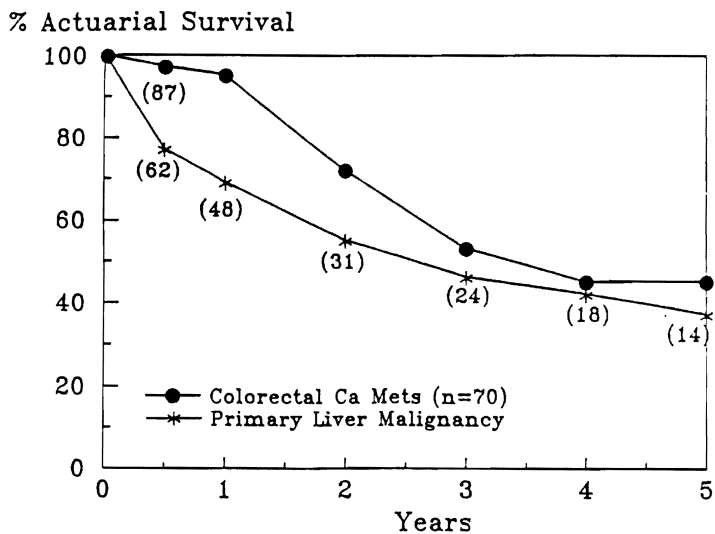


Fig. 4. Actuarial 5 years survival of 87 patients with primary hepatic malignancies. For comparison the fate of patients with colorectal metastases is shown.

global mortality in our total experience with 356 resections was 4.2% for all indications and with all resections (Tab. 10). The trisegmentectomies (right or left) had the greatest risk (8 and 14% respectively). The operative mortality for all other procedures was 0 to 3%.

A closer look at operative mortality

The 15 deaths in the 356 cases are documented separately in Table 11. 6 of the patients were cirrhotic, and for them liver failure was the principal factor in the fatal outcome from a few hours to 58 days later. 2 other patients, both young, died intraoperatively when massive traumatic injuries could not be repaired. Most of the other deaths were of older patients who either died during vain attempts at very difficult resections or subsequently from hepatic failure (Tab. 11).

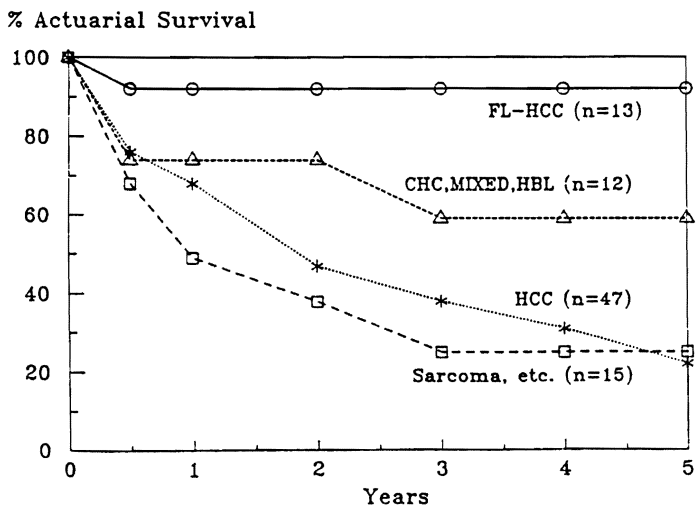


Fig. 5. The influence of histopathologic diagnosis on survival HCC = hepatocellular carcinoma; FL-HCC = fibrolamellar hepatocellular carcinoma; CHC = cholangiocarcinoma; HBL = hepatoblastoma

The long term course

Benign disease

All of the patients who survived the perioperative period are well 1 month to 17 years postoperative with a single exception. A 31 years old woman who underwent right trisegmentectomy for multiple hepatic adenomas was left with residual neoplasms in the lateral segment. 4 years later, she died of acquired immune deficiency syndrome. In a "look-back" blood bank investigation, a unit of HIV-infected blood was found to have been given to her in the postoperative period. The other patient with multiple adenoma recurrence is well 5 years after liver transplantation. The absence of chronic liver disease in the chronic survivors is noteworthy.

Primary hepatic malignancy

The life survival curves of all patients, patients with nonfibrolamellar hepatomas, patients with fibrolamellar hepatomas, and patients with malignancies other than hepatomas are summarized in Figure 4. The projected 5 years survival of 40% was not quite as good as the 45% survival after hepatic resection for colorectal metastases (Fig. 4). The 12% perioperative mortality for patients with primary tumors was the main factor in this difference; there was no operative mortality after resection of colorectal metastases. Invariably, the late deaths in both groups were due to recurrent tumor.

The histopathologic diagnosis of the primary tumor was an important determinant of the eventual outcome. Nonfibrolamellar hepatocellular carcinomas, sarcomas, and miscellaneous rare malignancies had only a 25% 5 years survival expectation (Fig. 5). The best prognosis was with fibrolamellar hepatoma. Of 13 patients whose fibrolamellar tumors could be resected, 12 are alive from 6 months to 17 years (Fig. 5). The only death was of a patient who had an emergency transplantation after the outflow of the hepatic remnant was compromised by right trisegmentectomy.

Patients with cholangiocarcinomas, mixed lesions, and hepatoblastomas had an actuarial 5 years survival between worst and best groups described above (Fig. 5).

Discussion

This unusually extensive experience with subtotal hepatic resection was a fringe effect of having a liver transplantation center. Many of the patients were referred after the conclusion was reached from initial exploration that the lesions could not be resected. The consequence was a large percent of trisegmentectomies.

As the years have passed, the total number of cases has increased to the point that this is the largest personal or institutional series in the world of resections for indications other than trauma. The only patients to face a substantial perioperative mortality were those with primary malignancies. Those in this group who did not survive operation tend to have very extensive tumors or a high incidence of underlying liver disease.

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Primary Cholangiocarcinoma of the Hepatic Hilus. How to Approach and how to Choose the Type of Surgical Management

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Key-words: Cholangiocarcinoma of hepatic hilus - resection of hepatic ducts - extended resection of hepatic ducts - results of hepatic duct resection.

Schlüsselwörter: Cholangiokarzinom des Leberhilus - Gallengangsresektion - erweiterte Gallengangsresektion - Ergebnisse der Gallengangsresektion.

Summary: 45 consecutive patients with proximal malignant biliary obstruction underwent surgery between September 1983 and May 1987. 27 patients (group A) had complete or partial resection and 18 (group B) underwent complete tumor resection with concomitant major liver resection with or without resection of the regional vascular structures of the porta hepatis. Reconstruction of the intrahepatic biliary tree in all patients was carried out by mucosa-to-mucosa intrahepatic cholangiojejunostomies between segmental hepatic ducts and a Roux-Y jejunal loop with only temporary use of anastomotic tubes. 5 patients died, 2 group-A patients (2/27) and 3 of the 18 group-B patients. Resection was radical in 2 patients of group A and in 6 of group B. At the time of writing (May 1987) 29 patients were alive, 16 from group A (16/27) and 13 from group B (13/18). Survivors have a satisfactory quality of postoperative life.

Based on the results, simple resection of tumor is considered as the method of choice for the management of proximal malignant biliary obstruction in the majority of patients. Combined tumor and liver resection with or without regional vascular resection is reserved for a group of patients in whom after careful perioperative assessment of the clinical and operative characteristics, the increased risk of such procedures should be contemplated in favor of a prospective longer long-term survival.

Primäres Cholangiokarzinom des Leberhilus. Die Auswahl chirurgischer Optionen

Zusammenfassung: 45 Patienten mit einem Cholangiokarzinom der Hepatikusgabel wurden operiert. Bei 27 Patienten (Gruppe A) wurde der Tumor komplett oder partiell ohne zusätzliche operative Maßnahmen reseziert, während bei 18 Patienten (Gruppe B) eine Eingriffserweiterung vorgenommen wurde: 11mal Leberresektion, 6mal Leberresektion plus Resektion und Rekonstruktion von regionalen Gefäßen, 1mal Resektion und Rekonstruktion von regionalen Gefäßen ohne Leberresektion. Die Wiederherstellung der Gallendrainage erfolgte durch intrahepatische Cholangio-Jejunostomien. 5 Patienten verstarben postoperativ. Die überlebenden Patienten verloren ihren Ikterus und konnten ein zufriedenstellendes Leben ohne Restcholangitis führen. Im Mai 1987 waren 29 Patienten noch am Leben. Die vorliegende Erfahrung zeigt, daß die einfache Resektion des Gallengangskarzinoms mit einer niedrigen Mortalität und einer hohen langfristigen