

**TUMORS AT THE BILIARY CONFLUENCE — HOW TO CHOOSE
BETWEEN EXTERNAL DRAINAGE, ENDOPROSTHESES, STENTS,
AND RADIATION**

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TUMORS AT THE BILIARY CONFLUENCE — HOW TO CHOOSE BETWEEN EXTERNAL DRAINAGE, ENDOPROSTHESES, STENTS, AND RADIATION

OBJECTIVES:

1. To review the surgical, endoscopic, and percutaneous (interventional) management of bifurcation lesions from the perspective of a multidisciplinary “team” approach.
2. To review the etiology of the more common benign and malignant conditions found at the biliary bifurcation.
3. To review the current interventional techniques used to treat patients with lesions at the biliary bifurcation.

I. INTRODUCTION

Optimal management of patients with lesions at the biliary bifurcation requires a multidisciplinary approach frequently involving the Primary Care Physician, Surgeon, Gastroenterologist, and Interventional Radiologist. The Radiologist is frequently involved at multiple levels in the workup of patients with lesions at the biliary bifurcation. These include:

- 1) Confirmation of surgically suspected obstructive jaundice using cross-sectional imaging¹ (i.e., Ultrasound [US]²⁻⁴, computed tomography [CT]⁵, magnetic resonance imaging [MRI]⁵).
- 2) Precisely defining biliary anatomy to determine the severity and level of obstruction using percutaneous techniques (i.e., percutaneous transhepatic cholangiography [PTHC or PTC]).
- 3) Drainage of obstructed bile ducts (i.e., percutaneous transhepatic biliary drainage [PTHB or PTB]⁶).

- 4) Obtaining tissue and/or bile to confirm a suspected diagnosis (i.e., percutaneous biopsy⁷⁻¹⁴ and/or bile sampling for cytopathology¹⁵).
- 5) Providing unilateral or bilateral biliary access:
 - a) for eventual surgical resection of the bifurcation lesion(s) followed by biliary reconstruction through creation of Roux-en-Y hepaticojejunostomies²⁰.
 - b) as access for palliation using percutaneous interventional techniques (e.g. biliary endoprosthesis^{6,16,17,21-31}).
 - c) a means of percutaneous biliary access for brachytherapy^{32,33} (e.g. Iridium 192 seeded wires placed through the indwelling biliary drainage catheters for delivery of local radiation in the setting of malignant disease at the bifurcation).
 - d) as a means of biliary access for adjunctive biliary procedures (e.g. transhepatic biliary endoscopy³⁴, balloon dilation of the benign biliary strictures³⁵⁻⁴², long-term internal/external biliary stenting in the setting of benign or malignant disease at the bifurcation^{6,16}, etc.).
- 6) In specific clinical situations, assisting the Gastroenterologist in endoscopic biliary interventions (e.g. the "rendezvous procedure"). This technique involves the Interventional Radiologist percutaneously advancing a guidewire through an obstructing biliary lesion and into the duodenum from a transhepatic approach. The

Gastroenterologist then grasps the wire tip during endoscopy. This provides "through and through" access for placement of an endoprosthesis, for dilation of a high-grade stricture at the bifurcation, etc.

- 7) Confirming a biliary leak using radionuclide hepatobiliary scintigraphy⁴³.

Thus, the Radiologist plays an essential role in the diagnostic workup and management of patients with lesions at the biliary confluence.

II. ETIOLOGY OF TUMORS AT THE BILIARY CONFLUENCE

Tumors at the biliary confluence may cause obstruction due to intrinsic occlusion or extrinsic compression. Dilated intrahepatic ducts (diffuse or segmental) are seen on cross-sectional imaging studies. Depending on the degree of obstruction, clinically evident jaundice may or may not be present.

Benign "tumors" of the biliary confluence include: 1) Extrinsic compression of the confluence by enlarged lymph nodes, cysts, and inflammatory lesions. 2) Intrinsic obstruction due to stones, and infrequently tumors arising from the bile duct epithelium or wall (e.g. papillomas, adenomas, granular cell myoblastomas, hamartomas, etc.). Most benign bile duct tumors are found in the periampullary region or the common bile duct and are quite uncommon in the intrahepatic ducts¹. Occasionally benign lesions such as a patient with an atypical "central" obstruction due to sclerosing cholangitis may appear to have a tumor at the biliary confluence.

Malignant tumors of the biliary confluence also include: 1) Extrinsic compression of the biliary duct bifurcation by metastatic disease (e.g. to lymph nodes at the bifurcation), 2) Local extension of tumors from adjacent structures (e.g. primary hepatic, pancreatic, gall bladder, duodenal, or gastric malignancies), 3) Malignant tumors arising from the bile duct epithelium or wall

(e.g. cystadenocarcinomas, cholangiocarcinoma, villous tumors, embryonal rhabdomyosarcoma [sarcoma botryoides], extension of ampullary carcinoma or carcinoid, etc.)^{1,16}.

Cholangiocarcinoma is a slow growing uncommon tumor with a peak incidence in the sixth and seventh decades. The tumor is two to three times more common in males than in females. Most cholangiocarcinomas are adenocarcinomas with a minority being of other histologic types such as squamous cell and anaplastic.¹ Cholangiocarcinoma infrequently spreads by lymphatic or blood borne means; occurring in only 12% of patients at the time of clinical presentation.³³ Rather cholangiocarcinoma invades hepatic parenchyma and locally invades hepatic arteries and portal veins, making surgical resection difficult.³²

- The growth patterns of cholangiocarcinoma include (1) infiltrating-scirrhou, (2) nodular, and (3) papillary.¹ The infiltrating-scirrhou pattern is most common ¹⁻³ Characteristically, this growth pattern presents as a focal stricture, often without a mass⁴ and the scirrhou reaction explains the difficulty in obtaining positive preoperative biopsies. When extensive, it may mimic sclerosing cholangitis.¹

In about five percent of patients, a papillary form of growth of adenocarcinoma may occur.⁴ This form results in expansion of the bile ducts and one finds intraluminal masses.⁴ Benign conditions which predispose patients to developing cholangiocarcinoma include: inflammatory bowel disease, gallstones, hepatolithiasis, choledochal cysts, sclerosing cholangitis, and Clonorchis infection.^{1,2,44-47}

III. SURGICAL, ENDOSCOPIC, AND PERCUTANEOUS (INTERVENTIONAL) MANAGEMENT OF PATIENTS WITH TUMORS AT THE BILIARY CONFLUENCE: A TEAM APPROACH

The goal of therapy for patients with benign or malignant tumors of the biliary confluence is elimination of tumor whenever possible and/or relief of symptoms (e.g. drainage of biliary infection, relief of symptomatic jaundice, etc.). This is accomplished by surgical resection of the lesion in an attempt to "cure", surgical "debulking" followed by adjunctive therapy (such as brachytherapy, chemotherapy, etc.), or palliation through endoscopic or percutaneous (interventional) techniques (e.g. placement of endoprotheses).

- For benign conditions, persistent obstructive symptoms such as recurrent bouts of cholangitis associated with benign lesions at the biliary confluence and/or stones may ultimately require surgical resection of the biliary confluence followed by creation of biliary-enteric anastomoses (Roux-en-Y hepaticojejunostomies). Prior to surgery, the Gastroenterologist and/or Interventional Radiologist actively participate in patient management. After confirmation of the degree and level of biliary obstruction based on cross-sectional imaging studies, the Gastroenterologist is frequently asked to perform endoscopic retrograde cholangiopancreatography (ERCP). This defines anatomy and frequently results in some form of therapy (e.g. brush biopsy of suspicious lesions at the confluence, balloon dilation of strictures, sphincterotomy to facilitate biliary drainage, etc.) However, obstructing tumors at the confluence are not well visualized by ERCP if contrast cannot be injected

beyond the level of obstruction. Such is the case when tumors cause strictures involving central right anterior and posterior ducts, and the main left bile duct. In such instances, a percutaneous transhepatic cholangiogram (PTC), sometimes performed bilaterally, will precisely define biliary anatomy.

In general, ERCP should be used in patients with tumors of the biliary confluence when:

- 1) Intrahepatic bile ducts are nondilated.
- 2) The patient has an absolute contraindication to PTC/PBD (i.e. a coagulopathy that cannot be corrected).
- 3) The patient has a relative contraindication to PTC/PBD (i.e. ascites, etc.).

- PTC (often followed by PBD) should be performed:

- 1) When ERCP fails.
- 2) When the patient has had a prior biliary-enteric anastomosis. Such surgical biliary reconstructions frequently prevent successful cannulation of the ampulla by ERCP.
- 3) If surgical resection of the tumor at the biliary confluence is planned. PBD (often bilateral) is performed to relieve obstructive symptoms (e.g. to drain infected bile). In some centers, the presence of a percutaneously placed biliary drainage catheter(s) facilitates intraoperative biliary reconstruction and aids in the surgical creation of biliary enteric anastomoses.¹⁶⁻²⁰
- 4) In those patients who are not surgical candidates and who have known malignant tumors at the biliary confluence, bilateral PTC/PBD will allow palliative endoprosthesis placement^{16,17,21-31}. The endoscopist may not be able

to successfully relieve obstruction from malignant tumors at the biliary confluence. An endoprosthesis placed during endoscopy is frequently deployed into either the right or the left biliary duct. This may result in inadequate biliary drainage.

To summarize, the team approach is essential in managing patients with tumors at the biliary confluence. Depending on planned therapy, the therapeutic options generally consist of either attempts at surgical resection or nonsurgical procedures (endoscopic or interventional) aimed at palliation. A review of interventional techniques and the choice of which technique to employ will be discussed next.

IV. EXTERNAL DRAINAGE, BILIARY ENDOPROSTHESES, STENTS, OR RADIATION? HOW TO CHOOSE.

Previous reported studies on PBD have reported prevalences of 4.6-25% for major complications and 0-5.6% for procedure related deaths⁴⁸⁻⁵³. Yee and Ho reviewed the medical literature and combined the results of six groups of investigators. In the combined group of 702 patients, the overall percentage of major complications was 8% and the percentage of deaths 2%. Six hundred nine of the 702 patients (87%) had malignant biliary obstruction⁵⁴. The authors indicate that the patient's general physical condition is a major determinant of the likelihood of complications. In Yee and Ho's own series of 206 patients undergoing PBD, 54 had benign and 152 had malignant biliary disease. In the malignant group, 85 patients (56%) had one or more complications; ten of these (7%) had major complications. Five patients (3%) suffered cholangitis with hypotension, and three of these died as a result. Two patients (1%) had major bile peritonitis; one died as a result, and the other required laparotomy for evacuation of bile. Two patients (1%) had

dyspnea due to bilious pleural effusions which developed after inadvertent dislodgement of the biliary drainage catheters. Both required chest tubes. One patient (1%) had a major intraperitoneal hemorrhage due to liver laceration. This patient required surgical repair and a blood transfusion.

Of the 54 patients with benign biliary lesions, complications of PBD occurred in nine patients (17%) vs 56% in the malignant group. Of the benign group with complications, one (2%) was major vs 7% in the malignant group. The single patient with a major complication developed bile peritonitis after premature removal of his biliary drainage catheter. This patient had a benign biliary stricture from pancreatitis. No procedure related deaths occurred in the benign group. In the above retrospective study, it is apparent that patients with malignant disease are at higher risk for major complications compared to patients with benign disease. Unfortunately the data is not stratified to the percentage of patients with lesions at the biliary confluence. Similar findings regarding the patient's general state of health have been described in the surgical literature⁵⁵. Despite this, percutaneous techniques should be used after careful consideration of treatment options (e.g. surgical, endoscopic, percutaneous). Metallic stents should be avoided in patients with benign biliary disease at the bifurcation. Such stents will become incorporated into the bile duct wall. Should surgery be eventually required, a greater length of duct may need to be resected. Patency of metallic stents is limited to approximately 6-12 months.

For patients with malignant lesions at the biliary bifurcation, the type of tumor frequently dictates management. Bilateral access is generally required to relieve obstruction and to effectively drain infected bile. Unresectable cholangiocarcinoma, often slow growing, is managed at the author's institution by palliating the patient using internal/external biliary drainage catheters. This is preferred because patients often outlive the patency of plastic endoprosthesis or metallic stents.

An added benefit of the use of internal/external biliary drainage catheters is that of using the transhepatic biliary access to deliver high doses of radiation i.e. brachytherapy. Through the indwelling biliary drainage catheters, intracavitary radiation may be delivered (e.g. use of Iridium 192 seeded wires). Encouraging results in a limited number of patients have been reported by Nunnerly et al using this method³².

Patients with limited life expectancy and bilateral percutaneous access may experience improved quality of life through the use of biliary endoprotheses. In general, bifurcation lesions are difficult to treat using either plastic or metallic stents (endoprotheses). Though more expensive, metallic stents, e.g. Wallstents (Schneider USA Inc., Minneapolis, MN), Z stents (Cook Inc., Bloomington, IN), Palmaz stents (Johnson and Johnson Interventional Systems Co., Warren, NJ) are frequently used. At the author's institution, Wallstents are often preferred because of the smaller percutaneous deployment system (i.e. 7 French), the ability to perform transhepatic drainage and stent placements in "one step", and the avoidance of painful transhepatic tract dilation (e.g. 10-14 French) as would be required when using other metallic stents or plastic endoprotheses.

ERCP for patients with benign or malignant lesions at the bifurcation may prove inadequate. Intrahepatic bile duct anatomy may be inadequately seen and plastic or metallic stents are often difficult to deploy by ERCP. It is the opinion of the author that endoprosthesis placed during ERCP should be reserved primarily for distal common bile duct(CBD) lesions.

V. CONCLUSION:

Choosing the appropriate biliary drainage method should thus be based on 1) the patient's overall health status, 2) the etiology of the lesion at the confluence, 3) the expected length of time that biliary endoprotheses or external/internal drainage catheters will be required, 4) whether the

patient is to have surgery or palliative treatment, 5) the ability of the patient to care for himself/herself. In general, ERCP should be reserved for defining anatomy, especially in patients with nondilated ducts. External drainage alone is generally to be avoided because of the significant loss of fluids and electrolytes. Internal/external drainage is preferred for "long term" biliary access. "Long term" may generally be considered greater than 6 months. Stents are changed every 2 to 3 months on an outpatient basis.

A "common sense" team approach to the management of patients with lesions at the biliary confluence has been provided. An understanding of the etiology of the lesion, the natural history, the general condition of the patient's health, and an awareness of the surgical or nonsurgical options will hopefully simplify therapy, avoid costly duplication by medical services within the hospital, and optimize patient management.

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REFERENCES

1. Dachman AH. "Primary Biliary Neoplasia in Radiology of The Liver, Biliary Tract and Pancreas, A.C. Friedman and A.H. Dachman (eds.), Mosby-Year Book, Inc., St. Louis, 1994; 611-632.
2. Meyer DG, Weinstein BJ. Klatskin Tumors of the Bile Ducts: Sonographic Appearance. *Radiology* 1983; 148:803-804.
3. Subramanyam BR, Raghavendra BN, Balthazar EJ, et al. Ultrasonic Features of Cholangiocarcinoma. *J Ultrasound Med* 1984; 3:405-408.
4. Schnur MJ, Hoffman JC, Koenigsberg M. Ultrasonic Demonstration of Intraductal Biliary Neoplasms. *J Clin Ultrasound* 1982; 10:246-248.
5. Brink JA. Biliary Tract Imaging: Computed Tomography and Magnetic Resonance Imaging. *Biliary Radiology* 1992; 1:16-32.
6. Osterman FA Jr., Venbrux AC. "Obstructive Jaundice: Percutaneous Transhepatic Interventions" in Current Surgical Therapy, Cameron J.L. (ed), Mosby-Year Book, Inc. 1995; 394-399.
7. Teplick SK, Haskin PH, Kline TS, Sammon JK, Laffey PA. Percutaneous Pancreaticobiliary Biopsies in 173 Patients Using Primarily Ultrasound or Fluoroscopic Guidance. *Cardiovasc Intervent Radiol* 1988; 11:26-28.
8. Cohan RH, Illescas FF, Braun SD, Newman GE, Dunnick NR. Fine Needle Aspiration Biopsy in Malignant Obstructive Jaundice. *Gastrointest Radiol* 1986; 11:145-150.

9. Mendez G Jr, Russel E, Levi JU, Koolpe H, Cohen M. Percutaneous Brush Biopsy and Internal Drainage of Biliary Tree Through Endoprosthesis. *AJR* 1980; 134:653-659.
10. Terasaki K, Wittich GR, Lycke G, Walker R, Nowels K, Swanson D, Lucas D. Percutaneous Transluminal Biopsy of Biliary Strictures with a Bioprobe. *AJR* 1991; 156:77-78.
11. Elyaderani MK, Gabrielle OF. Brush and Forceps Biopsy of Biliary Ducts Via Percutaneous Transhepatic Catheterization. *Radiology* 1980; 135:777-778.
12. Schechter MS, Doemeny JM, Johnson JO. Biliary Ductal Shave Biopsy with Use of the Simpson Atherectomy Catheter. *JVIR* 1993; 4:819-824.
13. Kim D, Porter DH, Siegel JB, Mowschenson PM, Steer ML. Common Bile Duct Biopsy with the Simpson Atherectomy Catheter. *JVIR* 1993; 4:819-824.
14. Yip CKY, Leung JWC, Chan MKM, Metrewell C. Scrape Biopsy of Malignant Biliary Stricture Through Percutaneous Transhepatic Biliary Drainage Tracts. *AJR* 1989; 152:529-530.
15. Muro A, Mueller JPR, Ferrucci JT, Taft PD. Bile Cytology: A Routine Addition to Percutaneous Biliary Drainage. *Radiology* 1983; 149:846-847.
16. Venbrux AC, Osterman FA, Jr. "Malignant Obstruction of the Hepatobiliary System" in Abrams' Angiography, 4th edition. Vol III, Interventional Radiology, S. Baum and M.J. Pentecost, (eds), Little, Brown and Co., Boston, 1996, in press.
17. Savader SJ, Venbrux AC, Osterman FA. "Interventional Radiology in Cancer Diagnosis and Management" in Niederhuber JE, ed. Current Therapy in Oncology, Philadelphia: Mosby-Year Book, 1993:98-120.

18. Cameron JL. "Proximal Cholangiocarcinoma: Palliation by Transhepatic Stenting and Hepaticojejunostomy" in Cameron JL, Atlas of Surgery, Vol I, Philadelphia: BC Decker, Inc., 1990:84-93.
19. Cameron JL. "Resection of a Proximal Cholangiocarcinoma with Hepatic Lobectomy and Reconstruction Utilizing a Silastic Transhepatic Biliary Stent and Hepaticojejunostomy" in Cameron JL, Atlas of Surgery, Vol I, Philadelphia: BC Decker, Inc, 72-83.
20. Cameron JL. "Resection of a Proximal Cholangiocarcinoma with Reconstruction Utilizing Silastic Transhepatic Biliary Stents and Bilateral Hepaticojejunostomies" in Cameron JL, Atlas of Surgery, Vol I, Philadelphia: BC Decker, Inc., 1990:58-71.
21. McLean GK, Burke DR. Role of Endoprosthesis in the Management of Malignant Biliary Obstruction. *Radiology* 1989; 170:961.
22. Lammer J. Biliary Endoprosthesis - Plastic Versus Metal Stents. *Radiologic Clinics of North American* 1990; 28:1211-1221.
23. Lammer J, Neumayer K. Biliary Drainage Endoprosthesis: Experience with 201 Placements. *Radiology* 1986; 159:625.
24. Coons HG, Carey PH. Large-bore, Long Biliary Endoprosthesis (Biliary Stents) for Improved Drainage. 1983; 148:89.
25. Burcharth F. A New Endoprosthesis for Non-Operative Intubation of the Biliary Tract in Malignant Obstructive Jaundice. *Surg Gynecol Obstet* 1978; 146:76.
26. Dooley JS, Dick R, George P, et al. Percutaneous Transhepatic Endoprosthesis for Bile Duct Obstruction: Complications and Results. *Gastroenterology* 1984; 86:905.

27. Mueller PR, Ferrucci JT, Jr., Teplick SK, et al. Biliary Stent Endoprosthesis: Analysis of Complications in 113 Patients. *Radiology* 1985; 156:637.
28. Ring EJ, Schwarz W, McLean GK, et al. A Simple Indwelling Biliary Endoprosthesis Made From Commonly Available Catheter Material. *AJR* 1982; 139:615.
29. Gordon RL, Ring EJ, LaBerge JM, Doherty MM. Malignant Biliary Obstruction: Treatment with Expandable Metallic Stents - Follow-up of 50 Consecutive Patients. *Radiology* 1992, 182; 697-701.
30. Salomonowitz EK, Adam A, Antonucci F, Stuckmann G, Zollikofer CL. Malignant Biliary Obstruction: Treatment with Self-Expandable Stainless Steel Endoprosthesis. *Cardiovascular and Interventional Radiology* 1992; 15:351-355.
31. Becker CD, Glattli A, Maibach R, Baer HU. Percutaneous Palliation of Malignant Obstructive Jaundice with the Wallstent Endoprostheses: Follow-up and Reintervention in Patients with Hilar and Non-Hilar Obstruction. *JVIR* 1993; 4:597-604.
32. Nunnerley HB, Karani JB. Intraductal Radiation in Interventional Radiology of the Biliary Tract. *Radiol Clin North Am* (Burhenne HJ, Guest editor) 1990; 28:1237-1240.
33. Wheeler PG, Dawson JL, Nunnerley HB, et al. Newer Techniques in the Diagnosis and Treatment of Proximal Bile Duct Carcinoma: An Analysis of 41 Consecutive Patients. *Q J Med* 1981; 50:247-259.
34. Venbrux AC, Robbins KV, Savader SJ, Mitchell SE, Widlus DM, Osterman FA. Endoscopy as an Adjuvant to Biliary Radiologic Intervention. *Radiology* 1991; 180:355-361.
35. Morrison MC, Lee MJ, Saini S, Brink JA, Mueller PR. Percutaneous Balloon Dilatation of Benign Biliary Strictures. *Radiologic Clinics of North America* 1990; 28:1191-1201.

36. Jeng KS, Yang FS, Ohta I, Chiang HJ. Dilatation of Intrahepatic Biliary Strictures in Patients with Hepatolithiasis. *World J. Surg* 1990; 14:587-593.
37. Lammer J, Deu E. "Percutaneous Management of Benign Biliary Strictures" in Current Practice of Interventional Radiology, Kadir S. (ed.) Philadelphia, Decker Inc., 1991; 550-553.
38. Moore AV, Illescas FF, Mills SR, et al. Percutaneous Dilatation of Benign Biliary Strictures. *Radiology* 1987; 163:625-628.
39. Martin EC, Karlson KB, Fankuchern EI, et al. Percutaneous Transhepatic Dilation of Intrahepatic Biliary Strictures. *AJR* 1980; 135:837-840.
40. Martin EC, Fankuchern EI, Laffey KJ, et al. Percutaneous Management of Benign Biliary Disease. *Gastrointest Radiol* 1984; 9:207-212.
41. Trambert JJ, Bron KM, Zajiko AB, et al. Percutaneous Transhepatic Balloon Dilatation of Benign Biliary Strictures. *AJR* 1987; 149:945-948.
42. Salmonowitz E, Castaneda-Zuniga WR, Lund G, et al. Balloon Dilatation of Benign Biliary Strictures. *Radiology* 1984; 151:613-616.
43. Gelman R, Alexander MS, Zucker KA, Bailey RW. The Use of Radionuclide Imaging in the Evaluation of Suspected Biliary Damage During Laproscopic Cholecystectomy. *Gastrointest Radiol* 1991; 16:201-204.
44. Radin DR, Ray MJ, Ralls PW, et al. Hepatolithiasis Complicated by Cholangiocarcinoma. *J Comput Assist Tomogr* 1987; 11:315-317.
45. Sher L, Iwatsuki S, Lebeau G, Zajko AB. Hilar Cholangiocarcinoma Associated with Clonorchiasis. *Dig Dis Sci* 1989; 34:1121-1123.

46. Kim YI, Yu ES, Kim ST. Intraductal Variant of Peripheral Cholangiocarcinoma of the Liver with Clonorchis Sinensis Infection. *Cancer* 1989; 63:1562-1566.
47. Nichols DA, MacCarty RL, Gaffey TA. Cholangiographic Evaluation of Bile Duct Carcinoma. *AJR* 1983; 141:1291-1294.
48. Mueller PR, vanSonnenberg E, Gerrucci JT Jr. Percutaneous Biliary Drainage: Technical and Catheter Related Problems in 200 Procedures. *AJR* 1982; 138:17-23.
49. Ishikawa Y, Oishi I, Miyai M, et al. Percutaneous Transhepatic Drainage: Experience in 100 Cases. *J Clin Gastroenterol* 1980; 2:305-314.
50. Hamlin JA, Friedman M, Stein MG, Bray JF. Percutaneous Biliary Drainage: Complications of 118 Consecutive Catheterizations. *Radiology* 1986; 158:199-202.
51. Nakayama T, Ikeda A, Okuda K. Percutaneous Drainage of the Biliary Tract: Technique and Results in 104 Cases. *Gastroenterol* 1980; 2:305-314.
52. Carrasco CH, Zounoza J, Bechtel WJ. Malignant Biliary Obstruction: Complications of Percutaneous Biliary Drainage. *Radiology* 1984; 152:343-346.
53. Berquist TH, May GR, Johnson CM, Adson MA, Thistle JL. Percutaneous Biliary Decompression: Internal and External Drainage in 50 Patients. *AJR* 1981; 136:901-906.
54. Yee ACN, Ho CS. Complications of Percutaneous Biliary Drainage: Benign vs Malignant Diseases. *AJR* 1987; 148:1207-1209.
55. Pitt HA, Cameron JL, Postier RG, Gadacz TR. Factors Affecting Mortality in Biliary Tract Surgery. *Am J Surg* 1981; 141:66-72.