Diagnosis and Management of Biliary Obstruction

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ABSTRACT

- **Objective:** To review diagnosis and management of biliary obstruction.
- **Methods:** Review of the literature.
- **Results:** Biliary obstruction remains a common problem. Causes include choledocholithiasis, benign strictures, post-surgical injury, primary bile duct cancer, and pancreatic cancers. All of the problems can produce biliary obstruction, yet each is managed differently. The physical examination, laboratory studies, and imaging modalities available can help with the selection of the appropriate intervention. A multidisciplinary approach is recommended.
- **Conclusion:** Patients with biliary obstruction can be rapidly diagnosed and treated. Long-term outcomes are generally dependent on the nature of the underlying disease state.

Biliary obstruction is a common condition, and patients often present with a relevant history with characteristic findings on physical exam. Laboratory findings typically reveal elevated total bilirubin, alkaline phosphatase, and gamma-glutamyl transferase (GGT) levels (obstructive pattern). The available diagnostic modalities include transabdominal ultrasound, computed tomography scan, magnetic resonance imaging with cholangiopancreaticography, endoscopic retrograde cholangiopancreatography, and endoscopic ultrasound. Infrequently used modalities include intraductal ultrasound and percutaneous cholangiopancreatography.

This article reviews the evaluation and treatment of patients with suspected biliary obstruction; both benign and malignant causes of biliary obstruction are discussed. The diagnosis and management of biliary obstruction is not always straightforward. This article focuses on current data and guidelines that can assist with the decision-making process in the primary care setting.

**CASE 1**

**Initial Presentation**

A 38-year-old male presents to the emergency department (ED) for episodes of intermittent abdominal pain in the upper right quadrant starting 24 hours ago. He states his urine is dark and his stools are clay-colored. He denies weight loss and night sweats but has nausea. Vital signs are normal. Physical examination reveals jaundiced skin and scleral icterus. Abdominal exam reveals pain with deep palpation of the right upper quadrant with a positive Murphy’s sign. There are no masses, no hepatosplenomegaly, and there is no guarding or rebound tenderness. Labs reveal an AST of 430 U/L (0–35 U/L), an ALT of 380 U/L (0–35 U/L), an alkaline phosphatase of 590 U/L (36–92 U/L), a total bilirubin of 4.6 mg/dL (0.3–1.2 mg/dL), a direct bilirubin of 1.9 (0–0.3 mg/dL), an albumin of 4.3 g/dL (3.5–5.5 g/dL), a protein of 7.1 g/dL (6–7.8 g/dL), and a white blood cell count (WBC) of 13.0 (4–10 × 10^9/L).

Right upper quadrant transabdominal ultrasound shows a dilated common bile duct at 0.8 cm, echogenic foci and percutaneous cholangiopancreatography.

**How common is choledocholithiasis?**

**How is it diagnosed?**

Gallstones are present in approximately 15% of the US population, or in 20 million Americans [1]. Up to 10% to 15% of patients undergoing cholecystectomy will have choledocholithiasis; however, clinical manifestations occur in only 3% of patients [2]. In 2007, there were 111,021 discharges for choledocholithiasis [3].

Stones that originate from the gallbladder are termed secondary bile duct stones. Primary bile duct stones arise within the bile ducts and are less commonly encountered. Risk factors for primary bile duct stones include bile duct dilation (from advanced age, post-cholecystectomy, recur-
rent cholangitis, biliary strictures, primary sclerosing cholangitis), pregnancy, and East Asian race (oriental cholangiohepatitis). Primary bile duct stones typically occur in the extrahepatic ducts but can occur at any level of the biliary tree, including the intrahepatic bile ducts (hepatolithiasis).

**Clinical Presentation**
Symptomatic uncomplicated choledocholithiasis causes sterile obstruction and presents as right upper quadrant pain that lasts longer than that of biliary colic. The pain may be intermittent due to a “ball-valve” effect. Nausea and vomiting can occur, while fevers are less likely.

Complicated choledocholithiasis occurs either from acute cholangitis or from gallstone pancreatitis, or from both simultaneously. Cholangitis is characterized by fever, jaundice, and right upper quadrant pain (Charcot’s triad). Occasionally, altered mental status and hypotension from sepsis occur in severe infections (Raynaud’s pentad).

Asymptomatic choledocholithiasis is discovered during cholecystectomy or incidentally by imaging for another reason.

**Diagnosis**
Typical physical exam findings include jaundice, scleral icterus, and right upper quadrant pain. Fever may be present or absent.

Liver biochemistry tests can reveal that aminotransferases increase initially, but rarely exceed a level of 500 IU. This is followed by the elevation of total bilirubin (both fractions), alkaline phosphatase, and GGT (obstructive pattern) [4]. When liver chemistries are normal, the likelihood of biliary obstruction is very low [5].

Transabdominal ultrasound (TUS) is the initial imaging test of choice due to its attractive cost and safety profile. TUS can show cholelithiasis, common bile duct (CBD) or intrahepatic duct dilation, and choledocholithiasis. Historically, TUS was reported to have a poor sensitivity (22%-55%) for detecting common bile duct stones. When done by experienced readers, it has a sensitivity of 82% and specificity of 88% [6-8]. CBD dilation is more reliably detected by TUS (sensitivity 77%-87%) [9,10]. A CBD diameter > 6-8 mm is considered to be dilated in patients with intact gallbladders [11]. A normal bile duct diameter on TUS has a 95% to 96% negative predictive value for choledocholithiasis [6,12].

Magnetic resonance imaging with cholangiopancreatography (MRCP) is frequently used in the evaluation of patients with suspected biliary obstruction. MRCP has strong sensitivities (82%-84%) and specificities (96%) in the diagnosis of choledocholithiasis, with a negative predictive value (NPV) of 92% to 100% [20]. When compared with ERCP, MRCP has a diagnostic accuracy of 92% [13-15,21].

Endoscopic ultrasound (EUS) can produce both an endoscopic and an ultrasound image in real time. When the ultrasound probe is pressed against the gut wall, it provides the endoscopist with high-resolution images of the surrounding anatomy. EUS is a safe and well-tolerated procedure that has been shown to have high sensitivity (89%-93%) and specificity (94%-96%) for detecting choledocholithiasis and is equivalent to MRCP [16–18]. Additionally, if EUS demonstrates choledocholithiasis, the endoscopist can proceed directly to ERCP for stone extraction [19]. EUS requires patient sedation, carries a low risk of esophageal perforation, bleeding, and infection, and is therefore typically second line to MRCP unless the patient has contraindications to MRCP such as metal implants or cannot tolerate the procedure (anxiety, claustrophobia, lying flat).

Endoscopic retrograde cholangiopancreatography (ERCP) is rarely used as the first test for diagnosing choledocholithiasis as its role has been replaced by MRCP as it has a better safety profile. ERCP has comparable sensitivities and specificities to MRCP but has the potential for associated complications such as acute pancreatitis, cholangitis, perforation, and bleeding [20–22].

**How is choledocholithiasis managed?**

**Common Bile Duct Stones**
Several clinical decision making aids have been published [23,24,25]. The American Society for Gastrointestinal Endoscopy (ASGE) guidelines describe the risk stratification of patients based on the predictors for choledocholithiasis when symptomatic gallstones are proven on imaging [26]. Very strong predictors include a CBD stone on TUS, ascending cholangitis, and a total bilirubin level > 4 mg/dL. Strong predictors include a CBD diameter > 6 mm on TUS if the gallbladder is intact and a total bilirubin level of 1.8 mg/dL to 4 mg/dL. Moderate predictors include age > 55 years, gallstone pancreatitis, or any abnormality in liver chemistry test other than bilirubin. The presence of 1 very strong predictor or both strong predictors.
puts the patient at high risk for choledocholithiasis. Patients with no predictors are at low risk, and all other patients are at intermediate risk.

Patients at high risk for choledocholithiasis often proceed directly to ERCP. For intermediate-risk patients, cholecystectomy with intraoperative cholangiography is recommended. If positive, then laparoscopic bile duct exploration or postoperative ERCP is recommended (generally the latter is performed). Additional clinical scenarios and management options are described in the guidelines [27]. ERCP has also been shown to be safe during pregnancy [28,29].

**Intrahepatic Stones**

Intrahepatic stones are typically endemic to East Asia and rarely occur in North America. Management starts with ERCP with stone retrieval with baskets or balloons and is usually successful, but lithotripsy may be required. If this fails, percutaneous approaches with drains and/or lithotripsy can be attempted [30]. Surgery is occasionally utilized for recalcitrant stones.

**Endoscopic Interventions**

ERCP with sphincterotomy is a first-line endoscopic intervention in the treatment of choledocholithiasis. Endoscopic biliary sphincterotomy is performed by deep biliary cannulation via the major papilla, followed by biliary sphincterotomy via electrocautery using a device known as a sphincterotome. Stones can be cleared in a single procedure greater than 90% of the time. Large or difficult to remove stones may require mechanical, laser, or electrohydraulic lithotripsy (Figure 1). Mechanical lithotripsy uses baskets made of wire that entrap and crush bile duct stones. This can be performed for stones at any location within the biliary tree. Stone fragments are then removed via traction balloons or baskets. The success rate is 80% to 90% [31–33].

Extracorporeal shock wave lithotripsy is a similar technique to that used for renal stones. It has been shown to have an 89% stone clearance rate after 3.5 sessions; however it is rarely used in clinical practice [34].

Endoscopic shock wave lithotripsy is performed by passing a shock wave lithotrope through the endoscope and pulverizing the stone within the bile duct [35].

Plastic stents are used to provide biliary drainage in patients with choledocholithiasis who are poor surgical candidates and in those with stones that are refractory to the above measures.

The risks associated with ERCP include pancreatitis (1.8%–7%), infection (0.6%–1.0%), bleeding (0.3%–0.9%), and perforation (0.4%). The severity of post-ERCP acute pancreatitis can be mild to severe [36–39].

**Case 1 Continued**

The patient underwent preoperative ERCP with biliary sphincterotomy, and 2 small CBD stones were removed. Laparoscopic cholecystectomy was then performed without difficulty.

Nine months post-discharge, he returns to the ED with jaundice. Vital signs are normal. Physical examination reveals jaundiced skin and scleral icterus. Abdominal exam reveals a nondistended abdomen with 3 small incisions that are well healed. He complains of moderate pain with palpation of the right upper quadrant. Liver function tests reveal an AST of 200 U/L, an ALT of 230 U/L, an alkaline phosphatase of 490 U/L, a total bilirubin of 5.6 mg/dL, an albumin of 4.3 g/dL, and a protein of 7.1 g/dL. TUS shows dilated intrahepatic bile ducts but normal size of the CBD. MRCP shows a stricture in the common hepatic duct.

* How common are postoperative bile duct strictures? How are they diagnosed?

Postoperative bile duct injuries include leaks, duct transections, and strictures. Postoperative strictures represent
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80% of all benign biliary strictures in North America [40]. They occur in 0.84% to 3.9% of patients following laparoscopic cholecystectomy and are associated with significant morbidity [41,42]. Patients with ductal transections or leaks can present days to weeks postoperatively, while patients with strictures can present up to several months or even years later.

Benign biliary strictures also occur in patients who receive an OLT. These typically occur at the duct-to-duct anastomosis (Figure 2). They are classified as anastomotic and nonanastomotic. Anastamotic strictures occur in 5% to 10% of orthotopic liver transplants (OLTs). They occur primarily from fibrotic healing [43,44]. Patients present within the first year following transplantation with elevated total bilirubin and alkaline phosphatase [45]. Pain, fever, jaundice and pruritus can also occur.

Nonanastomotic strictures occur in 1% to 19% of OLTs and are due to ischemia. Ischemia can be secondary to hepatic artery thrombosis, length of time from explant to transplant, vasopressor use in donors, and older age of donor. Patients present around 3 to 6 months with similar findings as those with anastomotic strictures [46–48].

Chronic pancreatitis causes benign strictures in the distal bile duct at the intrapancreatic portion of the CBD. It is due to periductal inflammation with progressive fibrosis and scarring. Strictures occur in 3% to 10% of patients with chronic pancreatitis [49–51]. Painless jaundice to severe pancreatitis can occur, with or without ascending cholangitis.

Other rare causes of benign biliary strictures that will not be addressed here include primary sclerosing cholangitis, autoimmune cholangitis with or without associated autoimmune pancreatitis, recurrent pyogenic cholangitis, HIV cholangiopathy, chemotheraphy-induced sclerosing cholangitis, and Mirizzi’s syndrome. Mirizzi’s syndrome occurs when there is a gallstone impacted in the cystic duct that compresses the CBD, resulting in biliary obstruction.

Diagnosis

Physical exam findings and labs are similar to those in patients with choledocholithiasis.

Imaging usually starts with TUS or occasionally contrast-enhanced CT. MRCP is the preferred noninvasive imaging modality for the diagnosis of strictures. It is the pre-procedural imaging modality of choice, as MRCP shows the biliary anatomy both above and below the stricture [52]. ERCP is indicated initially for patients with prior strictures. ERCP also allows for tissue acquisition via brushings and biopsies. Stricture biopsy and cytology assists in differentiating malignant from benign strictures.

Strictures can be smooth and tapering or blunt and shelf-like. The latter is more common in malignancy, but benign and malignant strictures can be difficult to distinguish on appearance alone.

Postoperative strictures are typically localized to the triangle of Callot or near the level of the cystic duct remnant following cholecystectomy. Anastamotic strictures occur at the duct-to-duct anastomosis, whereas nonanastomotic strictures can occur at any level of the biliary tree [53]. Strictures due to chronic pancreatitis occur in the distal CBD.

• How are postoperative bile duct strictures managed?

Postoperative bile duct strictures are treated endoscopically, surgically, or percutaneously. The current preferred treatment modality is ERCP with stricture dilation and/or stent placement, with long-term success in 70% to 100%. Serial ERCPs with stent exchanges can be required every 3 to 6 months for at least 1 year. Placement of multiple side-by-side plastic stents is a common practice [54–57]. Temporary plastic stents or removable fully covered self-expanding metal stents (SEMS) are available. Metal stents require little or no maintenance and can be left in for much longer periods of time.
Post-transplant strictures are treated primarily endoscopically. A percutaneous approach alone is second-line therapy. Surgical revision or liver re-transplantation is used when endoscopic or percutaneous approaches fail [58]. Anastomotic strictures are managed by serial stricture dilation with plastic stent placement (multiple and side-by-side) every 3 months until stricture resolution. This is successful in 75% to 91% of patients [59,60]. Fully covered retrievable SEMS are an effective option but are not widely used [61,62].

Nonanastomotic strictures are technically difficult to treat endoscopically, with higher complication rates (cholangitis), and higher failure rates (25%–50%). Stents are more frequently obstructed by biliary sludge and casts. Patients may require liver re-transplantation because endoscopic and percutaneous approaches are often unsuccessful [63–65].

The standard treatment of strictures due to chronic pancreatitis is ERCP with the placement of multiple plastic stents. Resolution can be achieved in up to 90% of cases when multiple stents are placed sequentially [66–68]. Covered SEMS are comparable to plastic stents and need not be exchanged, requiring fewer interventions [69]. Complications, notably stent migration, may occur more frequently with covered SEMS; therefore, stent type must be selected on a case-by-case basis.

**CASE 2**

**Initial Presentation and Workup**

A 68-year-old male smoker with a 50 pack-year history presented to the office for a 20-lb weight loss and jaundice. A TUS was ordered, which showed dilation of the CBD. A CT scan showed a mass at the pancreatic head with lesions in the liver. He was referred for endoscopic ultrasound with biopsy and ERCP with plastic stent placement due to mass effect on the CBD. His biopsy results show adenocarcinoma. As he has distant metastases, he is a nonoperative candidate.

- What laboratory and imaging studies are helpful in pancreatic cancer?

In 2012, up to 43,920 new cases of pancreatic cancer will be diagnosed in the United States, and 37,390 people will die from the disease [70]. Mortality from pancreatic cancer remains high as the cancer is either locally advanced or has metastasized at the time of diagnosis (53% of patients present with metastatic disease, with a 5-year estimated survival of only 1.8%). Biliary obstruction occurs due to external compression by a pancreatic head mass, although direct invasion of the ducts can occur. Surgery, most commonly pancreaticoduodenectomy (Whipple procedure), is the only chance for a cure.

**Clinical Evaluation**

Jaundice occurs in 77% of those with masses in the pancreatic head [71]. Many patients have painless jaundice, while others can have pain which is usually epigastric with radiation to the back. Weight loss, nausea, and malaise can occur.

Laboratory results usually show an elevated total and direct bilirubin and alkaline phosphatase. CA 19-9 is a tumor marker used for determining prognosis, potential for surgical resection, and response to chemotherapy or surgery, and for monitoring cancer recurrence [72]. When CA 19-9 is > 70.5 U/mL, the sensitivity and specificity for differentiating malignant from benign obstructions are 82.1% and 85.9%, respectively [73].

Imaging modalities include CT, MRCP, EUS, and ERCP. Multidetector CT (MDCT) is the imaging modality of choice as it provides data on resectability and...
prognosis. MDCT has an accuracy of 99%, positive predictive value of 87% to 100%, and NPV of 100% in the diagnosis of pancreatic cancer and for determining resectability [74–76].

MRCP is effective at differentiating malignant from benign strictures and in the preoperative evaluation of pancreatic masses [77]. MRCP has a sensitivity of 91.9% to 94.44% and specificity of 75% to 81.81% for detecting malignant causes of biliary obstruction [78–80].

EUS with fine needle aspiration (FNA) is the preferred modality for a cytological diagnosis and is widely used for obtaining accurate information regarding locoregional staging. When EUS imaging findings are paired with cytology results, the sensitivity and specificity for pancreatic adenocarcinoma are 94.3% and 100% respectively [81,82].

ERCP with brush cytology has a limited sensitivity (35.19%–62.5%) but excellent specificity (100%) in the evaluation of biliary strictures when no pancreatic mass is seen on imaging [83,84]. Intraductal ultrasound with biliary probes improves the sensitivity to 90% but is rarely done [85,86].

**What therapeutic options are recommended?**

As the majority of patients with pancreatic cancer present with advanced disease, most receive palliative ERCP with endoscopic decompression.

Uncovered SEMS, covered SEMS, and plastic stents are used to relieve the biliary obstruction from pancreatic cancer (Figure 3). Plastic stents are temporary and can be used to decompress the bile ducts while a tissue diagnosis is pending [87]. The plastic stent will generally be switched for a SEMS after adenocarcinoma is diagnosed.

Uncovered SEMS have better patency than plastic stents and have a lower risk of recurrent biliary obstruction [88–90]. Tumor in-growth through the stent interstices and tumor overgrowth at the proximal and distal end of the SEMS can cause occlusion. Covered SEMS have longer patency than uncovered SEMS, but have higher rates of stent migration and cholecystitis. Covered and uncovered SEMS do not prolong life expectancy [91,92]. At the present time it is difficult to advocate for covered SEMS over uncovered SEMS, and the use of both types of devices is common in clinical practice.

Surgical biliary bypass (hepaticojejunostomy, often performed with a concomitant gastrojejunostomy in patients with gastric outlet obstruction) is done for patients who, at the time of planned pancreaticoduodenectomy, are found to have unresectable disease. Gastric outlet obstruction is commonly treated via endoscopic enteral stents [93].

Patients with clearly resectable tumors can proceed to surgery without biliary decompression if surgery is performed in short order [94]. Immediate surgery is only possible in 15% to 20% of cases [95]. Preoperative endoscopic decompression with plastic or SEMS is performed for surgical candidates when neoadjuvant therapy is planned or when any delays to surgery are envisioned [96].

**CASE 3**

**Initial Presentation and Workup**

A 65-year-old female presents with progressive jaundice, a 15-lb unintentional weight loss, and fatigue. Pertinent laboratory findings are an alkaline phosphatase of 670 U/L, total bilirubin of 6.3 mg/dL, and direct bilirubin of 4.5 mg/dL. A CT scan of the abdomen shows bile duct dilation. A MRCP shows a mass at the bile duct hilum, with proximal bile duct dilation.

**What other diagnostic tests should be ordered for this patient?**

Cholangiocarcinoma (CC) is a malignant tumor that originates from epithelial cells lining the bile ducts. CC within the liver is classified as intrahepatic (ICC), while CCs that originate in the bile duct along the hepato-duodenal ligament are classified as extrahepatic (ECC). ECC is further divided into perihilar “Klatskin” tumors and distal tumors. Twenty percent to 25% of CCs are intrahepatic, 50% to 60% are perihilar, and 20% to 25% are distal. The incidence rate of ICC has doubled in the US since 1975, while ECC rates have remained stable [98–100]. There are approximately 5000 new cases diagnosed in the US every year [101]. Risk factors include primary sclerosing cholangitis, biliary cirrhosis, chronic hepatolithiasis, alcoholic and nonalcoholic liver disease, nonspecific cirrhosis, liver flukes, and congenital biliary cystic disease [102].

**Diagnosis**

Biliary obstruction (jaundice, pale stools, dark urine, and pruritus) is more common in ECC. Cholangitis is rare in patients without prior biliary instrumentation. Systemic
manifestations of malignancy are more common in ICC. Physical exam findings can include palpable liver masses, painless enlargement of the gallbladder, or signs of portal hypertension from portal vein infiltration by the tumor and/or portal vein thrombosis. Liver function tests can show an obstructive pattern but are frequently normal [103]. The tumor marker CA 19-9 can be helpful for distinguishing malignant from benign strictures (cutoff value >20 U/mL) [104,105].

Differentiating ICC from ECC is relevant as staging and management of the 2 groups varies. Various staging systems exist and are based on tumor size, number of tumors, presence of vascular invasion, and number of involved lymph nodes.

Imaging evaluation starts with TUS which has a better diagnostic yield in ECC than ICC. When TUS is combined with CA 19-9 (cut-off value > 20 U/mL) in patients with primary sclerosing cholangitis, the sensitivity, specificity and NPV are 91%, 62%, and 98%, respectively. Duplex ultrasound can assess for tumor invasion of portal vein [106]. Multidetector CT can locate CC in nearly 100% of cases, is useful for staging, and can predict resectability in up to 91% of cases [107,108]. MRCP has a sensitivity and specificity of 94.3% and 100% for diagnosing CC and is frequently used [109]. Positron emission tomography/CT is used for staging CC, and successfully detects distant metastases in 70% to 100% of cases [110,111].

While ICC is primarily diagnosed via MRCP or MDCT (with or without liver biopsy), ECC is further evaluated with endoscopy. Cholangiography with ECRP has a sensitivity and specificity of 74% to 85% and 70% to 75% respectively for ECC (Figure 4) [112,113].

ERCP with brush cytology is regularly done, with reported sensitivities of 9% to 80% and a specificity of 100% for the diagnosis of CC [114–117]. Through-the-scope intraductal ultrasound (with stricture fine-needle aspiration or forceps biopsy) or the use of a cholangioscope can improve diagnostic yield, but these methods are not widely available [118].

If ERCP brush cytology results are inconclusive, EUS can be used to biopsy the mass (if its location and size are suitable) or enlarged lymph nodes. The small size of CC makes puncturing the tumor difficult. The sensitivity and specificity of EUS-FNA are 86% to 89% and 100%, respectively [119,120].

A surgical tissue diagnosis may be required when endoscopic methods are inconclusive.

Treatment options for CC vary depending on tumor location (intrahepatic, hilar, distal) and stage. Cure is only achieved with surgical resection; however, very few patients are surgical candidates or present with resectable tumors. The 5-year survival rate in surgical candidates with R0 resections (complete excision with negative margins) for ECC and ICC is only 25% to 30% [121,122].

ICC is rarely amenable to surgical resection for cure or for palliation. In 1 study of 862 patients with ICC, 6.3% of patients received surgical resections, 65.5% received palliative interventions (16% surgical, 44% endoscopic), and 24% received only chemo or radiation therapy [123].

Patients undergoing a curative resection (partial hepatectomy with or without lymph node dissection and extrahepatic bile duct resection) have a 5-year survival of 20% [124]. OLT is performed at only select centers but offers a significant survival benefit in a small percentage of patients. No current guidelines exist for neoadjuvant and adjuvant chemo or radiation therapy, although published
data supports their use when OLT is planned, according to the “Mayo protocol” [125]. In unresectable tumors, palliative chemoradiation therapy and transarterial chemoembolization offer only modest survival benefits [126,127]. When hepatic bile ducts are obstructed, the placement of plastic stents or SEMS can be achieved via endoscopic or percutaneous routes.

Patients with resectable hilar CC typically undergo bile duct resection with combined partial hepatectomy, followed by hepaticojejunostomy. Lymph node dissection and portal vein resection may be required. This aggressive approach has improved recurrence-free survival and long-term survival [128,129]. Staging laparoscopy and portal vein embolization can improve outcomes but are done on a case-by-case basis. Portal vein embolization can boost liver function prior to partial hepatectomy by causing atrophy of the embolized cancerous portion and reactive hypertrophy of the remaining liver.

Palliative treatment is achieved through endoscopic stenting with or without chemoradiation, brachytherapy, and/or photodynamic therapy. Hilar CC poses significant difficulties with regards to stent placement given the anatomic bifurcation. Unilateral placement of uncovered SEMS can achieve adequate drainage in the majority of patients [130]. New metallic Y-type stents can achieve bilateral drainage [131]. Treatment with intraluminal brachytherapy, chemo, or radiation therapy is used for poor surgical candidates and for palliation [132]. Photodynamic therapy offers a survival benefit but is performed only at a small number of centers [133].

The treatment and management of distal CC is similar to that of hilar CC with several exceptions. Small tumors may be more amenable to local bile duct resection without the need for chemoradiation, brachytherapy; however, some patients may need pancreaticoduodenectomy (Whipple’s procedure) to achieve negative surgical margins [134]. Palliative management techniques are also similar; however, there are more data for endoscopic interventions. When patient survival is estimated to be greater than 4.5 months, uncovered or covered SEMS are preferred to plastic stents as they have lower rates of stent occlusion [135,136]. When patients have distant metastases, plastic stents are preferred due to overall poor prognosis [137]. Covered and uncovered SEMS can be used to good effect for distal CC [138,139].

**What are other causes of biliary obstruction?**

**Biliary Obstruction Due To Extrinsic Compression**

Biliary obstruction secondary to extrinsic compression is infrequent. Compression occurs most commonly in the setting of adenopathy from lymphoma, metastatic cancer, or due to mass effect from locoregional tumors [140–144].

**Diagnosis**

Clinical presentation is typically characterized by obstructive jaundice and weight loss. There is no diagnostic algorithm, but workup follows that outlined for the above causes of bile duct obstruction, starting with TUS, followed by CT (assessing lymphadenopathy), MRCP, and then by ERCP or EUS. Locating the source of extrinsic compression on imaging can be difficult in some cases, and ERCP may be indicated.

**Treatment**

Management is on a case-by-case basis and is based on expert opinion. Endoscopic decompression and stent placement plays a central role in treatment. When patients are found to have compression from mass effect or from lymphadenopathy in the setting of metastatic disease, then SEMS are first line. If the compression is from non-metastatic lymphoma with localized adenopathy, then plastic stent placement is usually sufficient due to expected response from chemotherapy and/or radiation therapy.

**CONCLUSION**

Biliary obstruction can arise from many different etiologies that cause a similar clinical presentation. Determining the cause of obstruction is critical as disease-specific treatments exist. TUS, CT, MRCP, ERCP and EUS are available at most large centers and are very useful for both the diagnosis and treatment of biliary obstruction of all types. History, physical exam, and laboratory data findings that are suggestive of biliary obstruction should prompt the primary care physician to order further imaging studies and to have a low threshold to consult with a gastroenterologist. Imaging starts with TUS, and if biliary obstruction cannot be excluded, MRCP or MDCT should be considered depending on the suspected etiology. EUS and ERCP are typically reserved for patients who cannot undergo MRCP or when a tissue biopsy is required.
Endoscopic interventions are widely used for the management of benign and malignant biliary obstruction. The use of plastic and metal stents (covered and uncovered) in the treatment of both benign and malignant causes of biliary obstruction is growing.

Plastic stents are removable but prone to occlusion and need to be exchanged periodically. They are used more often for stones or benign strictures. Uncovered SEMS are permanent but have longer patency rates than plastic stents. They are used for malignant obstructions, typically for palliation. Covered SEMS are removable and may have longer patency rates than uncovered metal stents. They are newer to the market and their role is not yet defined, but they can be used for both benign and malignant causes of biliary obstruction.

The primary care physician’s awareness of the available therapies and their associated complications is important. The management of biliary obstruction is often not straightforward, and a multidisciplinary approach is recommended.

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REFERENCES

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56. Kuzela L, Olzman M, Sutka J, et al. Prospective follow-up of patients with bile duct strictures secondary to laparo-
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88. Krishna NB, Saripalli S, Safdar R, Agarwal B. Intraductal US in evaluation of biliary strictures without a mass lesion on CT scan or magnetic resonance imaging: significance
118. Tamada K, Tomiyama T, Wada S, et al. Endoscopic transpapillary bile duct biopsy with the combination of intra-


