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ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY IN THE NEXT MILLENNIUM

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The advent of endoscopic retrograde cholangiopancreatography (ERCP) over 20 years ago dramatically changed the diagnosis and treatment of biliary and pancreatic diseases. The minimally invasive nature inherent to ERCP coupled with its ability to be performed under conscious sedation resulted in its rapid dissemination to hospitals around the world. ERCP enabled the preoperative diagnosis of biliopancreatic disease where surgical exploration might otherwise have been required, and offered an attractive alternative to surgical therapy.

Today, diagnostic and therapeutic applications of ERCP are well established, but face an uncertain future. Technologic advances in radiologic imaging have challenged its diagnostic role, and minimally invasive laparoscopic approaches have recaptured some therapeutic indications. The future of ERCP depends on the ability of its proponents to demonstrate advantages in cost and outcomes. Advances in miniature endoscope technology are necessary to carry the diagnostic and therapeutic capabilities of ERCP into the furthest reaches of the biliary and pancreatic ductal systems.

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DIAGNOSIS OF BILIOPANCREATIC DISEASE

The indications for diagnostic ERCP will diminish as alternative imaging modalities achieve better visualization of the biliary and pancreatic ducts without the procedural risks of ERCP. Furthermore, these alternative imaging modalities define ductal anatomy relative to surrounding tissue and organs. Three modalities currently lead the challenge to diagnostic ERCP: (1) MR cholangiopancreatography, (2) CT cholangiopancreatography, and (3) endoscopic ultrasound (EUS).

MR Cholangiopancreatography

MR cholangiopancreatography offers imaging without radiation exposure, contrast injection, or sedation. Comparative trials between MR cholangiopancreatography and ERCP indicate a comparable accuracy in detecting stenosed segments and bile duct obstruction (sensitivity 91 %, specificity 100%).[76] Information can be obtained about segments above the area of obstruction. It can delineate malignant strictures with sensitivity and specificity of 86% and 98%, respectively.[10] The sensitivity of MR cholangiopancreatography in detecting biliary stones has been reported to be 81% to 95%.[10,76] The resolution, sensitivity, and specificity of MR cholangiopancreatography can be potentially improved by the development of endoscopic MR imaging, which is currently undergoing testing.[38]

MR cholangiopancreatography is an attractive alternative to ERCP for the diagnosis of chronic pancreatitis. It is able to depict main pancreatic duct changes characteristic of chronic pancreatitis and detect intraductal pancreatic calculi.[76] Furthermore, MR cholangiopancreatography can diagnose ductal disruption or leakage and pseudocyst formation (Fig. 1).[76]

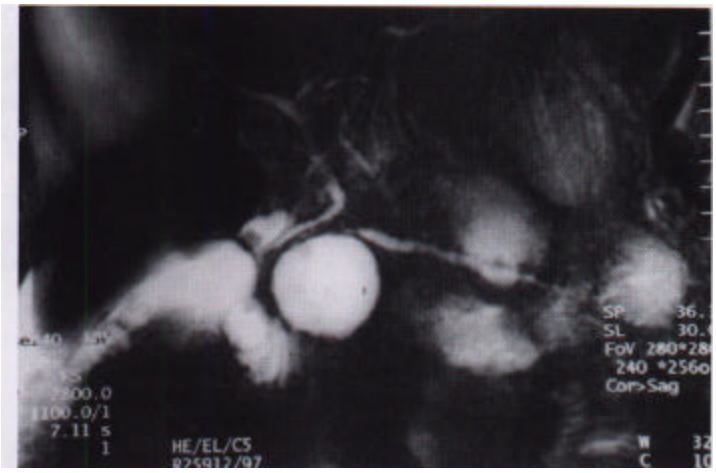

Figure 1. MR cholangiopancreatography demonstrating a pseudocyst in the pancreatic head adjacent to the main duct.

Underlying anatomic anomalies, such as pancreas divisum, that may contribute to pancreatitis are also seen.[76] The advantages of MR cholangiopancreatography need to be weighed against several limitations. Theresolution is not adequate to define nondilated intrahepatic biliary ducts and pancreatic side branches, gallbladder pathology, hepatolithiasis, and pancreatic calcifications.[59,76] Imaging can be limited by hyperconcentrated bile or sludge, blood, air, or proteinaceous material.[35,59,76] Air in the bile ducts can mimic stones, and sludge can mimic stenosis.[35,59] Fluid collections external to the pancreatic and biliary ducts may obscure the region, and surgical clips and stents may create artifact.[10] MR cholangiopancreatography is contraindicated in patients at risk from the magnetic field (e.g., cardiac pacemakers, cerebral aneurysm clips) and should be avoided in individuals with claustrophobia.[10]

CT Cholangiopancreatography

CT cholangiopancreatography shares many of the benefits of MR cholangiopancreatography regarding definition of anatomy.[33, 48] It can identify common duct stones with a sensitivity of 84% to 88%, specificity of 94% to 97%, and accuracy of 94%.[51,59] Although contrast may not be required for stone identification with newer helical CT protocols, it is a requirement for the depiction of smaller structures.[48] Similar to intravenous cholangiography, this need for contrast is a disadvantage when it is unable to reach pathologic areas, such as in the patient with biliary obstruction, high-grade strictures, or large stones.[48] Insufficient or inhomogeneous distribution of contrast may result in faulty interpretation.[48] CT cholangiopancreatography possesses the same limitations as MR cholangiopancreatography in the visualization of pancreatic side branches,[58] and is limited by the potential to miss stones that are isoattenuating with surrounding bile.[8]

Endoscopic Ultrasound

Endoscopic ultrasound is well established as a highly accurate imaging modality for the pancreas and extrahepatic biliary tree. EUS is nearly 100% accurate for the detection of common bile duct stones. This is particularly notable in patients with normal diameter ducts and stones less than 1 cm.[23]

Comparative studies have shown EUS is superior to CT, MR imaging, ultrasonography, and angiography in the detection of pancreatic cancer or masses.[23] This is most evident in tumors less than 3 cm in diameter ,[35] and its accuracy is reported to be as high as 92% in the diagnosis of intraductal pancreatic tumors.[73] In addition to lesion identification, EUS permits guided, fine-needle aspiration with malignant cytology having virtually a 100% positive predictive value.[21,23] It can also assist in staging by identifying involvement of adjacent vascular (portal vein, superior mesenteric vessels) and tissue (stomach, spleen) structures.[23]

High-frequency ultrasound probes that can be inserted through the biopsy channel of a duodenoscope into the biliary and pancreatic ducts have been used to perform intraductal ultrasonography to stage ampullary, biliary, and pancreatic malignancies. Autopsy studies of intraductal ultrasonography have demonstrated the common bile duct and main pancreatic duct to be three-layered structures.[3] The high resolution afforded by intraductal ultrasonography probes enables accurate assessment of the depth of invasion and involvement of neighboring vessels, such as the portal vein and right hepatic artery. There is a potential to use intraductal ultrasonography to differentiate between malignant and benign strictures.[35]

As with MR cholangiopancreatography and CT cholangiopancreatography, EUS offers an attractive alternative to ERCP for the diagnosis of chronic pancreatitis. Utilizing criteria such as hyperechoic foci, hyperechoic strands, lobularity, hyperechoic duct, irregular duct, visible side branches, ductal dilation, calcification, and cysts, EUS can accurately diagnose chronic pancreatitis with both sensitivity and specificity in excess of 85%.[17,26,63]

Future Role of Diagnostic ERCP

For biliary stones, the choice of imaging technique depends on the probability that a stone is present. If a stone is strongly suspected, ER cholangiopancreatography will retain its diagnostic role because diagnosis can be combined with stone extraction. The option of performing laparoscopic common bile duct exploration with cholecystectomy may influence the decision to perform ERCP (see later). Available equipment and expertise will primarily dictate the choice between MR cholangiopancreatography, CT cholangiopancreatography, and EUS. EUS should be given preference when the objective is to exclude a common bile duct stone.

ERCP will retain a role in the evaluation of biliopancreatic malignancy, because most patients at the time of clinical presentation are elderly, poor surgical candidates, and have unresectable disease. Diagnostic ERCP, ductal tissue sampling, and stent decompression of the obstructed duct can be performed in the same session, preserving the goals of palliative management. Patients who are candidates for curative surgery, on the other hand, should undergo CT cholangiopancreatography or MR cholangiopancreatography as the first-line imaging procedure to exclude unresectability (T4 disease or distant metastases). EUS complements MR cholangiopancreatography or CT cholangiopancreatography by providing more accurate local staging and an opportunity to obtain a tissue diagnosis by endosonography-guided fine-needle aspiration.

ERCP will retain a portion of its traditional diagnostic role in clarifying areas that are poorly visualized by the other imaging modalities, such as the intrahepatic biliary ducts and side-branches of the pancreatic duct, areas of potential artifact, and areas showing borderline pathology. It will

retain a significant diagnostic role as a staging platform for cholangioscopy and pancreatoscopy.

New Diagnostic Applications of ERCP

Cholangioscopy and Pancreatoscopy

Cholangioscopy currently has recognized utility in the deployment of laser and shock wave lithotripsy probes, tissue sampling, and in the clarification of cholangiographic filling defects and strictures.[22,53,54,66] Early work shows a similar capability for pancreatoscopy. Pancreatoscopes have demonstrated an ability to differentiate pancreatic cancer from chronic pancreatitis in cases with local stenosis or elevated lesions of the main pancreatic duct.[20,44,75] It is also useful in diagnosing and determining the extent of mucus-producing tumors of the pancreas (Fig. 2; for A, See also Color Plate 8, Fig. 14).[75] Recent advances include the development of fine-caliber flexible miniscopes that can be passed through a normal papilla without sphincterotomy,[53,56] through a 6 to 7F catheter, or alongside endoprostheses.[54] These developments herald a new age where visual inspection of the pancreatic and biliary ducts will occur as routinely as colonoscopy and endoscopy. It will create new diagnostic indications, disease characterizations, and screening recommendations similar to what followed the development of endoscopic evaluation in other areas of the gastrointestinal tract. It can be expected that endoscopic therapies, such as polypectomy, argon plasma lasers, and mucosal resections, may soon find roles in the biliopancreatic system.

Tissue and Secretion Analysis

Cytology and biopsy, although highly specific for the diagnosis of malignancy, have a reported sensitivity as low as 46.7% and 64.9%, respectively, when applied to biliary stenoses.[64] Combination of the two provides little improvement with a sensitivity of 70.4%.[64] The development of cholangioscopy and pancreatoscopy will improve this by permitting visual examination of the site and directed biopsy. Improved detection will be facilitated by the use of vital staining as elsewhere in the gastrointestinal tract with initial reports already describing the use of methylene blue and p53 immunohistochemical staining.[68]

As the capabilities of gene analysis and polymerase chain reaction testing expand, a new diagnostic role will be created for tissue and fluid sampling from the biliary and pancreatic ducts. Telomerase activity is reported to be present in 95% of surgically resected pancreatic cancer specimens, and early results show that extracts from pancreatic juices collected during ERCP can undergo a telomeric amplification protocol assay and achieve an identification in 86% of patients preoperatively.[39] Other studies have examined pancreatic juice DNA for K-ras mutations, finding it in 64% to 67% of patients with a pancreatic neoplasm versus less than 2% without cancer.[43,74]

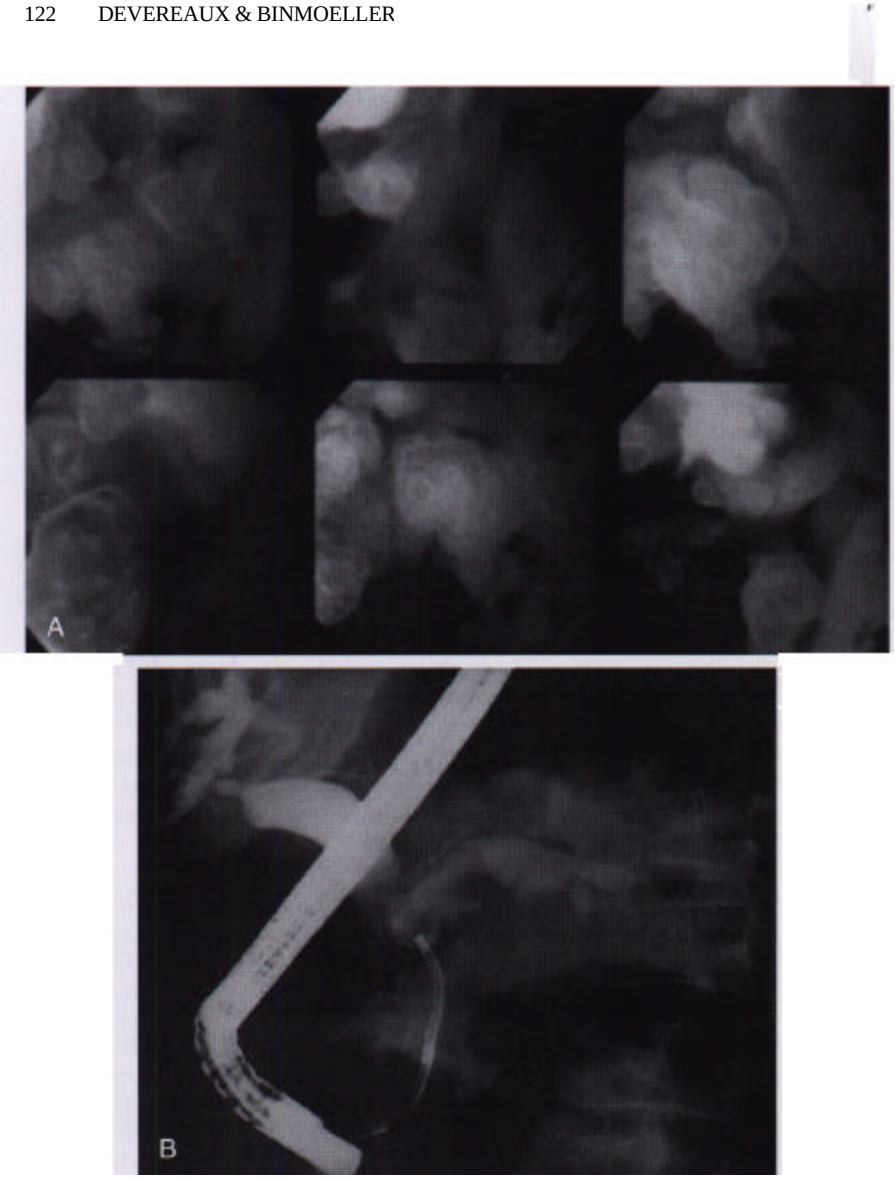

Figure 2 A, Video pancreatoscopy views showing an intraductal, papillary, mucin-producing tumor. (See also Color Plate 8, Fig. 14.) 8, Pancreatogram showing amorphous pancreatic duct-filling defects as typically seen in mucinous ductal ectasia.

Beyond analysis for malignancy there is an ongoing debate about the utility of bile examination for microlithiasis. It is apparent that its presence plays a role in recurrent pancreatitis, and may contribute to biliary colic and symptoms that overlap with sphincter of Oddi dysfunction. Because the condition is poorly defined, incompletely understood,

and difficult to diagnose, benefits of therapy have been difficult to predict. It is evident that a subset of these patients benefits from sphincterotomy,[34,42,79] and as diagnostic testing improves enough to permit the selection of these patients a new diagnostic role may evolve.

THERAPY OF BILIOPANCREATIC DISEASE

Stones

The capabilities of endoscopic common duct stone extraction are well established. In a series of over 8000 patients, less than 1 % required surgical intervention for bile duct stone removal.[65] Additionally, only a small percentage of these patients required more sophisticated techniques than the widely available balloon catheters, Dormia basket, and mechanical lithotriptors.[65] Stenting is a useful adjuvant for managing large stones, preventing cholangitis until further definitive treatment, and potentially facilitating stone extraction through mechanical disruption of the stone.[65] Common duct stone removal, in addition to relieving biliary obstruction, has demonstrated benefits in severe attacks of biliary pancreatitis.[4,67]

Stones refractory to mechanical lithotripsy include giant stones, impacted stones, and the Mirizzi syndrome.[11,19,65] Intraductal shock wave lithotripsy using electrohydraulic and laser technology has been applied by the transpapillary route to fragment successfully these difficult stones. This generally requires the use of a cholangioscope visually to guide the application of shock waves to the stone surface. Success rates in excess of 90% have been reported in multiple small series.[1,11,40,52,65] Recent technologic advances include a mechanism for autorecognition of stones, which minimizes the risk of accidental injury to the bile duct. Extracorporeal shock wave lithotripsy is an alternative approach to fragment bile duct stones when intraductal lithotripsy is not an option or fails (e.g., intrahepatic stones or stones above a stricture).[52, 65]

In chronic pancreatitis, the removal of pancreatic stones has been reported to improve or relieve abdominal pain and pancreatitis exacerbations in over 90% of patients.[29,71] More than half of these patients have a sustained relief of pain at 2-year follow-up.[29] Pancreatic stone extraction may be technically difficult by standard methods though, because the stones are often trapped above fibrotic or angulated strictures. Preliminary fragmentation by extracorporeal shock wave lithotripsy has been used in numerous centers as an adjunct to ERCP to facilitate clearance of pancreatic duct stones.[14,27]

Advancement of laparoscopic surgery has challenged the therapeutic role of ERCP in choledocholithiasis. Laparoscopic surgeons have crossed the cystic duct to tackle common duct stones. Intraoperative cholangiograms can be obtained in up to 95% of patients by a transcystic approach.[31,72] Following cystic duct dilation an assortment of instruments traditionally used by biliary endoscopists can be inserted into the bile duct including baskets, balloons, and cholangioscopes for shock wave

lithotripsy. Clearance rates have been reported as high as 96%.[31] Laparoscopic common bile duct exploration through a choledochotomy has also become more common with a success rate approaching 95% in trained hands.[72]

The choice between an endoscopic transpapillary and a laparoscopic approach to choledocholithiasis will continue to depend on multiple factors including stone size, number, location, and available expertise.[18] Laparoscopic transcystic removal is currently limited by the difficulties inherent in the extraction of large stones (>8 mm), multiple stones, and common hepatic duct stones.[18,61] Common bile duct exploration remains a technically demanding procedure that requires sophisticated equipment. As the techniques of laparoscopic common bile duct exploration and stone extraction improve and become more widespread, the need for preoperative diagnostic ERCP will diminish. ERCP will retain a role, however, in the treatment of stones in patients with cholangitis, pancreatitis, and other comorbid conditions that increase surgical risk and in patients who are poor candidates for laparoscopic diagnosis and management." It will also continue to play a key role in the postoperative diagnosis and treatment of choledocholithiasis.

Benign Obstruction

Current treatment relies upon endoscopic dilation and stenting. This can provide relief of obstructive symptoms, but usually requires longterm stenting with periodic stent exchanges to achieve permanent stricture dilation.[4,28] Results are better for postoperative and trauma-related strictures than strictures secondary to chronic pancreatitis.[28]

For postoperative strictures, the diagnostic role of ERCP will diminish as other imaging modalities mature and can identify complications requiring reoperation, such as complete transection or complex injury of the common bile duct.[25] Therapeutic ERCP, however, will continue to be the approach of choice for partial strictures. The role of ERCP in the management of biliary strictures following liver transplantation is certain to grow, because reports have shown good results in the majority of cases.[36,60,62] Long-term stenting of up to a year is usually required, but the restenosis rates after stent removal have been found to be very low.

In diffuse, progressive types of strictures, such as that of primary sclerosing cholangitis, dilation and stenting must be used cautiously because these rarely achieve adequate long-term results and serve only as a bridge to transplantation. A dominant stricture superimposed on diffuse ductal disease can be found in 15% to 20% of patients with primary sclerosing cholangitis.[80] In the absence of symptomatic obstruction, any instrumentation of the bile duct, including sphincterotomy, should be avoided to prevent cholangitis. At the symptomatic stage, interventions should be tailored to correct the acute symptoms while avoiding procedural manipulations that might increase the difficulty of a later liver

transplantation. Dilation should be performed cautiously and a removable plastic stent should be used in favor of an expandable metal stent.

Over the past decade endoscopic therapy has been increasingly used as a less invasive alternative to surgery for the treatment of pancreatic ductal strictures.[30] The therapeutic goal has been the palliative relief of the severe pain associated with chronic pancreatitis. Studies have shown that endoscopic stenting results in at least partial pain relief in 70% to 80% of patients.[12,14,57,70] Further studies that have evaluated the long-term outcome of endoscopic therapy have shown sustained pain relief in up to 87% of patients who initially respond.[12] In the patients experiencing benefit, more than half can be expected to have continued pain relief upon removal of the stents.[12,14,57] Dilation with a catheter, bougie, or balloon catheter may be necessary to permit stenting.

New techniques are being applied that improve our ability to manage high-grade strictures. Soehendra stent retrievers have been utilized literally to core a path through high-grade strictures that permitted the passage of only a 0.035-in wire in both the biliary[32,81] and pancreatic ducts[9,14] (Fig. 3). The stent retriever causes tissue to become trapped within the threads of the device, and this sample can be submitted for cytologic evaluation as an adjuvant to biopsy or brushing. The performance of a stricturoplasty on high-grade strictures utilizing a sphinctertome4' was recently described

Figure 3. Use of the Soehendra stent retriever over a guidewire for dilation of a high-grade stenosis in the pancreatic head.

and underscores the expansion of endoscopic microsurgical techniques in the biliary and pancreatic ducts.

Currently, endoscopic interventions require multiple sessions to achieve therapeutic benefit, but this will diminish as stent technology progresses and decreases the incidence of stent dysfunction, occlusion, and migration. Improved stent technology may also diminish the incidence of stent-related ductal changes and the need to minimize the duration of stenting to prevent them.[16] Balloon design will improve, permitting easier insertion and better maneuverability. Smaller guiding catheters and higher-strength balloon material will also allow stretching of very severe strictures.[78]

Ductal Disruption and Leaks

Bile leaks usually occur postoperatively secondary to surgical injury. They persist because the bile follows the path of least resistance through the damaged portion of the bile duct rather than through the papilla. Endoscopic therapy has included sphincterotomy alone, sphincterotomy with stent placement, stent placement alone, and nasobiliary drainage. All have been found to be effective with success rates of 90% to 100%.[13, 49, 58]

Pancreatic duct leaks usually occur secondary to pancreatitis or complicated pancreatic trauma. Transpapillary stenting has been found to be effective in the treatment of ductal disruption.[37] This can be the definitive therapy and avoids long periods of external drainage, hyperalimentation, and surgical intervention.

Pseudocysts arising in the setting of chronic pancreatitis typically communicate with the pancreatic duct and are associated with pancreatic duct outflow obstruction. The most effective means of treating this type of pseudocyst remains transpapillary stenting. Transmural drainage may produce pseudocyst resolution, but recurrence is likely if outflow obstruction remains. Pseudocyst resolution occurred in 80% to 93% of patients following stenting when communication with the main pancreatic duct was identified, regardless of the presence or absence of stricturing.[14,15]

Malignant Obstruction

Stenting

The ability to palliate malignant biliary obstruction utilizing stenting is well established, but hampered by the difficulties in maintaining stent patency. Conventional plastic stents have a median patency of 4.9 months.[46,50] Metallic stents have been found to prolong the median patency, but are limited by a high reocclusion rate due to tumor ingrowth at about 9.8 months.[46,50] The recent development of covered metallic stents addresses the limitation of tumor ingrowth, but it is unclear whether this will translate into prolonged patency.[69] Covered stents may occlude faster

than uncovered Stents, and may be more prone to stent migration. Intraductal irradiation can be used in conjunction with expandable stent placement to recanalize cancerous strictures and permit parallel placement for hilar lesions.[45]

Photodynamic Therapy

Photodynamic therapy is an exciting and promising new therapy that restores biliary drainage and improves quality of life in patients with nonresectable disseminated cholangiocarcinomas.[55] Similar response is reported for patients experiencing obstructive jaundice from inoperable pancreatic cancer.[82] Future advances in the development of photosensitizing agents that improve selectivity for malignant tissue will expand the role of photodynamic therapy in the palliation of malignant obstruction. Additionally, as imaging techniques become more adept at identifying earlier-stage lesions, its potential as a curative intervention for superficial mucosal tumors may increase.

Brachytherapy and Chemotherapy

Currently, brachytherapy is an inpatient procedure involving percutaneous transhepatic cholangioscopy. A recent report described the utilization of ERCP to place a metallic stent in the common bile duct, and a nasobiliary catheter through the stent to facilitate transfer of the radioactive material.[24] This method permits the administration of the radiation therapy on an outpatient basis. As newer therapies are developed for tumors of this region, the role of ERCP to facilitate the transport of radioactive elements or chemotherapeutic agents to be instilled within the ducts can be expected to expand.

Percutaneous Transhepatic Approach

The role of percutaneous transhepatic cholangiopancreatography for the diagnosis and treatment of biliary disease has expanded with the development of thin-diameter cholangioscopes and expandable metallic Stents. Any development achieved, however, can be adapted for use via endoscopy, which eliminates the unique risks inherent in a percutaneous approach. Percutaneous transhepatic cholangiopancreatography will continue to play an active role in therapeutic biliary interventions, especially for proximal bile duct strictures and regions inaccessible due to distal obstruction.

QUALITY ASSURANCE

Physician Credentialing

The efficacy and safety of any procedure depends on the experience of the operators and their assistants. Requirements for physician credentialing

in ERCP are in a state of flux. The American Society for Gastrointestinal Endoscopy provided guidelines' for the granting of privileges for performing ERCP. They recommended a minimum of 75 diagnostic and 25 therapeutic procedures that are to include 20 sphincterotomies and 5 stent placements before competency could be assessed. Recent reports indicate that the exposure provided by most gastroenterology training programs in therapeutic ERCP does not meet the requirements for competency, and that objective criteria of skill need to be developed.'-" A prospective study showed that at least 180 supervised procedures are required to achieve competency," and others suggest that an ability freely to cannulate the desired duct in a minimum of 80% of cases must be demonstrated." It is intuitively obvious that as the complexity of interventions increases, the critical need for experience during training will be more acute. Maintenance of the skills acquired will require ongoing exposure. This is beyond the scope of many centers currently, and will require stricter criteria for training programs in this field. It will further fuel the drive for the development of dedicated multidisciplinary centers for biliopancreatic disease.

Multidisciplinary Centers for Biliopancreatic Disease

Because we can expect fewer diagnostic ERCPs, the development of increasingly difficult therapeutic interventions, and a need for greater exposure to achieve competency, there will be a resulting shift of ERCP from the community hospitals to the academic referral center. Increasing cost and diminishing reimbursement will also be a driving force. The development of referral centers is logical and will have the advantages of state-of-the-art equipment and high case volume to reinforce expertise.

Multidisciplinary centers for biliopancreatic disease will become more popular as the traditional barriers between surgery, endoscopy, and radiology fade and as third-party payment focuses on disease-related reimbursement for interventions. There is already considerable overlap between the approaches of the laparoscopic surgeon, biliary radiologist, and endoscopist. Specialists from each area will be able to collaborate closely and offer an optimal interdisciplinary diagnostic and therapeutic approach. The concentration of ERCPs at referral centers will facilitate clinical research and technology development. The foundation of this advantage will lie in increased patient numbers, uniformity of operator skills and methods, and a homogeneous study population.

Assistants, Equipment, and Accessories

The development of a multidisciplinary referral center performing advanced therapeutic interventions will require a facility for operation that meets the same standards as those of the specialties it unites: endoscopy, surgery, and radiology. The advanced radiologic and endoscopic

equipment with a myriad of accessories will need an aggressive quality monitoring program and the development of a highly trained support staff.

In the future, dedicated endoscopy nurses and technicians will become a requirement of accreditation for these procedures. They will need specialized training to achieve adequate knowledge of the accessories for ERCP, their latest modifications, and applications. As therapeutic interventions increase in complexity, the requirements of sedation and monitoring will need a dedicated assistant or anesthesiologist.[5,7] They will be driven to develop strategies to achieve maximal efficiency from the standpoint of technology, pricing, and patient flow as is currently occurring in dedicated endoscopy, surgery, and radiology centers in isolation.

Databases and Documentation

The multidisciplinary approach to biliopancreatic disease relies on the conveyance of endoscopic images and procedure reports to other endoscopists, radiologists, surgeons, and pathologists. Standards for electronic data exchange[2] are also undergoing rapid change to accommodate improvements in digital imaging and the development of electronic charting and computer databases. This will require investment in computer hardware and programming that increases flexibility in communicating to a wide variety of operating systems. In the future, the use of an approved database is certain to become standard. The database will apply consensus criteria for complications and outcomes, and provide data to design strategies for improving the efficacy and safety of ERCP.

Outcomes Research

As ERCP is challenged by alternative modalities and procedure costs increase, there will be a growing need for outcomes and effectiveness studies to justify its application. It will become necessary to demonstrate not only cost effectiveness, but also significant impact on patient outcome. Because many maneuvers are palliative in nature and do not always impact on patient survival, outcome studies will need to include quality-of-life parameters. These studies will be facilitated by the development of the multidisciplinary center and improvement in electronic exchange of data as described previously.

CONCLUSION

As imaging modalities, such as MR cholangiopancreatography, CT cholangiopancreatography, and EUS mature, the diagnostic role of ERCP will diminish to the few areas for which their assessment is inadequate.

ERCP will develop new diagnostic indications through visual inspection of the ducts by cholangioscopy and pancreatoscopy, and visually guided tissue sampling. With more widespread applicability of miniscope technology in the biliary and pancreatic ducts, therapeutic ERCP can expect a renaissance. Visual identification of the abnormality will engender new interventional possibilities. Endoscopic technology used in other parts of the gastrointestinal tract, such as thermal and chemical ablation, may find applicability in the biliary and pancreatic ducts. This, in turn, will require the development of new accessories adapted to miniscopes. The increasing complexity of therapeutic ERCP, encompassing both cholangiopancreatography and cholangiopancreatoscopy, will mandate new training guidelines for ERCP. These interventions will be restricted to dedicated centers that are able to support the required technology and expertise.

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