Diagnostic imaging of patients with pancreato-biliary diseases: comparison among ultrasound, computed tomography and magnetic resonance imaging

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Purpose

The aim of this study was to evaluate the role of MRCP compared with US and MSCT in diagnosing pancreaticobiliary disease; we performed a comparative analysis of imaging results in the main regions of the pancreaticobiliary system (gallbladder, intrahepatic bile ducts, extrahepatic bile ducts, main pancreatic duct); furthermore, we directly compared the results of multi-slice CT and those of MR imaging in tumor detection and in evaluating resectability of expansile malignant lesions in a group of patients with pancreatic masses.

Methods and Materials

A total of 110 patients (63 M, 48 F), ranging in age from 22 to 89 years, with pancreaticobiliary diseases was studied before surgery (n=99) or after cholecystectomy (n=11) for lithiasis. MRCP was performed in all patients while US was acquired in 55 patients and MSCT was performed in 77 patients. Histology (n=34), biopsy (n=38), endoscopic retrograde cholangio-pancreatography (ERCP) (n=28) and/or clinical-imaging follow-up (n=10) data were considered as standard of reference. Patient population was divided in three groups; Group 1 (n=55) consisted of a comparison between MRCP and US in biliary tract diseases; Group 2 (n=37) consisted of a comparison between MRCP and MSCT in biliary tract diseases; Group 3 (n=40) consisted of a comparison between MRCP and MSCT in pancreatic masses. For ultrasonography, patients were imaged with an ATL 5500 HDI unit after a 6-h fast and in various positions (supine, left lateral, upright). Examinations were carried out with a 3.5-4 MHz probe initially placed subcostally during deep breath-holding or between the 10th and 11th rib, without breath-holding. In all US studies, colour Doppler imaging was used to differentiate portal branches from dilated bile ducts. CT examinations were performed with a 64-detector row MSCT scanner (Aquilion, Toshiba). MR study was performed with a 1.5-Tesla scanner (Philips, Gyroscan Intera). Images were reviewed separately by two radiologists for each technique who evaluated US images as well as read CT and MR images, respectively. The readers evaluated the images independently and were blinded to patients’ clinical findings; in case of discordant imaging interpretation, a third reader for each technique was invited to provide an additional evaluation.

In groups 1 and 2, a regional analysis of the concordance or discordance of the results obtained with the two imaging techniques was carried out by comparing the main regions of the pancreaticobiliary system: gallbladder and cystic duct, intrahepatic bile ducts, extrahepatic bile ducts (divided into common hepatic duct and common bile duct) and main pancreatic duct. Statistical significance of results of the regional analysis in the two groups was evaluated using the McNemar test, with significance set at \( p < 0.05 \).
In Group 3, each reader used a score from 1 to 5 for identifying and characterising the pancreatic masses (1=definitely benign, 2=probably benign, 3=indeterminate, 4=probably malignant, 5=definitely malignant). The readers also evaluated the resectability of the malignant lesions (n=32), according to previously reported criteria [36], using a score from 1 to 3 (1=resectable, 2=indeterminate, 3=unresectable); for each of the two modalities, we calculated sensitivity, specificity, diagnostic accuracy and positive (PPV) and negative (NPV) predictive values for both identifying and evaluating resectability of the pancreatic masses. To assess statistical significance of any differences between CT and MR imaging, we used the McNemar test, with significance set at \( p < 0.05 \).

**Results**

In Group 1, 212 biliary regions were analysed: gallbladder and cystic duct in 47 cases, intrahepatic bile ducts in 55, extrahepatic ducts in 55 and main pancreatic duct in 55. As eight patients were undergoing follow-up after cholecystectomy, the gallbladder region was not evaluated. The analysis showed concordant results in most cases and in most anatomical regions of the pancreaticobiliary system. In the evaluation of the gallbladder region, there was concordance between MRCP and US in 45 cases (96%). Similarly, in the evaluation of the intrahepatic bile ducts, there was concordance between MRCP and US in 52 cases (95%). In the evaluation of the main pancreatic duct, there was concordance between MRCP and US in 52 cases (95%). MRCP and US were also concordant in yielding negative findings in the remaining 46 cases. In the study of the extrahepatic bile ducts, there was concordance between MRCP and US in 46 cases (84%); however, in nine cases (16%) the results were discordant; in particular, MRCP showed filling defects related to middle-proximal stones (n=3) and distal stones (n=6) in the extrahepatic bile ducts, as confirmed by ERCP; these lesions went undetected at US (Figure 1). Based on statistical analysis, the 16% discordance between MRCP and US in the evaluation of the extrahepatic bile ducts was statistically significant (\( p=0.003 \)).

In Group 2, 143 biliary regions were analysed: gallbladder and cystic duct in 32 cases, intrahepatic bile ducts in 37, extrahepatic bile ducts in 37 and main pancreatic duct in 37. Five patients were studied during follow-up after cholecystectomy, so the gallbladder region was not assessed. The analysis of the two techniques yielded concordant results in most cases in the gallbladder region (91%) and the main pancreatic duct (92%). In contrast, in the study of the intra-hepatic and extra-hepatic ducts, the two methods yielded a rate of discordance of 19% (n=7) and 16% (n=6), with positive findings on MRCP compared with CT in all cases; positive findings on MRCP were the presence of simple ductal ectasia of the intrahepatic bile ducts (n=7) (Figure 2), common bile duct (n=1), common hepatic duct (n=3) and proximal common bile duct (n=1) due to bile stones, or a lack of signal at the level of the proximal common bile duct (n=1) due to a malignant stenosing lesion (cholangiocarcinoma), as confirmed by ERCP. Based on
statistical analysis, the 19% discordance rate in evaluating the intrahepatic bile ducts was statistically significant ($p=0.008$), as was the 16% discordance rate in evaluating the extrahepatic bile ducts ($p=0.01$).

In Group 3, results of the CT and MR imaging studies in patients with ductal adenocarcinoma or cystic tumours of the pancreas, along with biopsy ($n=25$) and/or histology ($n=7$) results, consisted of 31 cases of pancreatic malignancies, of which 24 were ductal adenocarcinomas, six were mucinous cystadenocarcinomas and one was an intraductal mucinous papillary tumour; in one case, the lesion was benign and consisted of a serous cystadenoma. Lesions involved the pancreatic head ($n=19$), body ($n=7$) and tail ($n=6$) and were from 1 to 8 cm in size [2.6 ± 1.2 standard deviation (SD)]. In the remaining eight patients, the pancreatic masses corresponded to tissue degeneration due to chronic pancreatitis, which was diffuse in the majority of patients (7/8 cases) and focal in one case only. With regard to identification and localisation of pancreatic masses, the overall results of CT and MR imaging demonstrated a comparable diagnostic accuracy of CT and MR imaging (98%). Only one patient with focal chronic pancreatitis was negative for neoplastic lesions on both CT and MR imaging. The results of CT and MR evaluation in terms of tumor resectability consisted of 25 patients with unresectable tumours, of which 13 had neoplastic invasion of both mesenteric vessels, associated with hepatic metastases in one case, nine had involvement of the superior mesenteric vein (Figure 3), again associated with hepatic metastases in one case, and one patient, with a tumour of the pancreatic body, showed invasion of the celiac trunk. Finally, in two patients, unresectability was due to the presence of hepatic metastases. Thus, the diagnostic accuracy of CT and MR imaging in the judgement of tumour resectability was similar, with values of 94% and 90%, respectively ($p$=not significant); there were two cases in which both CT and MR imaging provided a false negative result, and one case in which MR imaging only provided a false negative result.

Images for this section:
Fig. 1: Figure 1A. Choledocholithiasis: discordant findings between ultrasound and MRCP for the main biliary tract. Ultrasound: the choledocus is dilated (maximum transverse diameter: 11 mm) with no evidence of stones associated.
Fig. 2: Figure 1B. Choledocholithiasis: discordant findings between ultrasound and MRCP for the main biliary tract. MRCP confirms the diagnosis of choledocus ectasia and shows two round "filling defects" in the distal tract of the choledocus, suggestive for stones.
**Fig. 3:** Figure 2A. Intra-hepatic biliary lithiasis: discordance between CT and MRCP findings. CT shows intra-hepatic biliary ducts dilation, with no evidence of associated focal lesions.
Fig. 4: Figure 2B. Intra-hepatic biliary lithiasis: discordance between CT and MRCP findings. MRCP shows signs of intra-hepatic biliary lithiasis represented by diffuse duct ectasia and by the presence of focal "filling defects" (arrow) near the hilum; furthermore, a stone within the gallbladder is detected in the infundibulum.
**Fig. 5:** Figure 3A. T2-weighted MR image confirms the presence of the cystic mass in pancreatic head with similar (“tear-drop”) appearance of SMV, which shows low signal intensity.

**Fig. 6:** Figure 3B. Enhanced T1-weighted MR image shows similar CT characteristics of the tumor mass.
Conclusion

The results of our study suggest that compared with US and CT, MRCP provides greater diagnostic accuracy in evaluating the intrahepatic and extrahepatic bile ducts because it identifies a larger number of strictures secondary to gallstones and their impact on biliary dynamics (pre-stenotic dilatation, post-stenotic bile flow); furthermore, on the basis of our experience we also suggests that MR imaging of the pancreas performed with a state-of-art-equipment and a dedicated study protocol represents a valuable alternative to CT in the diagnostic assessment of patients with pancreatic masses; in particular, MRCP provides both accurate identification and characterization of lesions and an appropriate evaluation of resectability in case of malignant masses; the non-invasiveness, the lack of ionising radiation compared to CT, the panoramic capabilities and the high contrast resolution of MRCP in depicting the pancreatobiliary system are significant technical advantages that justify its routine clinical use as a supplement to US, with CT being restricted to patients with contraindications to MRCP or to settings where MRI is not available.

References


Personal Information