CONCLUSIONS: MDCT imaging and post-processing techniques have significant application in the diagnosis of benign and malignant lesions, as well as a malignant tumor of the common bile duct ampulla.

Key Words: Common bile duct ampulla, Malignant tumor, Multi-detector CT.

Introduction

Pancreatic head cancer, terminal cholangiocarcinoma, and ampullary carcinoma (duodenal papillary carcinoma) are common types of bile duct malignant tumors. The early stages for these tumors lack typical clinical manifestations, which complicate the early diagnosis. When discovered in late stages, these tumors show low surgical resection rates and poor prognoses, with the 3-year survival rate around 30%\(^1\). The clinical manifestations are mainly biliary obstruction, jaundice, and abdominal pain. Detecting methods include ultrasound imaging, magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), computed tomography (CT) and cholangiography imaging. ERCP and PTC can directly visualize the biliary tree, obtain tissue specimens for pathological diagnosis (gold standard), and perform interventional therapy\(^2,3\). However, these are invasive and highly traumatic methods, and usually not considered as the preferred method of examination. Ultrasound imaging is susceptible to intestinal gas interference, which decreases sensitivity and specificity\(^4\). MRCP is non-radioactive and more sensitive to soft tissue imaging, but shows decreased ability to identify stones, inflammation, and other benign lesions\(^5\). Multi-detector CT (MDCT) has the advantages of high scanning...
speed, thin slice, high resolution, and isotropy. MDCT can reconstruct the biliary duct three-di-
mensional shape by combining with multi-phase 
enhancement and volumetric scan. This imaging 
method clearly shows the structure of the 
bile duct and the surrounding soft tissue. This is 
called negative CT bile duct imaging 6,7. The aim 
of this study is to analyze MDCT imaging char-
acteristics for different types of malignant tumors 
in the common bile duct ampullary region, and to 
provide a reference for accurately diagnosing ear-
ly stage tumors, designing therapeutic regimens, 
and improving survival prognosis.

Patients and Methods

Patients
We examined retrospectively the common bile 
duct ampullary malignant tumor in the Henan 
Provincial People’s Hospital (Zhengzhou Uni-
versity People’s Hospital) pathologically diag-
nosed by obtaining tissue samples. The Ethic 
Committee of Henan Provincial People’s Hospi-
tal approved this study. We analyzed 30 cases of 
pancreatic head cancer, 35 of terminal cholangio-
carcinoma, and 26 of ampullary carcinoma. We 
also collected 40 cases of benign lesions in the 
same period, including 28 with stones, 12 with 
inflammation. 12 males and 18 females had pan-
creatic head cancer with an average age of 65.6 ± 
13.2. The pathological types included ductal ade-
nocarcinoma, clinical stage II (5 cases), stage III 
(13 cases), stage IV (12 cases). 15 cases showed 
poor differentiation, 9 with moderate differenti-
tation, and 6 were well differentiated. Clinical 
manifestations were mainly jaundice, fever, and 
abdominal pain. Of the terminal cholangiocar-
cinomas, 20 were males and 15 females with an 
average age 63.5 ± 12.8 years. The pathological 
types included different stages of bile duct epithe-
lial cell carcinoma: 6 cases in clinical stage II, 14 
in stage III, and 15 in stage IV. 16 cases had poor 
differentiation, 14 moderate differentiated, and 5 
were well differentiated. The clinical manifesta-
tions were mainly biliary obstruction, jaundice, 
and liver dysfunction. We examined 14 males and 
12 females with ampullary carcinoma with an av-
erage age of 65.6 ± 14.7 years. The pathological 
types included different stages of adenocarcino-
ma: 4 cases in clinical stage II, 13 stage III, and 9 
in stage IV. 12 cases had poor differentiation, 11 
moderate differentiation, and 3 were well differ-
entiated. The clinical manifestations were mainly 
abdominal pain, nutritional disorders, and intes-
tinal obstruction. Benign lesions were diagnosed 
in 22 males and 18 females, with an average age 
of 60.86 ± 15.5 years. The clinical manifestations 
were biliary obstruction, jaundice, fever, and ab-
dominal pain. There was no significant difference 
in sex and age distribution of patients with differ-
ent types of lesions (p>0.05).

Research Methods
United States GE Lightspeed 64 slice spiral 
CT scanner, ADW4.2 post-processing station 
and double-syringe high-pressure injector were 
used. Scanning range was from the top of the 
right diaphragm to the lower pole of both kid-
nies. Conventional scanning parameters were 
set at slice thickness 5 mm, layer spacing 5 
mm, 120 kV, 250 mA, pitch 1.5, bulb tube ro-
tation time 0.8 sec 100 mL enhancing contrast 
agent Ultravist 370 was injected via intrave-
nous bolus injection at a rate of 3.0 mL/sec, 
arterial, venous phase and equilibrium phase 
scanning were performed at 35, 80, and 180 sec 
delay with the same scan parameters as above. 
The data were input into post workstation and 
performed with thin-section reconstruction us-
ing multi-planar reconstruction (MPR) and sur-
face reconstruction (CPR), parameters were set 
at 1.25 mm slice thickness and 1.25 mm slice 
increment. The research was divided into im-
age scanning group, post processing group, im-
age analysis group and data statistics group, 
each group had 2-3 professionals.

Observation Indexes
We analyzed image quality, focusing on dila-
tation of intrahepatic and extrahepatic bile duct, 
gallbladder and common bile duct, and morphol-
yogy and enhancement pattern of lesions and sur-
rounding tissues. We selected images without ar-
tifacts, clearly showing bile duct and surrounding 
structures.

Statistical Analysis
Statistical analysis was carried out using 
SPSS20.0 software (SPSS Inc., Chicago, IL, 
USA). Measurement data were expressed as mean 
± standard deviation, single-factor ANOVA was 
used to compare two groups, The LSD-t method 
was used to compare between every two. Enu-
meration data were expressed as a number of cases 
or %; the χ2-test was performed for comparis-
ons between the two groups. Differences were 
considered statistically significant when p <0.05.
Results

Analysis of Bile Duct Dilation
We observed intrahepatic and extrahepatic bile duct, and pancreatic duct dilation in pancreatic head cancer cases. 27 cases (90.0%) showed double duct sign and no significant dilatation of gallbladder. 13 cases (43.3%) were combined with pancreatic head and pancreatic duct atrophy. Severe intrahepatic and extrahepatic bile duct dilation were observed in terminal cholangiocarcinoma (bile duct diameter 1.9 ± 0.6 cm). 13 cases (37.1%) showed completely blocked distal bile duct and local lumen disruption. 12 cases (34.3%) showed moderate gallbladder dilation and no significant dilatation of the pancreatic duct. Light to moderate dilation of the intrahepatic and extrahepatic bile duct was observed in ampullary carcinoma with no obvious gallbladder dilatation. 8 cases (30.8%) showed pancreatic duct dilatation. 5 cases (19.2%) showed double duct sign. No obvious intrahepatic, extrahepatic bile duct, and pancreatic duct dilatation were found in benign lesions. Gallbladder dilation was observed in 10 cases (25.0%). The dilation rate of intrahepatic, extrahepatic bile duct, and gallbladder was the highest in terminal cholangiocarcinoma and pancreatic head carcinoma showed the most obvious double duct sign.

Morphology of Lesion and Surrounding Tissue
Pancreatic head cancer showed an enlarged pancreatic head. The average diameter of the tumor was 3.3 ± 0.8 cm. They showed significant lumen pressure and no significant thickening of the tube wall. 6 cases (20.0%) showed soft tissue mass in the pancreas contour, protruding to the outside of the pancreatic contour and the superior mesenteric vein. 18 cases (60.0%) showed low-density necrosis inside the tumor. Terminal cholangiocarcinoma showed 1.9 ± 0.7 cm average tumor diameter, tube wall eccentricity, ring thickening and soft-tissue density modules, and no obvious necrosis, liquefaction or calcification. 7 cases (20%) showed enlarged lymph nodes around the tumor, protruding towards the common bile duct wall. Ampullary carcinoma showed circular isodensity nodules. The average tumor diameter 2.5 ± 0.6 cm, with wall eccentricity, ring thickening, and stenosis. 4 cases (15.4%) showed peripheral lymphadenopathy. Benign lesions showed round, oval, or irregular hyperdensity shadow, no significant thickening of the lumen, and no significant changes in the surrounding tissue morphology. The pancreatic head cancer had a larger diameter, a higher rate of internal necrosis, and was more vulnerable to invading the surrounding tissues. Terminal cholangiocarcinoma had a smaller diameter and more thickening of the tube wall.

Enhancement Pattern Analysis
The plain scan density of pancreatic head carcinoma was slightly lower than pancreatic parenchyma. The arterial and venous phases had a slight early stage enhancement. The enhancement degree was lower than in normal pancreatic tissue. The internal necrotic area was not enhanced and the boundary was unclear. In terminal cholangiocarcinoma, the thickening of the wall showed isodensity. The enhancement was obvious, the delayed enhancement was more common. The intrahepatic and extrahepatic bile duct enhancement degree was significantly higher than in pancreatic head cancer and slightly higher than in ampullary carcinoma. The edge of ampullary carcinoma was significantly enhanced. The enhancement degree in ampullary carcinoma was higher than in pancreatic cancer and lower than in the common bile duct cancer. Arterial and venous phase enhancement were significant. Benign lesions did not show any significant enhancement.

Discussion
MDCT imaging and post-processing techniques can be used to examine tubular structures with a large curvature such as pancreatic duct and bile duct dilation, stenosis, and cross-sectional truncation changes. Curved surface reconstruction can also show all or most of the left and right hepatic duct, cystic duct, common hepatic duct, and common bile duct. The structures can be shown in the same plane through the choice of different paths and angle rotation, or fractional reconstruction. The images can comprehensive display overall biliary morphology, clearly showing the location of obstructions, proximal obstruction, dilation, obstruction range, and spatial structure relationship with the adjacent tissue structure. Thus, MRCT-derived three-dimensional images can accurately identify the nature of these lesions. According to our study, we conclude that benign lesions and different types of malignant tumors in the ampullary region show robust differences by MRCP.
The differences include the dilation of intrahepatic and extrahepatic bile duct, gallbladder, common bile duct, lesion size, wall and lumen morphology, surrounding tissue involvement, and enhancement patterns of lesions at different stages. Pancreatic head cancer mainly originates in the pancreatic duct epithelial cells, has a low blood supply and vulnerability to necrosis, forms cystic space, does not significantly enhance in arterial phase, and forms density difference with normal pancreatic parenchyma11,12. The tumors have high malignancy, fast proliferation rate, invade adjacent tissue, and metastasize easily at an early stage. Therefore, these tumors have large diameters and obvious internal necrosis13. The pancreatic head is located outside the lumen of the common bile duct ampulla. The luminal pressure is obvious, but wall thickening and stenosis are not obvious. The common pancreatic and bile ducts converge at the ampulla area to form a typical “double duct sign”14. The infiltrate type is more common in terminal cholangiocarcinoma showing markedly delayed enhancement, which may be related to the rich fibrous tissue in tumors15. The tumor cells grow along the inner tube wall. Therefore, the thickening of the wall is uneven and more obvious, distal lumen occlusion is common, and proximal common bile duct expansion is the most significant16. Ampullary carcinomas mainly present nodular masses in the inner wall of the descending duodenum below the pancreatic head, with significant enhancement in arterial phase17. CT findings of ampullary carcinoma mostly fall in between pancreatic cancer and terminal cholangiocarcinoma, which makes it harder to identify. Ampullary carcinoma has a significant dilatation of intrahepatic bile duct but no significant atrophy in pancreatic body and tail, which may contribute to the diagnosis18.

Conclusions

MDCT imaging and post-processing techniques demonstrate a significant value in the diagnosis of bile duct ampullary benign and malignant lesions as well as malignant tumor characteristics, identifying from the bile duct dilatation, lesions, surrounding tissue and enhancement patterns.

Conflict of interest

The authors declare no conflicts of interest.

References


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