**Name of Journal**: *World Journal of Gastrointestinal Oncology*

**Manuscript NO:** 56445

**Manuscript Type**: ORIGINAL ARTICLE

***Retrospective Study***

**Clinical diagnosis and management of** **pancreatic mucinous cystadenoma and cystadenocarcinoma: Single-center experience with 82 patients**

Zhao ZM *et al*. Management for pancreatic MCA and MCC

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**Received:** April 30, 2020

**Revised:** May 18, 2020

**Accepted:** May 21, 2020

**Published online:** June 15, 2020

**Abstract**

BACKGROUND

Mucinous cystic neoplasm (MCN) of the pancreas is characterized by mucin-producing columnar epithelium and dense ovarian-type stroma and at risk for malignant transformation. Early diagnosis and treatment of MCN are particularly important.

AIM

To investigate the clinical characteristics of and management strategies for pancreatic mucinous cystadenoma (MCA) and mucinous cystadenocarcinoma (MCC).

METHODS

The clinical and pathological data of 82 patients with pancreatic MCA and MCC who underwent surgical resection at our department between April 2015 and March 2019 were retrospectively analyzed.

RESULTS

Of the 82 patients included in this study, 70 had MCA and 12 had MCC. Tumor size of MCC was larger than that of MCA (*P* = 0.049). Age and serum levels of tumor markers carcinoembryonic antigen (CEA), carbohydrate antigen (CA) 19-9, and CA12-5 were significantly higher in MCC than in MCA patients (*P* = 0.005, 0.026, and 0.037, respectively). MCA tumor size was positively correlated with serum CA19-9 levels (*r* = 0.389, *P* = 0.001). Compared with MCC, MCA had a higher minimally invasive surgery rate (*P* = 0.014). In the MCA group, the rate of major complications was 5.7% and that of clinically relevant pancreatic fistula was 8.6%; the corresponding rates in the MCC group were 16.7% and 16.7%, respectively.

CONCLUSION

Tumor size, age, and serum CEA, CA19-9, and CA12-5 levels may contribute to management of patients with MCN. Surgical resection is the primary treatment modality for MCC and MCA.

**Key words:** Pancreatic neoplasms; Mucinous cystadenoma; Mucinous cystadenocarcinoma; Biochemical indexes; Diagnosis; Surgery

**Citation:** Zhao ZM, Jiang N, Gao YX, Yin ZZ, Zhao GD, Tan XL, Xu Y, Liu R. Clinical diagnosis and management of pancreatic mucinous cystadenoma and cystadenocarcinoma: Single-center experience with 82 patients. *World J Gastrointest Oncol* 2020; 12(6): 642-650

URL: <https://www.wjgnet.com/1948-5204/full/v12/i6/642.htm>

DOI: https://dx.doi.org/10.4251/wjgo.v12.i6.642

**Core tips:** In this study, we retrospectively analyzed the clinical and pathological records related with pancreatic mucinous cystadenoma (MCA) and mucinous cystadenocarcinoma (MCC). We found that the MCC tumor size was larger than that of MCA, and age, serum carcinoembryonic antigen, carbohydrate antigen (CA) 19-9, and CA12-5 levels were also higher in MCC patients. As the tumor size of MCA increased, the level of serum CA19-9 also increased. Surgical resection is the primary treatment for MCC and MCA.

**INTRODUCTION**

Mucinous cystic neoplasm (MCN) is a cyst-forming epithelial tumor composed of ovarian-type stroma and mucin-producing columnar epithelium[1]. It is a rare pancreatic disease that does not communicate with the pancreatic duct[2]. Currently, owing to the development of imaging and endoscopic techniques, as well as the increased understanding of the disease, the detection rate of MCN has been increasing every year. The biological characteristics of MCN can potentially lead to the development of malignant tumors, and atypical columnar cell hyperplasia can be observed on most cyst walls[3,4]. Mucinous cystadenocarcinoma (MCC) may be formed *via* the malignant transformation of MCN with the same origin. It is generally discovered when patients present at the clinic with obstructive jaundice and evident abdominal mass. MCC has a poor sensitivity to radiotherapy and chemotherapy, and surgical resection is the primary treatment modality for MCC[5]. Early diagnosis and treatment of MCN are particularly important because of the potentially malignant manifestations and the lack of specific clinical symptoms. Therefore, this study retrospectively analyzed the data of 82 patients with pancreatic MCN who underwent surgical resection at our department between April 2015 and March 2019.

**MATERIALS AND METHODS**

***Study population***

Between April 2015 and March 2019, a total of 82 patients who underwent surgery at our department were included, of whom 70 had mucinous cystadenoma (MCA) and 12 had MCC as confirmed by postoperative pathology findings. The pancreatic MCN was defined as a pancreatic cystic tumor lined by columnar mucin-producing cells and overlying ovarian-type stroma. Carcinoma *in situ* and invasive carcinomas were considered malignant (MCC) and other MCN considered as MCA in this study. The baseline characteristics of the patients are shown in Table 1.

***Preoperative evaluation and postoperative management***

The surgical indications for MCA were based on the International Association of Pancreatology consensus guidelines[6-8]. Postoperative complication was defined as a complication occurring within 30 d after surgery or before discharge from the hospital. Clavien-Dindo grades II or less complications were categorized as moderate complications, and Clavien-Dindo grades III, IV, and V were considered major complications (graded by the Clavien-Dindo classification[9]). According to the 2016 update of the International Study Group on Pancreatic Surgery classification[10], fistulas of grades B and C were defined as clinically relevant pancreatic fistulas (CRPFs).

***Study methods***

Baseline patient characteristics, preoperative imaging results, preoperative laboratory parameters, intraoperative data, postoperative pathology, and postoperative complications were collected and analyzed.

***Statistical analysis***

Statistical analyses were performed using SPSS 22. Continuous variables are expressed either as the mean ± SD or median and interquartile range (IQR) depending on whether a normal distribution was verified. Specifically, data on age were normally distributed, and *t* test was used for comparisons; data on tumor size, serum carcinoembryonic antigen (CEA), carbohydrate antigen (CA) 125, and CA19-9 did not follow a normal distribution, and Mann–Whitney *U* test was used for comparisons. Correlation testing was conducted using Spearman rank correlation test. Discrete data are represented as rates (%), and were compared using Fisher's exact test. A *P* value < 0.05 was considered statistically significant.

**RESULTS**

***Pathology and symptoms***

According to the pathology examination of the postoperative paraffin sections, there were 12 patients with MCC (including 3 cases of carcinoma *in situ*) and 70 patients with MCA.

The MCA tumor size was between 1.5 cm and 10 cm, with a median (IQR) of 3.5 cm (2.5-6.1 cm), and the MCC tumor size was between 2.5 and 10 cm, with a median (IQR) of 5.8 cm (4.0-6.9 cm). The tumor size of MCC was larger than that of MCA, and the difference was statistically significant (*P* = 0.049, Table 1).

Of the 70 patients with MCA, 22 had nonspecific upper abdominal bloating and abdominal pain, 11 had a palpable abdominal mass detected during physical examination, 4 had weight loss, 1 had jaundice, and 1 had gastrointestinal symptoms, such as nausea, vomiting, and fatigue. Of the 12 patients with MCC, 4 had a palpable abdominal mass, 4 had abdominal pain, and 2 had jaundice.

***Tumor marker testing results***

Chemiluminescent immunoassay was performed to detect serum CEA, CA19-9, and CA12-5.

Mann-Whitney *U* test showed that the serum levels of all the three markers (CEA, CA19-9, and CA12-5) were significantly higher in MCC than in MCA patients (*P* = 0.005, 0.026, and 0.037, respectively), while the percentages of patients with CEA > 5 µg/L, CA19-9 > 37 U/mL, or CA12-5 > 35 U/mL were higher in MCC patients than in MCA patients (*P* = 0.021, 0.027, and 0.038, respectively; Table 1). Furthermore, the MCA tumor size was positively correlated with serum CA19-9 levels (*r* = 0.389, *P* = 0.001).

***Imaging results***

Imaging results showed that MCA tumors were located in the head of the pancreas in 13 (18.6%) patients, in the neck of the pancreas in 3 (4.3%), and in distal pancreas (the body and tail of the pancreas) in 54 (77.1%). MCC tumors were located in the head of the pancreas in 5 (41.7%) patients and in the body and tail of the pancreas in 7 (58.3%).

MCA usually appeared as oligocystic or macrocystic lesions with < 6 cysts, and the inner cyst diameter was generally larger than 2 cm. MCA often occurred in the body and tail of the pancreas. If the possibility of pancreatic pseudocyst was ruled out, the diagnosis of MCA should be considered for oligocystic lesions that occurred in the body and tail of the pancreas in middle-aged women (Figure 1). The risk of malignant transformation should be considered when the diameter of the cyst was too large (Figure 1).

***Surgery and postoperative complications***

Among the 70 patients with MCA, 4 underwent open surgery, 7 underwent laparoscopic surgery, and 59 underwent robotic surgery. The rate of minimally-invasive surgery was 94.3%. Among the 12 patients with MCC, 4 underwent open surgery and 8 underwent robotic surgery. The rate of minimally-invasive surgery was 66.7%. Minimally invasive surgery was significantly more frequent in patients with MCA compared with those with MCC (Table 1).

For patients with MCA, the rate of major complications was 5.7% and that of CRPF was 8.6%. The median postoperative hospital stay was 6.5 d. Postoperative complications are shown in Table 2. For patients with MCC, the rate of major complications was 16.7% and that of CRPF was 16.7%. The median postoperative hospital stay was 9 d. Postoperative complications are shown in Table 3.

**DISCUSSION**

Approximately 90% of MCNs occur in middle-aged premenopausal women[11]. MCNs accounts for approximately 10% of pancreatic cystic lesions, most of which are solitary cystic lesions typically located in distal pancreas[12] and possess the potential to become MCC. In this study, MCAs were primarily located in distal pancreas (77.1%), whereas 58.3% of MCCs were found in distal pancreas.

MCA is generally unilocular or multilocular, with a cyst diameter > 2 cm, and the internal fibrous septations are more apparent after enhancement[13,14]. Studies have drawn different conclusions regarding the specific threshold value of cyst diameter over which the risk of malignancy is increased. It is generally believed that the cyst wall diameter in malignant MCN is usually > 4 cm[15], or that a diameter of ≥ 6 cm is a risk factor for malignant tumors[11,16,17]. In addition, other manifestations suggestive of malignant MCA include peripheral calcification, irregularly contoured cyst walls, thickening of internal septations, increased papillary projections, intracystic nodules, local organ invasion, and vascular obstruction and compression. Di Paola *et al*[16] studied 65 patients with MCNs who underwent magnetic resonance imaging and found that there may be a risk of malignant transformation if the diameter is greater than 7 cm, septa and wall thickness was > 3 mm, and there were nodules. In this study, the median diameter of MCA was 3.5 cm and that of MCC was 5.8 cm. The MCC size was larger than that of MCA. Because malignant MCN less than 4 cm is rare (0.03%[18]), European Guidelines use this as a cut-off size for surveillance without resection[19]. However, one (8.3% of MCCs) patient in the current study with a tumor of 2.5 cm had invasive carcinoma. The cut-off value of tumor size might be reconsidered in the future revisions of guidelines.

Recently, a large multicenter study[1] on MCN showed that older age, high levels of serum CEA or CA19-9, large tumor size, and the presence of mural nodules were risk factors for MCC. Similar results were also observed in the current study. Age and serum levels of tumor markers CEA, CA19-9, and CA12-5 were significantly higher in MCC than in MCA patients. In addition, our study showed that the MCA tumor size was positively correlated with the level of serum CA19-9.

Given the challenges in the diagnosis of pancreatic cystic diseases, as well as the high malignant potential of MCN, the International Association of Pancreatology consensus guidelines recommended surgical resection. However, conventional laparotomy is associated with several issues, such as an overly large incision, delayed recovery, and significant psychological burden on the patients. With the development of minimally invasive technology, the use of laparoscopy and robotics has successfully eliminated the above-mentioned problems. Especially for younger patients, there is an urgent need for aesthetics of the wound and high quality of life after operation. Compared with laparoscopy, robotic surgery has distinct technical advantages, including the high-definition three-dimensional stereoscopic visualization, the flexible biomimetic mechanical wrist, and the stable tremor-free arm[20,21]. These advantages allow for the precise dissection and fine suturing required in pancreatic surgery[22,23]. In this study, the minimally invasive operation rate in the MCA group was 94.3%, which was higher than that (66.7%) of the MCC group. In minimally invasive surgery, robotic procedures accounted for the majority. Among patients with MCA included in the present study, 65.7% underwent distal pancreatectomy, 12.9% underwent pancreaticoduodenectomy, 4.3% underwent central pancreatectomy, and 17.1% underwent enucleation. For patients with MCC, 58.3% underwent distal pancreatectomy and 41.7% underwent pancreaticoduodenectomy. Distal pancreatectomy is a common surgery for MCN and the spleen should be preserved as much as possible for patients with MCA. In the MCA group, the rate of major complications was 5.7% and that of grade B pancreatic fistula was 8.6% with no grade C, which were slightly lower than other reports on pancreatectomy available in the literature[24,25].

This study had several shortcomings. First, the number of patients included is small, and as a single-center study, there may be statistical bias. Second, this study is retrospective; thus selection bias cannot be eliminated. The conclusions of this study still need to be validated in multi-center large-scale studies in the future.

In summary, MCN is commonly found in middle-aged women and typically occurs in the body and tail of the pancreas. Most MCN are oligocystic or macrocystic lesions with malignant potential. There remain considerable challenges for a definite diagnosis prior to surgery. Older age, high levels of serum CEA, CA19-9, or CA12-5, large tumor size, and the presence of mural nodules were risk factors for MCC. Minimally invasive surgical resection is a safe and effective treatment modality for patients with MCC and MCA.

**ARTICLE HIGHLIGHTS**

***Research background***

Mucinous cystic neoplasm (MCN) of the pancreas is characterized by mucin-producing columnar epithelium and dense ovarian-type stroma and at risk for malignant transformation. Early diagnosis and treatment of MCN are particularly important.

***Research motivation***

We comprehensively evaluated the clinical and pathological characteristics of MCA and MCC and further explored effective treatment strategy.

***Research objectives***

In this study, the authors aimed to investigate the clinical characteristics of and management strategies for pancreatic mucinous cystadenoma (MCA) and mucinous cystadenocarcinomas (MCC).

***Research methods***

The clinical and pathological data of 82 patients with pancreatic MCA and MCC who underwent surgical resection at our department between April 2015 and March 2019 were retrospectively analyzed.

***Research results***

Of the 82 patients included in this study, 70 had MCA and 12 had MCC. Tumor size of MCC was larger than that of MCA. Age and serum levels of tumor markers carcinoembryonic antigen (CEA), CA19-9, and CA12-5 were significantly higher in MCC than in MCA patients. MCA tumor size was positively correlated with serum CA19-9 levels. Compared with MCC, MCA had a higher minimally invasive surgery rate. In the MCA group, the rate of major complications was 5.7% and that of clinically relevant pancreatic fistula was 8.6%; the corresponding rates in the MCC group were 16.7% and 16.7%.

***Research conclusions***

Tumor size, age, and serum CEA, CA19-9, and CA12-5 levels may contribute to management of patients with MCN. Surgical resection is the primary treatment modality for MCC and MCA.

***Research perspectives***

Age and serum CEA, CA19-9, and CA125 levels can be used as an effective tool to help clinicians quickly identify MCC and MCA. Minimally invasive surgical resection is an effective treatment for MCC and MCA.

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**Footnotes**

**Institutional review board statement:** The study was approved by the Institutional Review Board of the Chinese People's Liberation Army General Hospital (S2016-098-02).

**Informed consent statement:** Patients were not required to give informed consent to the study because the analysis used anonymous clinical data that were obtained after each patient agreed to treatment by written consent.

**Conflict-of-interest statement:** All authors declare no conflicts-of-interest related to this article.

**Data sharing statement:** No additional data are available.

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**Manuscript source:** Unsolicited manuscript

**Peer-review started:** April 30, 2020

**First decision:** May 15, 2020

**Article in press:** May 21, 2020

**Specialty type:** Oncology

**Country/Territory of origin:** China

**Peer-review report’s scientific quality classification**

Grade A (Excellent): A

Grade B (Very good): B, B, B

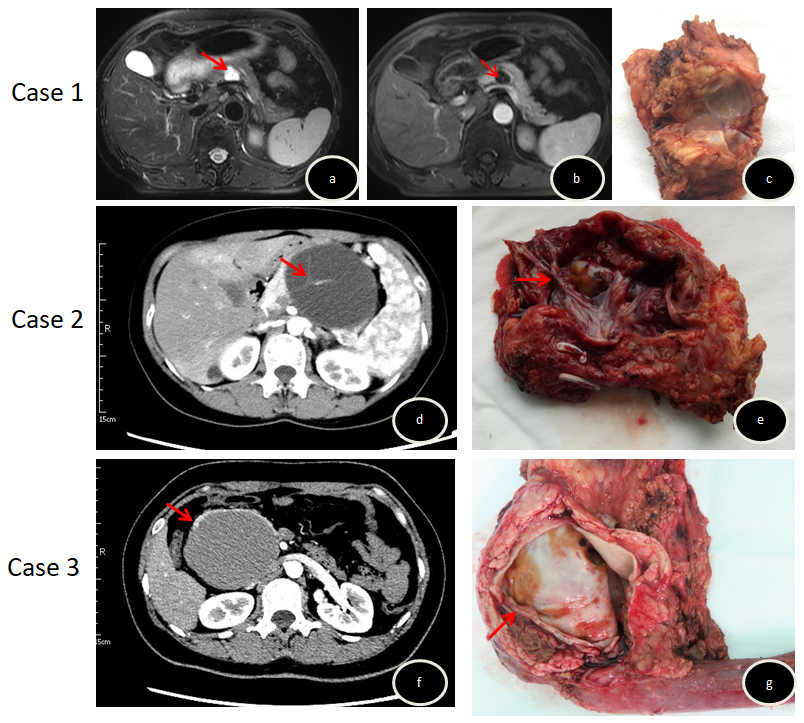
Grade C (Good): 0

Grade D (Fair): 0

Grade E (Poor): 0

**P-Reviewer:** Chamberlain MC, Dueland S, Kressel A, Sumi K **S-Editor:** Wang JL **L-Editor:** Wang TQ **E-Editor:** Qi LL

**Figure Legends**



**Figure 1 Imaging and histological characteristics of pancreatic mucinous cystadenoma and mucinous cystadenocarcinomas.** Case 1: Contrast-enhanced magnetic resonance imaging (MRI) for pancreatic mucinous cystadenoma (MCA). A: Pronounced cystic lesion approximately 2 cm in length in the body of the pancreas (arrow) as seen on a T2W axial MRI image; B: Cyst wall and internal septations enhancement in the portal phase,; C: Cut surface of the tumor with MCA pathology; Case 2: Contrast-enhanced computed tomography (CT) for pancreatic MCA. D: Cystic lesion in the body of the pancreas observed in the arterial phase of CT, with prominently enhanced internal septations (arrow); E: Cut surface of the tumor, with visible and pronounced internal septations (arrow) and MCA pathology; Case 3: Contrast-enhanced CT for pancreatic mucinous cystadenocarcinoma (MCC). F: Cystic lesion in the head of the pancreas observed in the arterial phase of CT. The cyst wall was thickened, but no internal septations were seen; G: Cut surface of the tumor. No internal septations can be seen. The thickness of the cyst wall measured approximately 3.5 mm (arrow); pathology testing showed features of MCC.

**Table 1 Patient characteristics in the two treatment groups, *n* (%)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Patient characteristic** | **MCA (*n* = 70)** | **MCC (*n* = 12)** | ***P* value** |
| Age, yr, mean ± SD | 46.2 ± 13.1 | 56.8 ± 9.4 | 0.0081 |
| Sex (Male: female) | 5:65 | 2:10 | 0.271 |
| Location, distal pancreas | 54 (77.1) | 7 (58.3) | 0.280 |
| Tumor size, cm, median (IQR) | 3.5 (2.5-6.1) | 5.8 (4.0-6.9) | 0.0491 |
| CEA (µg/L), median (IQR) | 1.4 (1.0-2.2) | 2.7 (1.6-5.5) | 0.0051 |
| > 5 µg/L | 2 | 3 | 0.0211 |
| CA19-9 (U/mL), median (IQR) | 14.2 (8.5-29.1) | 39.9 (13.0-71.0) | 0.0261 |
| > 37 U/mL | 13 | 6 | 0.0271 |
| CA12-5 (U/mL), median (IQR) | 12.1 (7.7-19.4) | 19.0 (10.8-36) | 0.0371 |
| > 35 U/mL | 3 | 3 | 0.0381 |
| Operative, minimally invasive | 66 (94.3) | 8 (66.7) | 0.0141 |

1Values are statistically significant. MCA: Mucinous cystadenoma; MCC: Mucinous cystadenocarcinomas; IQR: Interquartile range; CEA: Carcinoembryonic antigen; CA19-9: Carbohydrate antigen 19-9; CA12-5: Carbohydrate antigen 12-5.

**Table 2 Postoperative complications of pancreatic mucinous cystadenoma (*n* = 70)**

|  |  |
| --- | --- |
| **Feature** | ***n* (%)** |
| Pancreaticoduodenectomy | 9 (12.9) |
| Distal pancreatectomy | 46 (65.7) |
| Central pancreatectomy | 3 (4.3) |
| Enucleation | 12 (17.1) |
| Major complications (Clavien-Dindo ≥ 3) | 4 (5.7) |
| CRPF | 6 (8.6) |
| Grade B | 6 (8.6) |
| Grade C | 0 (0) |
| No CRPF | 64 (91.4) |
| Biochemical Leak | 36 (51.4) |
| Normal enzyme level | 28 (40.0) |
| Postoperative haemorrhage | 2 (2.9) |
| Delayed gastric emptying | 2 (2.9) |
| 90-d mortality | 0(0) |
| Postoperative hospital stay, days, median (IQR) | 6.5 (5.0-8.0) |

MCA: Mucinous cystadenoma; CRPF: Clinically relevant pancreatic fistula; IQR: Interquartile range.

**Table 3 Postoperative complications of mucinous cystadenocarcinoma (*n* = 12)**

|  |  |
| --- | --- |
| **Feature** | ***n* (%)** |
| Pancreaticoduodenectomy | 5 (41.7) |
| Distal pancreatectomy | 7 (58.3) |
| Major complications (Clavien-Dindo ≥ 3) | 2 (16.7) |
| CRPF | 2 (16.7) |
| Grade B | 2 (16.7) |
| Grade C | 0 (0) |
| No CRPF | 10 (83.3) |
| Biochemical leak | 6 (50.0) |
| Normal enzyme level | 4 (33.3) |
| Postoperative haemorrhage | 2 (16.7) |
| Delayed gastric emptying | 2 (16.7) |
| 90-d mortality | 0 (0) |
| Postoperative hospital stay, days, median (IQR) | 9.0 (7.3-13.5) |

MCC: Mucinous cystadenocarcinomas; CRPF: Clinically relevant pancreatic fistula; IQR: Interquartile range.