The European Research Journal 2023;9(5):903-909 Original Article

DOI: 10.18621/eurj.1282203 *Radiology*

Evaluation of intraductal papillary mucinous neoplasms detected incidentally with magnetic resonance cholangiopancreatography

Mustafa Orhan Nalbant

Department of Radiology, University of Health Sciences, Bakirkoy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey

ABSTRACT

Objectives: The aim of this study was to estimate the prevalence of coincidentally found intraductal papillary mucinous neoplasms (IPMNs) and assess their features with magnetic resonance cholangiopancreatography (MRCP) imaging.

Methods: The prevalence of incidentally detected IPMN was evaluated in 951 patients who underwent MRCP examination for various indications. MRCP images were assessed to analyze the number, size, location, and internal structure of lesions in patients with IPMN. Furthermore, the association between IPMN prevalence and age and gender was evaluated.

Results: IPMN was detected in 102 (10.7%) of 951 patients. Solitary IPMNs were located in different parts of the pancreas: in the uncinate process in 8 (7.8%), in the head and neck in 19 (18.6%), in the corpus in 10 (9.8%), and in the tail in 7 (6.9%) patients. IPMN was multiple in 58 (56.9%) patients. IPMN was identified in 41 (6.18%) patients under 65 years and 61 (21.18%) patients over 65 years, and the variance was statistically substantial ($p < 0.001$). IPMN diameter was 7.22 ± 4.3 mm in patients under 65 years and 9.21 ± 4.74 mm in those over 65 years, which was statistically significant ($p = 0.048$). Patients who were older were more likely to have multiple IPMNs ($p = 0.010$).

Conclusions: IPMNs increase in frequency, quantity, and size with age. MRCP is the most essential sequence for determining main pancreatic duct (MPD) involvement or communication, a critical finding for diagnosis. Since MRCP is capable of screening patients at very short intervals, it may be utilized for follow-up imaging in IPMN patients.

Keywords: Intraductal papillary mucinous neoplasm, pancreatic duct, pancreatic cystic lesion, magnetic resonance cholangiopancreatography

Cystic neoplasms of the pancreas are rare, comprising approximately 10% of pancreatic cysts and 1% of pancreatic carcinomas [1, 2]. As a consequence of developments in imaging technology, including computed tomography (CT), ultrasonography (USG), and magnetic resonance imaging (MRI) with magnetic resonance cholangiopancreatography (MRCP), they are one of the most commonly observed

Received: ***April 12, 2023;*** *Accepted:* ***May 5, 2023;*** *Published Online:* ***June 8, 2023***

How to cite this article: *Nalbant MO. Evaluation of intraductal papillary mucinous neoplasms detected incidentally with magnetic resonance cholangiopancreatography. Eur Res J 2023;9(5):903-909. DOI: 10.18621/eurj.1282203*

Address for correspondence: *Mustafa Orhan Nalbant, MD., University of Health Sciences, Bakirkoy Dr. Sadi Konuk Training and Research Hospital, Department of Radiology, Tevfik Saglam Cad., No. 11, Zuhuratbaba 34147, Bakirkoy, Istanbul, Turkey. E-mail: musnalbant88@hotmail.com, Phone: +90 212 542 44 91*

e-ISSN: 2149-3189

pathologies [3-8]. Pancreatic cystic neoplasms encompass an extensive spectrum of genetic, inflammatory, and malignant etiological factors [9].

Given the possibility of malignancy in these cystic neoplasms, accurate diagnosis and treatment are critical. Nonetheless, little data is available regarding its occurrence and clinical relevance in the general populace. Intraductal papillary mucinous neoplasm (IPMN) is one of the cystic neoplasms that is a precancerous mass of the pancreas [10-12]. IPMN has been divided into branch duct (BD-IPMN) and main duct (MD-IPMN) types depending on the site of the affected pancreatic duct [13, 14]. Consequently, individuals with a branch duct IPMN are frequently directed to monitoring programs, and surgery is suggested when follow-up findings imply the development of high-grade dysplasia or malignancy. After a 5-year observation period, it is suggested that the surveillance of asymptomatic patients with IPMNs that have not changed or have changed only moderately should be terminated [15-17].

Increasing data indicate that carcinoma progression in individuals with IPMNs occurs by two primary routes: de novo pancreatic ductal adenocarcinoma (PDAC) or arising from IPMN [18, 19]. On the basis of imaging features and/or pathological analyses, these carcinomas are distinguished clinically.

Few studies have been conducted to determine the prevalence of IPMNs to date. The objective of our study was to determine the prevalence of incidentally detected IPMN and their evaluation based on gender, age, size, location, and internal structure.

METHODS

Patient Data

Our institution's Ethics Committee approved this retrospective research (approval number: 2023/36). The patient files were examined for those who underwent MRCP examinations with different clinical indications between August 2020 and November 2022. The following were the inclusion criteria for the research: Patients with (a) MRCP imaging; (b) pancreatic cystic lesions and imaging results consistent with IPMN; (c) no known pancreatic cyst; and (d) adequate image quality for optimal evaluation.

The search turned up a sum of 1011 patients. 10 patients under 18 years of age; 5 patients with a connection between the cyst and the main pancreatic duct that could not be clearly established; 24 patients known to have a pancreatic cyst; 18 patients for whom the quality of the image was inadequate for assessment; and 3 patients with main duct IPMN (Fig. 1) were not included in the research. The investigation included 951 patients, 569 females, and 382 males with a mean age of 56.43 ± 15.07 years and a range of 31-85 years.

MRI Examination

A 3.0-T MR unit (Verio; Siemens Medical Solutions, Erlangen, Germany) was used to perform MRI. Thin-section turbo spin-echo T2-weighted (TSE) images were acquired in the axial, coronal, and sagittal planes (20 slices; thickness: 4 mm; TR/TE: 7800/150 ms; the amount of signals obtained: 2; resolution: 0.6 mm × 0.8 mm). Prior to the MRI scan, patients had to

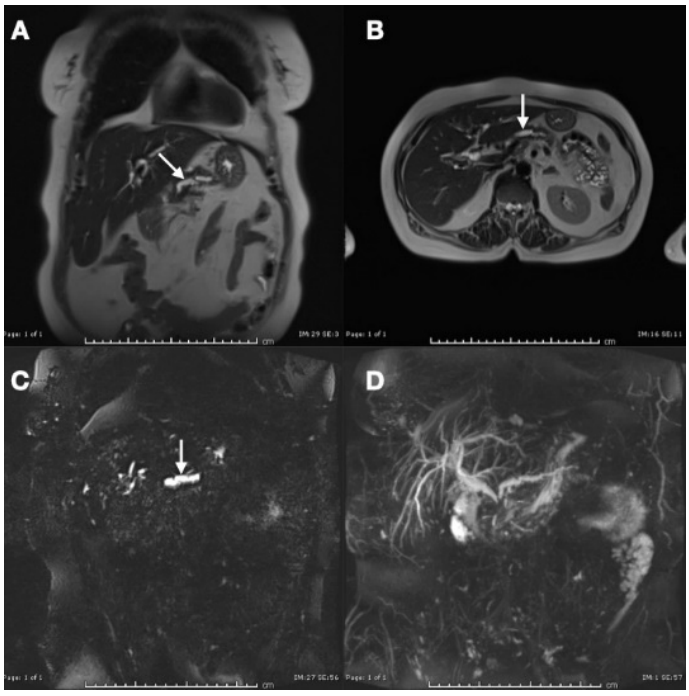

Fig. 1. Main duct intraductal papillary mucinous neoplasm in a 57-year-old male patient. (a) Coronal T2W, (b) axial T2W, and (c) MRCP images show dilatation of the main pancreatic duct without any stone or mass (white arrows). Accompanying dilatation is observed in the common bile duct in MRCP maximum intensity projection (MIP) image (d). The histopathology of the lesion was compatible with the main duct intraductal papillary mucinous neoplasm after surgery

fast for a minimum of six hours. At least six T2-weighted MRCP sequences, comprising coronal and sagittal planes, were taken during breath-holding using the quick SE technique. For 3D MRCP, a 3D fast-recovery turbo SE sequence was performed. Data was transmitted to a personal computer, where maximum intensity projection was used to recreate 3D MRCP images.

Image Analysis

All scans were assessed by a radiologist with seven years of hepatopancreatobiliary system MRI interpreting expertise, who was unaware of whether there was a cystic lesion in the pancreas. In patients with IPMN, the number, size, location, and internal structure of the lesions were analyzed using MRCP images. In addition, the association between IPMN frequency and age and gender was investigated.

Statistical Analysis

With the aid of the SPSS 25.0 software, statistical analyses were conducted. Using histograms and the Kolmogorov-Smirnov test, it was determined whether the variables followed a normal distribution. Descriptive statistics use mean, standard deviation, median, and IQR values. The Pearson Chi-Square Test was utilized to evaluate independent parameters. Between the two groups, nonparametric variables were analyzed using the Mann-Whitney U test. Statistical significance was accepted when the p value was below 0.05.

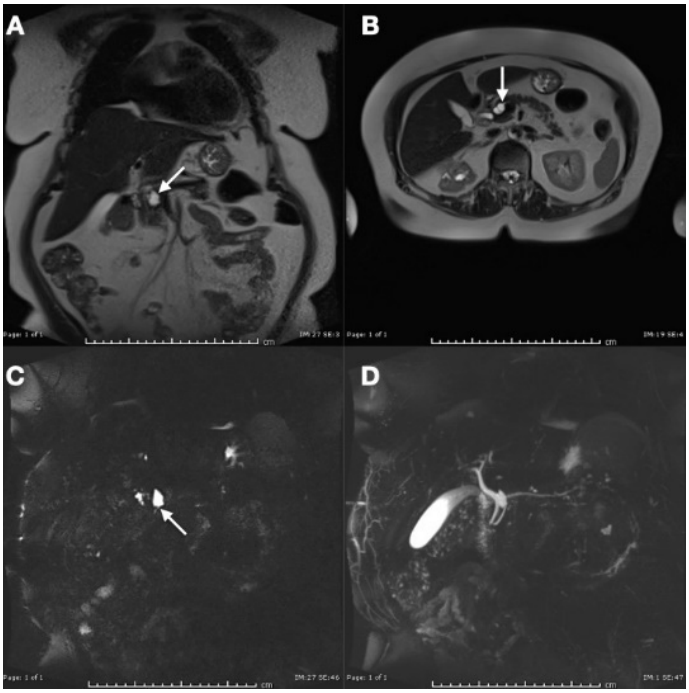

Fig. 2. Branch duct intraductal papillary mucinous neoplasm in a 60-year-old female patient. Coronal T2W (a) and axial T2W (b) images show a hyperintense lesion in the head of the pancreas (white arrows). The MRCP (c) image reveals the connection between the lesion and the main pancreatic duct (white arrow). The MRCP-MIP image displays the pure content of the cyst (d)

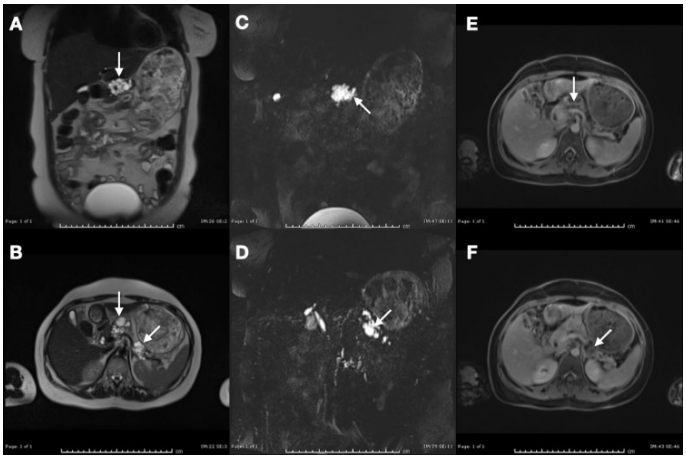

Fig. 3. Branch duct intraductal papillary mucinous neoplasms in a 51-year-old female patient. Coronal T2W (a) and axial T2W (b) images show hyperintense lesions containing multiple septa in the corpus and tail of the pancreas (white arrows). The MRCP images (c, d) demonstrate the connection between the lesions and the main pancreatic duct (white arrows). In the contrast-enhanced sequences, contrast enhancement is observed in the septa of the cysts

RESULTS

The research included 951 patients with a mean age of 56.43 ± 15.07 years, consisting of 382 males and 569 females. There were 663 patients under the age of 65 and 288 patients older than 65. There was no statistically significant difference in the incidence of IPMN between young and elderly patients based on gender ($p = 0.306$).

In our study, IPMN was detected in 102 (10.7%) of 951 patients. MRCP indications were choledocholithiasis in 506 (53.2%) patients, pancreatitis in 93 (9.8%) patients, malignancy in 348 (36.6%) patients, and biliary duct injury in 4 (0.4%) patients.

The mean tumor diameter was 8.51 ± 4.63 mm for

IPMNs. While IPMN was solitary in 44 (43.1%) patients, it was multiple in 58 (56.9%) patients. Eight (7.8%) patients had solitary IPMNs in the uncinate process, 19 (18.6%) patients in the head and neck of the pancreas, 10 (9.8%) patients in the corpus of the pancreas, and 7 (6.9%) patients in the tail of the pancreas. In 58 (56.9%) patients, IPMN was multiple and localized in different parts of the pancreas. In 98 (96.1%) patients, the internal structure of IPMN was pure (Fig. 2), whereas 4 (3.9%) patients exhibited a complicated appearance with septations (Fig. 3) (Table 1).

Table 1. Findings detected in the MRCP examination

Characteristics	Data
Age (years) (mean ± SD) (range)	56.43 ± 15.07 (31-85)
Sex	
Male	382 (40.2)
Female	569 (59.8)
Quantity of patients with IPMN, n (%)	102 (10.7)
MRCP indications, n (%)	
Choledocholithiasis	506 (53.2)
Pancreatitis	93 (9.8)
Malignancy	348 (36.6)
Biliary duct injury	4 (0.4)
Quantity of IPMN, n (%)	
Solitary	44 (43.1)
Multiple	58 (56.9)
Location of IPMN, n (%)	
Uncinate process of pancreas	8 (7.8)
Head and neck of the pancreas	19 (18.6)
Corpus of the pancreas	10 (9.8)
Tail of the pancreas	7 (6.9)
Multiple	58 (56.9)
Internal structure of the IPMN, n (%)	
Pure	98 (96.1)
Complicated	4 (3.9)
Tumor diameter (mm) (mean ± SD) (range)	8.51 ± 4.63 (3-32)

MRCP = magnetic resonance cholangiopancreatography, IPMN = intraductal papillary mucinous neoplasm, SD = standard deviation

IPMN was detected in 41 patients under the age of 65 (6.18%) and in 61 patients over the age of 65 (21.18%) and there was a statistically significant difference ($p < 0.001$). In the group of patients under 65 years of age, the mean diameter of the IPMN was 7.22 ± 4.3 mm, whereas it was 9.21 ± 4.74 mm in the group of patients over 65. This variance was statistically substantial ($p = 0.048$). In the older patient group, the number of IPMNs was higher than in the younger cohort, and they tended to be multiple in the older patient group ($p = 0.010$) (Table 2).

DISCUSSION

The frequency of coincidental pancreatic IPMNs has grown recently as a result of technological advancements in imaging. However, their incidence has not been thoroughly investigated. In our research, we collected data from patients who underwent MRCP, the most effective method for investigating incidental IPMNs.

Several investigations have examined the pancreatic cystic neoplasm prevalence to date, with reported rates ranging from 0.2% to 36.0% [6-9, 20]. According to our research, this rate was 10.7%. IPMN is the most prevalent cystic pancreatic neoplasia (70%) and may be malignant and multiple. IPMN can exhibit a whole range of histologic alterations, with a variable incidence between BD-IPMN and MD-IPMN [21, 22]. Based on its localization, there are three morphological forms of IPMN: the MD-IPMN, the BD-IPMN, and the mixed type. Malignancy rates are considerably greater for MD-IPMN and mixed types and lower for BD-IPMN [23].

IPMN is typically seen in asymptomatic individuals, has a median age of diagnosis of 60 years old, and disproportionately affects males compared to females. However, in this research, no significant difference was found in terms of gender in the incidence of IPMN. On imaging, mucin secretion causes cystic ductal segment dilatation in IPMN. MRI is the most effective tool for defining IPMN, and MRCP is the most essential sequence for evaluating MPD communication or involvement, which are key points for IPMN identification [21].

Without obstruction, MD-IPMN can cause diffuse or segmental MPD dilatation (> 5 mm). In diffuse

Table 2. Comparison of IPMN findings for patients under and over 65 years of age

	< 65 years	≥ 65 years	*p* value
Quantity of patients with IPMN, n (%)	41/663 (6.18)	61/288 (21.18)	**< 0.001[b]**
Sex, n (%)			0.306[b]
Male	14 (34.1)	27 (44.3)	
Female	27 (65.9)	34 (55.7)	
IPMN diameter (mm), (mean±SD)	7.22 ± 4.3	9.21 ± 4.74	**0.048[a]**
Quantity of IPMN, n (%)			**0.010[b]**
Solitary	24 (58.5)	20 (32.8)	
Multiple	17 (41.5)	41 (67.2)	

IPMN = intraductal papillary mucinous neoplasm, SD = standard deviation
[a]Mann Whitney U Test; [b]Chi-squared test.

MD-IPMN, MPD dilatation is more homogenous with regular margins, helping to differentiate from chronic pancreatitis. In diffuse MD-IPMN, the MPD enlargement is more symmetrical and has uniform outlines, distinguishing it from chronic pancreatitis [24]. Parenchymal atrophy is typically observed in MD-IPMN. Segmental MD-IPMN can spread through MPD if left untreated [25, 26]. Diffuse or segmental dilatation of branch ducts and MPD is a hallmark of mixed-type IPMN. Conversely, BD-IPMN may cause MPD dilatation due to mucin overproduction, thereby imitating mixed-type IPMN [27].

BD-IPMN manifests as a multifocal or unifocal cystic lesion that communicates with the main pancreatic duct. Cysts may be multi- or unilocular, with diameters varying from a few millimeters to a few centimeters; they are frequently grouped in clusters like clusters of grapes; and they are typically separated by small septa, which enhance after contrast injection [28]. The demonstration of communication with the MPD is essential for BD-IPMN diagnosis; hence, a high-quality MRCP is the most crucial step in the entire imaging procedure [29].

IPMN has a varied malignant potential; hence, the Fukuoka consensus was published with two-tiered malignancy prediction categories. The first tier consists of "worrisome features," a set of diagnostic observations indicating that the mass may progress to malignancy. EUS is needed to risk-strategize the lesion, and follow-up is required. The second tier is "high-risk stigmata," which signal the lesion may be cancerous and require surgical excision if the patient is eligible [14]. To summarize the 2017 Fukuoka revised consensus on the management of IPMN, patients with high-risk stigmata must have excision if physically possible; patients with worrisome features require additional workup; and individuals without either need follow-up at varied periods based on the dimensions of the biggest cyst [14].

In patients with IPMN, terminating or extending monitoring may be risky due to the persistent risk of concurrent PDAC [30]. In the research of 197 patients with IPMN and other cystic pancreatic lesions, Tada *et al*. found that the IPMN group is "at high risk" of advancing to pancreatic cancer, with a frequency that is 22.5 times greater than the estimated population mortality [10]. In a research study of 130 cases on surveillance following pancreatic resection for IPMN, He *et al*. [31] found that after 1, 5, and 10 years, the probability of PDAC or a new IPMN needing surgery was 0%, 7%, and 38%, respectively.

Owing to the increased number of CPLs, especially in elderly cases, the follow-up strategy overwhelms radiological facilities with a huge number of asymptomatic subjects [32-36]. As MRI is the best method for monitoring these patients, and as it is "time-consuming," pancreas-specific MRI protocols ought to be examined. In the identification of significant cystic lesion alterations and mural nodules, some publications have already demonstrated that a brief MR technique provides the same information as a more time-consuming and expensive complete ap-

proach. We think that MRCP examination is a fast and optimal modality for screening patients with IPMN at short intervals.

Limitations

Our study included a number of limitations. Due to the retrospective nature of our study, selection bias was inevitable despite our use of tight inclusion criteria. We did not assess the progression on follow-up imaging in IPMN patients since we were primarily interested in determining the incidence of IPMN observed incidentally on MRCP in this study. Additional investigation is essential for verification.

CONCLUSION

IPMN is the most frequent cystic pancreatic neoplasia that can be multifocal and cancerous, which is typically detected incidentally with cross-sectional imaging. It occurs more frequently, in greater numbers, and at larger sizes with age. MRCP is the most crucial imaging method for identifying MPD communication or involvement, a crucial finding for IPMN diagnosis. Follow-up imaging in IPMN patients is of great importance, so MRCP can be used for screening patients at short intervals.

Ethics Committee Approval

This retrospective study was performed at the University of Health Sciences, Bakirkoy Dr. Sadi Konuk Training and Research Hospital. The study protocol (2023/36) was approved by the Institutional Review Board on January 23, 2023. Written informed consent was obtained from all patients.

Authors' Contribution

Study Conception: MON; Study Design: MON; Supervision: MON; Funding: N/A; Materials: MON; Data Collection and/or Processing: MON; Statistical Analysis and/or Data Interpretation: MON; Literature Review MON; Manuscript Preparation: MON, and Critical Review: MON.

Conflict of interest

The author disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The author disclosed that they did not receive any grant during conduction or writing of this study.

REFERENCES

1. Shyr YM, Su CH, Tsay SH, Lui WY. Mucin-producing neoplasms of the pancreas. Intraductal papillary and mucinous cystic neoplasms. Ann Surg 1996;223:141-6.
2. Jabłońska B. Biliary cysts: etiology, diagnosis and management. World J Gastroenterol 2012;18:4801-10.
3. Megibow AJ, Lombardo FP, Guarise A, Carbognin G, Scholes J, Rofsky NM, et al. Cystic pancreatic masses: cross-sectional imaging observations and serial follow-up. Abdom Imaging 2001;26:640-7.
4. Kiely JM, Nakeeb A, Komorowski RA, Wilson SD, Pitt HA. Cystic pancreatic neoplasms: enucleate or resect? J Gastrointest Surg 2003;7:890-7.
5. Fernández-del Castillo C, Targarona J, Thayer SP, Rattner DW, Brugge WR, Warshaw AL. Incidental pancreatic cysts: clinicopathologic characteristics and comparison with symptomatic patients. Arch Surg 2003;138:427-3.
6. Balcom IV JH, Fernandez-Del Castillo C, Warshaw AL. Cystic lesions in the pancreas: when to watch, when to resect. Curr Gastroenterol Rep 2000;2:152-8.
7. Zhang XM, Mitchell DG, Dohke M, Holland GA, Parker L. Pancreatic cysts: depiction on single-shot fast spin-echo MR images. Radiology 2002;223:547-53.
8. Laffan TA, Horton KM, Klein AP, Berlanstein B, Siegelman SS, Kawamoto S, et al. Prevalence of unsuspected pancreatic cysts on MDCT. AJR Am J Roentgenol 2008;191:802-7.
9. Brugge WR, Lauwers GY, Sahani D, Fernandez-del Castillo C, Warshaw AL. Cystic neoplasms of the pancreas. N Engl J Med 2004;351:1218-26.
10. Tada M, Kawabe T, Arizumi M, Togawa O, Matsubara S, Yamamoto N, et al. Pancreatic cancer in patients with pancreatic cystic lesions: a prospective study in 197 patients. Clin Gastroenterol Hepatol 2006;4:1265-70.
11. Kawakubo K, Tada M, Isayama H, Sasahira N, Nakai Y, Yamamoto K, et al. Incidence of extrapancreatic malignancies in patients with intraductal papillary mucinous neoplasms of the pancreas. Gut 2011;60:1249-53.
12. Kleeff J, Korc M, Apte M, La Vecchia C, Johnson CD, Biankin AV, et al. Pancreatic cancer. Nat Rev Dis Primers 2016;2:16022.
13. Vege SS, Ziring B, Jain R, Moayyedi P; Clinical Guidelines Committee; American Gastroenterology Association. American gastroenterological association institute guideline on the diagnosis and management of asymptomatic neoplastic pancreatic cysts. Gastroenterology 2015;148:819-22.
14. Tanaka M, Fernández-Del Castillo C, Kamisawa T, Jang JY, Levy P, Ohtsuka T, et al. Revisions of international consensus Fukuoka guidelines for the management of IPMN of the pancreas. Pancreatology 2017;17:738-53.

15. Pergolini I, Sahora K, Ferrone CR, Morales-Oyarvide V, Wolpin BM, Mucci LA, et al. Long-term risk of pancreatic malignancy in patients with branch duct intraductal papillary mucinous neoplasm in a referral center. Gastroenterology 2017;153:1284-94.
16. Petrone MC, Magnoni P, Pergolini I, Capurso G, Traini M, Doglioni C, et al. Long-term follow-up of low-risk branch-duct IPMNs of the pancreas: is main pancreatic duct dilatation the most worrisome feature? Clin Transl Gastroenterol 2018;9:e158.
17. Scheiman JM, Hwang JH, Moayyedi P. American gastroenterological association technical review on the diagnosis and management of asymptomatic neoplastic pancreatic cysts. Gastroenterology 2015;148:824-48.
18. Yamaguchi K, Kanemitsu S, Hatori T, Maguchi H, Shimizu Y, Tada M, et al. Pancreatic ductal adenocarcinoma derived from IPMN and pancreatic ductal adenocarcinoma concomitant with IPMN. Pancreas 2011;40:571-80.
19. Patra KC, Bardeesy N, Mizukami Y. Diversity of precursor lesions for pancreatic cancer: the genetics and biology of intraductal papillary mucinous neoplasm. Clin Transl Gastroenterol 2017;8:e86.
20. de Jong K, Bruno MJ, Fockens P. Epidemiology, diagnosis, and management of cystic lesions of the pancreas. Gastroenterol Res Pract 2012;2012:147465.
21. Machado NO, Al Qadhi H, Al Wahibi K. Intraductal papillary mucinous neoplasm of pancreas. N Am J Med Sci 2015;7:160-75.
22. Tanaka M. Clinical management and surgical decision-making of IPMN of the pancreas. Methods Mol Biol 2019;1882:9-22.
23. Tanaka M, Fernández-del Castillo C, Adsay V, Chari S, Falconi M, Jang JY, et al.; International Association of Pancreatology. International consensus guidelines 2012 for the management of IPMN and MCN of the pancreas. Pancreatology 2012;12:183-97.
24. Kim JH, Hong SS, Kim YJ, Kim JK, Eun HW. Intraductal papillary mucinous neoplasm of the pancreas: differentiate from chronic pancreatits by MR imaging. Eur J Radiol 2012;81:671-6.
25. Procacci C, Carbognin G, Biasiutti C, Guarise A, Ghirardi C, Schenal G. Intraductal papillary mucinous tumors of the pancreas: spectrum of CT and MR findings with pathologic correlation. Eur Radiol 2001;11:1939-51.
26. Lim JH, Lee G, Oh YL. Radiologic spectrum of intraductal papillary mucinous tumor of the pancreas. Radiographics 2001;21:323-37.
27. Procacci C, Megibow AJ, Carbognin G, Guarise A, Spoto E, Biasiutti C, et al. Intraductal papillary mucinous tumor of the pancreas: a pictorial essay. Radiographics 1999;19:1447-63.
28. Pilleul F, Rochette A, Partensky C, Scoazec JY, Bernard P, Valette PJ. Preoperative evaluation of intraductal papillary mucinous tumors performed by pancreatic magnetic resonance imaging and correlated with surgical and histopathologic findings. J Magn Reson Imaging 2005;21:237-44.
29. Italian Association of Hospital Gastroenterologists and Endoscopists; Italian Association for the Study of the Pancreas; Buscarini E, Pezzilli R, Cannizzaro R, De Angelis C, Gion M, Morana G, et al.; Cystic Pancreatic Neoplasm Study Group. Italian consensus guidelines for the diagnostic work-up and follow-up of cystic pancreatic neoplasms. Dig Liver Dis 2014;46:479-93.
30. Tamura K, Ohtsuka T, Ideno N, Aso T, Kono H, Nagayoshi Y, et al. Unresectable pancreatic ductal adenocarcinoma in the remnant pancreas diagnosed during every-6-month surveillance after resection of branch duct intraductal papillary mucinous neoplasm: a case report. JOP 2013;14:450-3.
31. He J, Cameron JL, Ahuja N, Makary MA, Hirose K, Choti MA, et al. Is it necessary to follow patients after resection of a benign pancreatic intraductal papillary mucinous neoplasm? J Am Coll Surg 2013;216:657-65.
32. Torisu Y, Takakura K, Kinoshita Y, Tomita Y, Nakano M, Saruta M. Pancreatic cancer screening in patients with presumed branch-duct intraductal papillary mucinous neoplasms. World J Clin Oncol 2019;10:67-74.
33. Ideno N, Ohtsuka T, Matsunaga T, Kimura H, Watanabe Y, Tamura K, et al. Clinical significance of GNAS mutation in intraductal papillary mucinous neoplasm of the pancreas with concomitant pancreatic ductal adenocarcinoma. Pancreas 2015;44:311-20.
34. Ideno N, Ohtsuka T, Kono H, Fujiwara K, Oda Y, Aishima S, et al. Intraductal papillary mucinous neoplasms of the pancreas with distinct pancreatic ductal adenocarcinomas are frequently of gastric subtype. Ann Surg 2013;258:141-51.
35. Mandai K, Uno K, Yasuda K. Does a family history of pancreatic ductal adenocarcinoma and cyst size influence the follow-up strategy for intraductal papillary mucinous neoplasms of the pancreas? Pancreas 2014;43:917-21.
36. Moris M, Bridges MD, Pooley RA, Raimondo M, Woodward TA, Stauffer JA, et al. Association between advances in high-resolution cross-section imaging technologies and increase in prevalence of pancreatic cysts from 2005 to 2014. Clin Gastroenterol Hepatol 2016;14:585-93.