To review and discuss the CT features of the nonfunctioning islet cell tumors (NFICT) of pancreas in Veterans General Hospital in Taipei and in Taichung.

The pre-operative abdominal CT of 6 cases of the nonfunctioning islet cell tumors of pancreas had been reviewed retrospectively. The pre- and post-contrast enhanced CT of abdomen was performed in a dynamic fashion for 5 patients. The other patient underwent conventional pre- and post-contrast enhanced CT of abdomen. We focused on tumor size, location, margin, calcification, enhancement pattern and homogeneity. All tumors were surgically and histopathologically proven. Malignancy was defined as liver or nodal metastasis or vessel encasement.

Nonfunctioning islet cell tumors of pancreas occur in younger patients without gender predilection. The tumor sizes ranged from 2 to 8 cm with an average size of 4 cm. The tumors are more commonly located in pancreatic head / neck (n=4). On CT, the margin of the tumor was well-defined in 4 cases and irregular in 2 cases. No calcification in the tumors was detected. After contrast agent administration, 4 tumors were inhomogeneously better enhanced relative to the normal pancreatic parenchyma, while the other 2 did not appear to be enhanced differently. Two tumors were solid homogeneous in consistency; whereas 4 tumors showed heterogeneous to cystic components. Three tumors showed malignant appearance.

Several imaging characteristics are in favor of NFICT, including large tumor size, even tumor margin, heterogeneous in appearance, intratumoral calcification and focally or diffusely better enhanced than normal pancreatic parenchyma on post-contrast CT. Another group of NFICT manifests, just like functional ICT, as a small solid mass and well enhanced homogeneously.

Key words: pancreatic neoplasm; endocrine tumor of the pancreas; islet cell tumor; carcinoma, islet cell

Pancreatic nonfunctioning islet cell tumors (NFICT) are uncommon pancreatic tumors and constitute 15-25% of all islet cell tumors (ICT) [1,2]. NFICT do not result in clinical manifestations of endocrinopathy. The imaging features of NFICT are rarely reported. The aim of this paper is to present the computed tomographic (CT) findings of the NFICT diagnosed in our institution and to review the English literatures in order to make differential diagnosis from other pancreatic neoplasms, especially ductal adenocarcinoma (DAC).

MATERIALS AND METHODS

We retrospectively reviewed the medical records of histopathologically proven pancreatic ICT in Veterans General Hospital in Taipei and in Taichung between February 1995 and February 2002. Ten cases of NFICT with no clinical evidence of endocrinopathies were found. Only 6 cases [4 men and 2 women, ages: 36 to 61 years (mean: 47.5)] was included in this study because one of the patients had only preoperative MR imaging and the other three either did not undergo...
imaging studies or did not have CT images available. Pre- and post-contrast enhanced CT of pancreas were performed with a CT scanner (Somaton plus 4, Siemens). Intravenous contrast agent was administered in a dynamic fashion for 5 patients; while conventional contrast enhanced CT was undergone for one patient. The dynamic contrast-enhanced CT for pancreas consisted of 5 steps of imaging. In step 1 (non-contrast phase), we scan liver and pancreas with slice thickness of 7mm and pitch of 1 without administration of contrast agent. In step 2 (arterial predominant phase), 125 cc of contrast medium was administered by a power injector. In step 3, image scanning was triggered by the smart prep mode, which monitored the maximal enhancement of ascending aorta. In step 4, images were acquired by using helical mode with slice thickness of 3mm and pitch of 1. For the delayed scan (step 5), images were obtained 60-70 seconds after contrast agent administration using scanning protocol as step 1. Two radiologists (Chiang and Yen) reviewed all the images together and specially focused on several primary features, including tumor size, location, margin, calcification, enhancement pattern (in the arterial predominant phase and in the delayed phase) and homogeneity of enhancement. Secondary features, such as presence of hepatic or nodal metastases, encasement of vessels, biliary or pancreatic ductal dilatation, distal pancreatic atrophy, were also assessed. Malignancy was defined as the presence of CT findings of liver or nodal metastasis and vessels encasement.

RESULTS

All the primary CT appearances were summarized in table 1.

The sizes of the tumor ranged from 2 to 8 cm with an average size of 4 cm. In respects of the location, no obvious predilection was noted. The margins of the tumors were well demarcated (Fig. 1B) in 4 cases and irregular in 2 cases (Fig. 2B and 2C). No tumors contained detectable calcification on CT. Regarding the enhancement pattern, four tumors were diffusely (Fig. 1B) or partially (Fig. 2B) better enhanced in arterial predominant phase, hyper dense in 3 cases and iso dense in the delayed phase. Four tumors showed homogeneous (homo) enhancement in the arterial predominant phase and heterogeneous (hetero) in the delayed phase.

Table 1. CT appearances of the 6 cases with NFICT

<table>
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<tr>
<th>Patient No.</th>
<th>1</th>
<th>2</th>
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<tr>
<td>Enhancement in arterial predominance phase</td>
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<td>hyper dense</td>
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<td>iso dense*</td>
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<td>homo</td>
<td>homo</td>
<td>homo</td>
<td>hetero</td>
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* conventional CT performed
# homo: homogeneous, hetero: heterogeneous

Figure 1. CT appearance of a small nonfunctioning islet cell tumor (NFICT) was similar to the functioning counterpart. A) Pre-contrast scans showed an iso-dense well-defined solid nodule located in the pancreatic body. B) Post-contrast scans showed stronger enhancement of the nodule as compared with normal pancreatic tissue.
enhanced than normal pancreatic parenchyma. Two tumors were enhanced as well as normal pancreatic tissue. Four tumors were heterogeneously enhanced (Fig. 2B and 2C); whereas two tumors were homogeneously enhanced (Fig. 1B). Three out of six (50%) tumors were considered as malignant on the basis of CT appearances, with the presence of regional lymph node involvement (n=3) and portal vein encasement (n=1).

Preoperative diagnosis was correctly made in 2 patients. For the other preoperative diagnoses include DAC (n=1), lymphadenopathies (n=2) and leiomyoma (n=1).

All 6 patients underwent surgical exploration. Immunohistochemical staining of the tumors were done using multiple endocrine and exocrine markers, which confirmed neuroendocrine origin of the tumors.

**DISCUSSION**

From the review of the medical records and the previous reports in the literatures, we found that the average age was about 47 years of age. In contrast, DAC usually occurs in the patients old than 60 [1-5]. No gender predilection was noted [1-5]. Most initial symptoms were non-specific and indistinguishable from those of other pancreatic tumors. The tumor sizes are reported to be quite variable, ranging from 0.8 to 24 cm [6-7] with the mean size larger than 5.2 cm [4,6,8-9]. The mean size of tumors in our study was 4 cm, which may be due to two smaller tumors found incidentally. In respects of tumor location, there is predilection in the pancreatic head and neck region [1-2, 10], which may result in biliary and pancreatic ducts dilatation and atrophy of distal pancreas. The malignancy rates are quite variable, ranging from 31% to 92% [1,4,6,10]. In our study, three out of 6 tumors showed malignant appearance on CT with average size were 3.9 cm. It has been suggested that tumor size is not a reliable indicator for its biological behavior [5].

Stafford-Johnson et al [11] reported the effectiveness of dual-phase helical CT and suggested the imaging in the arterial phase better showed the differential attenuation between NFICT and normal pancreas and facilitated the detection of liver metastasis, especially for the small tumors less than 5mm. We
performed dual-phase helical CT for 5 patients and observed similar findings. Most of the tumors are enhanced better than normal pancreatic parenchyma both in the arterial predominant phase and in the delayed phase. However, in 1 out of 5 tumors, the enhancement quickly fainted out; thus, the tumor margin became blurred in delayed phase. If we only perform conventional study, the tumor may be missed.

The imaging features of NFICTs were rarely described [4, 6-9, 11]. We characterized the CT features of NFICTs, including enhancement pattern and calcification and reviewed the literatures (Table 2). In post-contrast CT, 49 out of 62 NFICTs (79%) appear to be partially or diffusely enhanced as compared with the adjacent normal pancreas, while other 13 (21%) tumors showed no significant enhancement or as well as pancreatic parenchyma. Buetow et al [9] reported that, only 14 of 50 tumors were solid and homogeneous. Heterogeneous areas corresponding to necrosis or cystic degeneration were noted in 36 tumors. Calcification were detected in 15 tumors (24%) on CT, which is much more sensitive than US. Vessel encasement in NFICT [8], unlike Eelkema et al [7] has reported.

In conclusion, several imaging characteristics of NFICT may help discriminating from other pancreatic tumors, especially DAC, which include unusually large tumor size, especially larger than 10cm, even tumor margin, heterogeneous in appearance due to necrosis or cystic degeneration, intratumoral calcification and partially or diffusely hyperdense than normal pancreatic parenchyma in post-contrast scans [7-8]. Another group of NFICT manifest radiographically just like functional ICT as small, homogeneously well-enhancing solid mass.

**REFERENCES**

5. Eckhauser FE, Cheung PS, Vinik AI, Strodel WE, Lloyd RV, Thompson NW. Nonfunctioning malignant neuroendocrine tumors of the pancreas. Surgery 1986; 100: 978-988

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<tr>
<td>Fugazzola [8]</td>
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<td>11</td>
<td>6.1</td>
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<tr>
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<tr>
<td>Stanford [11]</td>
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<td>6</td>
<td>6</td>
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<tr>
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<td>15 (24%)</td>
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# Size: mean value (cm)
無功能性胰臟胰島細胞腫瘤

顧昭培1 姜恵惠1 黃振義3 蘇正熙2 邱怡友1 張政彥1

台北榮民總醫院放射線部及國立陽明大學醫學院 放射線科1 外科部2
臺中榮民總醫院 放射線部3

無功能性胰島細胞瘤，約佔所有胰島細胞瘤的15-20%。因很罕見，少有研究探討其影像
發現，本研究著重在此瘤的電腦斷層影像表現。

本研究的六個病人，均接受術前電腦斷層，其中五位接受動態研究。當我們閱片時，著重
在腫瘤大小、位置、邊緣、鈣化、顯影程度、同質性。惡性變化定義為影像上具有血管侵犯及
轉移。手術檢體均經免疫化學染色證實為胰島細胞瘤。

好發於較年輕的病人，性別分布平均。腫瘤由小至中等不等，平均四公分。腫瘤稍好发
在胰體部和頭部（四例）。腫瘤邊緣規則者四例，不規則者兩例。均無鈣化。與正常胰臟組織
顯影程度相比，五例有部分或全部高顯影性、二例與胰臟相似。腫瘤是非均質性者四例、均
質性者二例。三例有惡性變化。

在電腦斷層影像檢查，無功能性胰島細胞瘤是偏向於：如腫瘤較大、邊緣平整、易中心液
化、鈣化、具有高度顯影區域。或表現類似功能性細胞瘤，為小而實心，均勻高度顯影腫
瘤。

關鍵詞：胰臟腫瘤一胰臟內分泌腫瘤一胰島細胞瘤一胰島細胞癌