Differential Diagnosis of Pancreatic Diseases Using PET

IV. 12. Differential Diagnosis of Pancreatic Diseases Using PET

Oikawa H., Takahashi H., Yoshioka T., Maeda S., Wakui A., Saito T., Tada M., Yamaguchi K.**, Itoh M.*** and Ido T.****

Department of Clinical Cancer Chemotherapy, and Pharmacology, Research Institute for Tuberculosis and Cancer, Tohoku University. Department of Radiology, Ryukyu University**. Cyclotron and Radioisotope Center, Tohoku University***.*

Introduction

In recent years, remarkable developments in X ray-computed tomography(X-CT), ultrasonography(US) have been achieved, but as these diagnostic methods essentially examine morphological changes or differences among various lesions, these have the limits of sensitivity of differential diagnosis. Since PET (positron emission tomography) with physiological pharmacoceuticals labeled with radionuclide emitting positron can image biochemical state of tissues or organs [1,2], and pancreatic diseases are almost accompanied by metabolic dysfunction of the pancreas parenchyma, this examination method shows the ability to detect metabolic changes in vivo. On the basis of the experimental results that the uptake of pancreatic tumor is higher than the parenchyma, and, on the contrary, the uptake of ^{11}C-methionine(^{11}C-Met.) in the pancreas parenchyma is higher than the tumor [3], the pancreatic images by PET using ^{18}FDG and ^{11}C-Met. might be displayed like mirror image.

This clinical report deals with the possibility of diagnosis of pancreatic diseases by PET.

Materials and Methods

Subjects

26 pancreatic cancer subjects were examined using both ^{18}FDG and ^{11}C-Met.. 14 subjects were examined by PET931/04(CTI, ECAT, USA) and the other 12 subjects were examined by ECAT II(EG&G, Ortec, USA). Of 26 cases, 12 had been histologically confirmed to have pancreatic cancer by operation, autopsy or cytology, and the others were diagnosed clinically on the basis of the results of X-CT, US, endoscopicretrograde cholangiopancreatography and so on (Table 1). 3 subjects with pancreatic cyst were also examined using both ^{18}FDG and ^{11}C-Met.. In addition, 1 subject with diabetes mellitus(DM), 1 subject with acute pancreatitis, 4 subjects with chronic pancreatitis and a normal volunteer were examined using only ^{11}C-Met.(Table 2). Written informed consent was obtained from all the cases.

Methods

The scan level for PET study were determined by X-CT. After the transmission scan, ^{11}C-Met.(4~16 mCi.) or ^{18}FDG (3~7 mCi.) was intravenously infused for about 30 seconds, and the emission scan was carried out for 15~20 min. after about 20 min.(PET931/04) or 20~30 min.(ECAT II) in the ^{11}C-Met. study and after about 22 min.(PET931/04) or 35~45 min.(ECAT II) in the ^{18}FDG study. First, PET using ^{11}C-Met. was carried out, when both ^{18}FDG and ^{11}C-Met. studies would be performed on the same subject. After radioactivity of ^{11}C-Met. had diminished thoroughly, the next study using ^{18}FDG was carried out. The scan was corrected for decay and attenuation and 3~7 ROIs(region of interest) were determined on the PET image. A ROI is about 0.8 cm^2 in area. The quantification of ^{18}FDG uptake of the tumor and ^{11}C-Met. uptake of the pancreas parenchyma was denoted as DAR [differential absorption ratio = (PET count × calibration factor)/(injected dose/body weight)], and the highest DAR in ROIs was determined as the uptake of them.

Results

(1) Normal volunteer

PET images using ^{11}C-Met. of a 36 year-old male are shown in Fig. 1. The whole pancreas could be recognized.

(2) Pancreatic cancer

Representative X-CT and PET images using ^{11}C-Met. of a 47 year- old female with pancreatic cancer and metastasis in the liver are shown in Fig. 2. In X-CT, the primary tumor of the pancreatic body could be recognized(Fig. 2(A)). In PET images using ^{11}C-Met., the head and tail of the pancreas were clearly shown, but the body occupied by tumor could not be visualized as hot image. On the other hand, in PET images using ^{18}FDG, the pancreatic tumor could be recognized(Fig. 2(B)). In all pancreatic cancer subjects which were studied, the tumor and the distal portion of the pancreas tended not to be visualized with ^{11}C-Met.

All of 14 pancreatic cancer subjects demonstrated partly high radioactivity of the pancreas itself and relatively low radioactivity of the tumor using ^{11}C-Met. On the other hand, 12 of the same 14 subjects using ^{18}FDG demonstrated high radioactivity of the tumor. DAR ratios of pancreas parenchyma to liver in PET images using ^{11}C-Met. were 0.5~1.5 with an average of 0.9.

(3) Pancreatic cyst

Representative X-CT and PET images using ^{11}C-Met. of a 67 year- old female are shown in Fig. 3. In X-CT, the pancreatic cyst of the body tail could be recognized as low density area (Fig. 3(A)). In PET images using ^{11}C-Met., high radioactivity were shown in the pancreatic head. On the other hand, in PET images using ^{18}FDG, the pancreatic cyst could not be recognized as hot image(Fig 3(B)). In 2 subjects with pancreatic cyst, DAR

ratios of pancreas parenchyma to liver in the images using ^{11}C-Met. were 1.3 and 2.2 with an average of 1.7.

(4) DM

PET images using ^{11}C-Met. of a 16 year-old male are shown in Fig. 4. In PET images using ^{11}C-Met., the whole pancreas could be recognized. DAR ratio of pancreas parenchyma to liver in PET images using ^{11}C-Met. was 2.0.

(5) Chronic pancreatitis

Representative X-CT and PET images using ^{11}C-Met. of a 70 year-old male are shown in Fig. 5. In X-CT, massive calcification in the pancreas was recognized(Fig 5(A)), and the uptake of ^{11}C-Met. in PET images was evaluated low (Fig 5(B)). The pancreas in 2 of 4 subjects could not be entirely visualized in PET images using ^{11}C-Met.. DAR ratios of pancreas parenchyma to liver in PET images using ^{11}C-Met. were 0.6 and 1.8.

Discussion

Routine diagnostic procedures can not clearly differentiate pancreatic cancer from chronic pancreatitis in some cases. It is not rare that chronic pancreatitis does not show significant abnormalities on X-CT and US, and the role of pancreas scintigraphy is still considered to play an important role in the evaluation of the diagnosis. Nevertheless, since the clinical usefulness of ^{75}Se-selenomethionine is limited because of its long half-life and low S/N ratio, the diagnosis of pancreatic diseases using ^{75}Se-selenomethionine has not frequently been made and new radiolabeled drugs have been studied [3,4]. One of new examinations is the PET study using ^{11}C- Met.

Though Syrota et al.[5] reported that PET using ^{11}C-Met. was more appropriate for evaluating pancreatic diseases, they considered that the major problem was the impossibility of differentiating between cancer and chronic pancreatitis, because chronic pancreatitis was associated with neoplasm. In the present series of subjects with PET using ^{18}FDG and ^{11}C-Met., 12 of 14 subjects which were studied using ^{18}FDG showed high radioactivity of the tumor, but the other 2 subjects showed low radioactivity of the tumor. It may be thought that the low radioactivity shows low viability of tumor cells in these cases. PET study using ^{18}FDG is very useful for diagnosing pancreatic cancer. Pancreatic cancer could not be entirely differentiated from other benign diseases only in PET images using ^{11}C-Met., though all of the same 14 subjects showed partly high radioactivity of the pancreas and relatively low radioactivity of the tumor. In comparison of the DAR ratio of pancreas parenchyma to liver in the PET images using ^{11}C-Met., the DAR ratio with pancreatic cancer was lower than that with other benign diseases, but pancreatic cancer could not be differentiated from chronic pancreatitis in the DAR ratio (Fig. 6). As few cases with chronic pancreatitis were studied, the comparison among pancreatic cancer and pancreatic cyst, chronic pancreatitis could not be made statistically. Further studies using ^{11}C-Met. in more subjects will elucidate the utility of the DAR ratio by which pancreatic cancer is compared with chronic pancreatitis. Further

studies on more patients with chronic pancreatitis will have to be carried out for analysis of the diagnosis of pancreatic diseases.

Conclusion

In PET images using ^{18}FDG, 12 of 14 subjects showed high radioactivity of the tumor, but the other 2 subjects showed low radioactivity of the tumor. PET study using ^{18}FDG is very useful for diagnosing pancreatic cancer.

In PET images using ^{11}C-Met., all of 14 subjects showed partly high radioactivity of the pancreas and low radioactivity of the tumor. Though PET using only ^{11}C-Met. could not clearly differentiate pancreatic cancer from pancreatic cyst and chronic pancreatitis, it is thought that the differentiation of pancreatic diseases might be diagnosed with the assistance of the comparison of DAR ratio of pancreas parenchyma to liver.

The diagnosis of the pancreatic cancer by means of the PET with ^{18}FDG can be made with very high accuracy. The accuracy of the diagnosis will improve, when the combination of this imaging diagnosis and DAR ratio of pancreas parenchyma to liver in the PET system using ^{11}C-Met. is used together with ^{18}FDG.

Acknowledgments

This work was supported in part by the Grant-in-Aid for Cancer Research from Ministry of Health and Welfare and for Scientific Research (No. 61570299, 01570347) from the Ministry of Education, Science and Culture.

References

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Table 1. Summary of pancretic cancer subjects.

NO.	Name	Sex	Age	Location	Histology	PET	18FDG	11C-Met.	P-L DAR ratio
1	T.A.	F	79	head	+	ECAT	+	+	0.5
2	F.A.	F	72	head		ECAT	−	−	
3	T.N.	M	66	head		ECAT	+	−	
4	N.O.	M	43	head	+	ECAT	+		
5	E.M.	M	61	head		ECAT	−		
6	K.K.	M	64	head	+	ECAT	−		
7	K.H.	F	51	head-body		ECAT	−	+	1.2
8	J.M.	M	77	body		ECAT	+	+	
9	T.O.	F	53	body	+	ECAT	+	−	
10	T.S.	M	29	body		ECAT	−	+	0.7
11	K.O.	M	79	tail	+	ECAT	−		
12	C.O.	M	62	cystic	+	ECAT	+		
13	R.S.	F	51	head		ECAT,931	±	+	
14	H.M.	M	61	body	+	ECAT,931	+	+	0.6
15	S.I.	F	59	tail	+	ECAT,931	+	+	0.6
16	S.I.	M	65	tail	+	ECAT,931	+	+	1.0
17	A.H.	F	70	head	+	931	+	+	0.5
18	S.K.	M	53	head		931	+	+	0.6
19	K.E.	F	56	head		931	+	+	0.6
20	A.T.	M	48	head	+	931	−	+	0.9
21	T.S.	M	60	head-body	+	931	+	+	0.9
22	A.I.	M	68	head-body		931	−	+	0.8
23	T.I.	M	64	body		931	+	+	1.3
24	T.O.	F	47	body		931	+	+	
25	Y.A.	M	62	body		931	+	+	1.4
26	T.K.	M	73	body-tail		931	±	+	1.6

Table 2. Summary of subjects with benign pancreas diseases and a normal volunteer.

NO.	Name	Sex	Age	Diagnosis	PET	^{18}FDG	^{11}C-Met.	P-L DAR ratio
1	S.M.	M	37	normal volunteer	ECAT		+	1.5
2	K.S.	M	16	diabetes mellitus	931		+	2.0
3	H.T.	M	43	acute pancreatitis	931		+	1.3
4	J.O.	M	51	chronic pancreatitis	ECAT		−	
5	M.A.	F	35	chronic pancreatitis	ECAT		+	0.6
6	S.Y.	M	78	chronic pancreatitis	ECAT		+	1.8
7	I.T.	M	70	chronic pancreatitis	931		−	
8	H.K.	M	40	pancreatic cyst	ECAT		+	1.3
9	Y.O.	F	67	pancreatic cyst	931	−	+	1.5
10	H.S.	F	78	pancreatic cyst	931	−	+	2.2

P-L DAR ratio: DAR ratio of pancreas parenchyma to liver in PET of ^{11}C-Met.
ECAT: ECAT II, 931: PET 931/04, ^{18}FDG: radioactivity of the pancreas using ^{18}FDG, ^{11}C-Met.: radioactivity of the pancreas using ^{11}C-Met., and Histlogy: Pancreatic cancer was histologically proved or not.

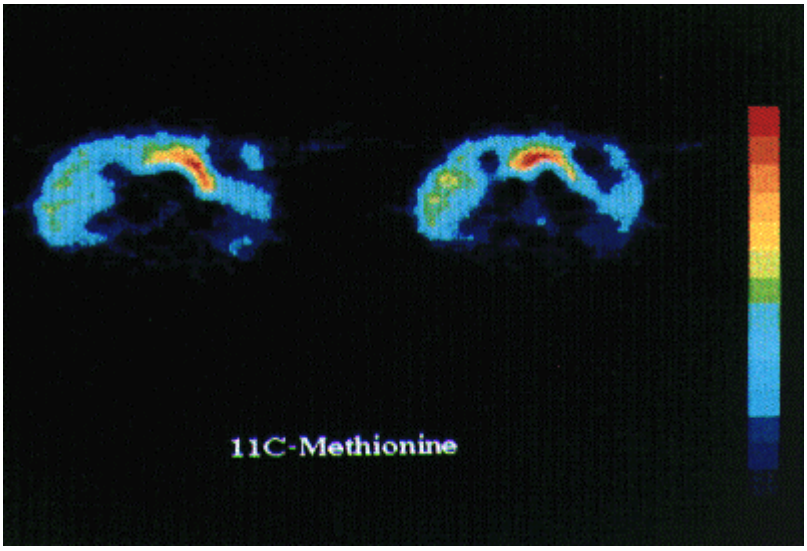

Fig. 1. PET images using ^{11}C-Met. of a 37-year-old normal male (case 1 in Table 2). PET image of the left is more cranical than the right. The whole pancreas can be recognized.

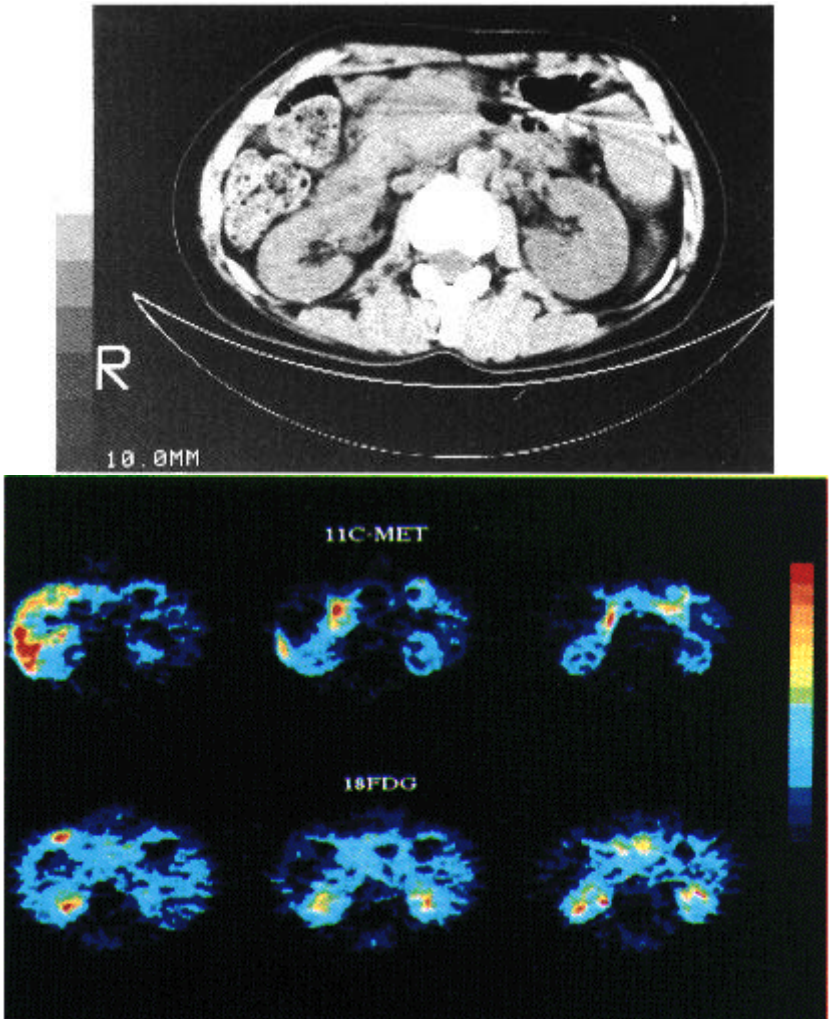

Fig. 2. A 47-year-old female with pancreatic body cancer (Case 24 in Table 1). (A) X-CT: The tumor of the pancreatic body can be recognized. (B) PET: PET image of the left is more cranial than the right. Upper line is PET images using ^{11}C-Met. The head and tail of the pancreas can be clearly shown, but the body occupied by tumor can not be visualized as hot image. Lower line is PET images using ^{18}FDG. The tumor of the pancreas can be recognized.

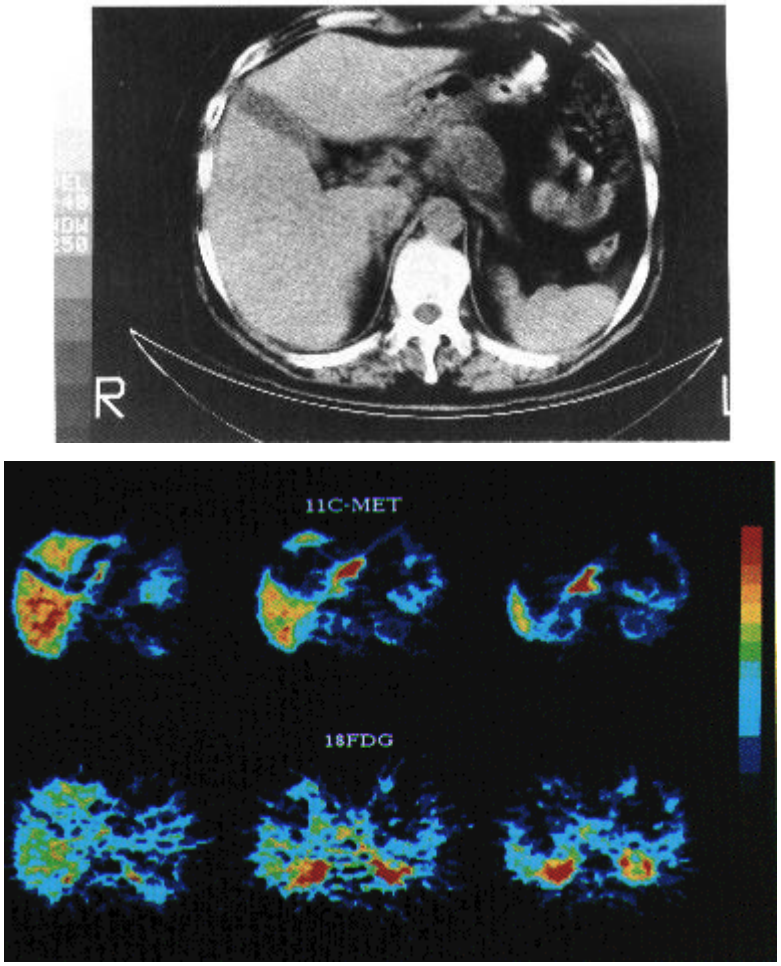

Fig. 3. A 67-year-old female with pancreatic cyst (Case 9 in Table 2). (A) X-CT: The pancreatic cyst of the body ~ tail can be recognized as low density area. (B): PET images of the left is more cranial than the right. Upper line is PET images using ^{11}C-Met. The head of the pancreas can be shown. Lower line is PET images using ^{18}FDG. The pancreatic cyst can not be visualized as hot image.

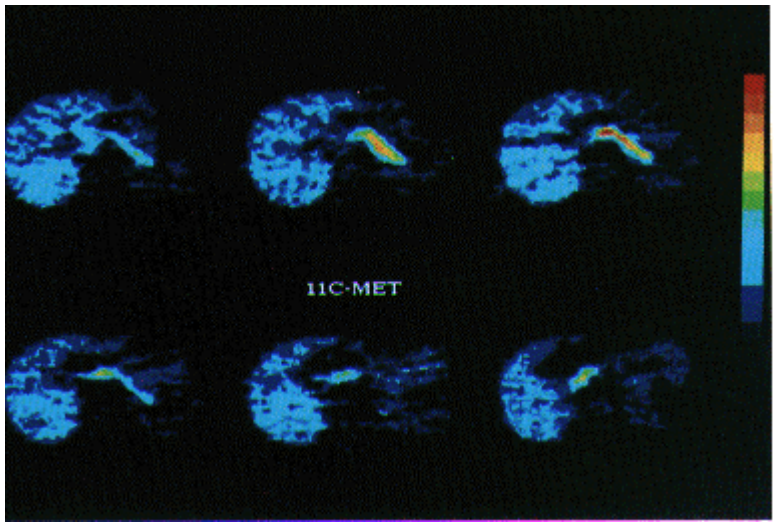

Fig. 4. PET image using ^{11}C-Met. of a 16-year-old male with DM (Case 2 in Table 2). PET image of the left is more cranial than the right and PET image of the upper line is more cranial than the lower line. The whole pancreas can be recognized.

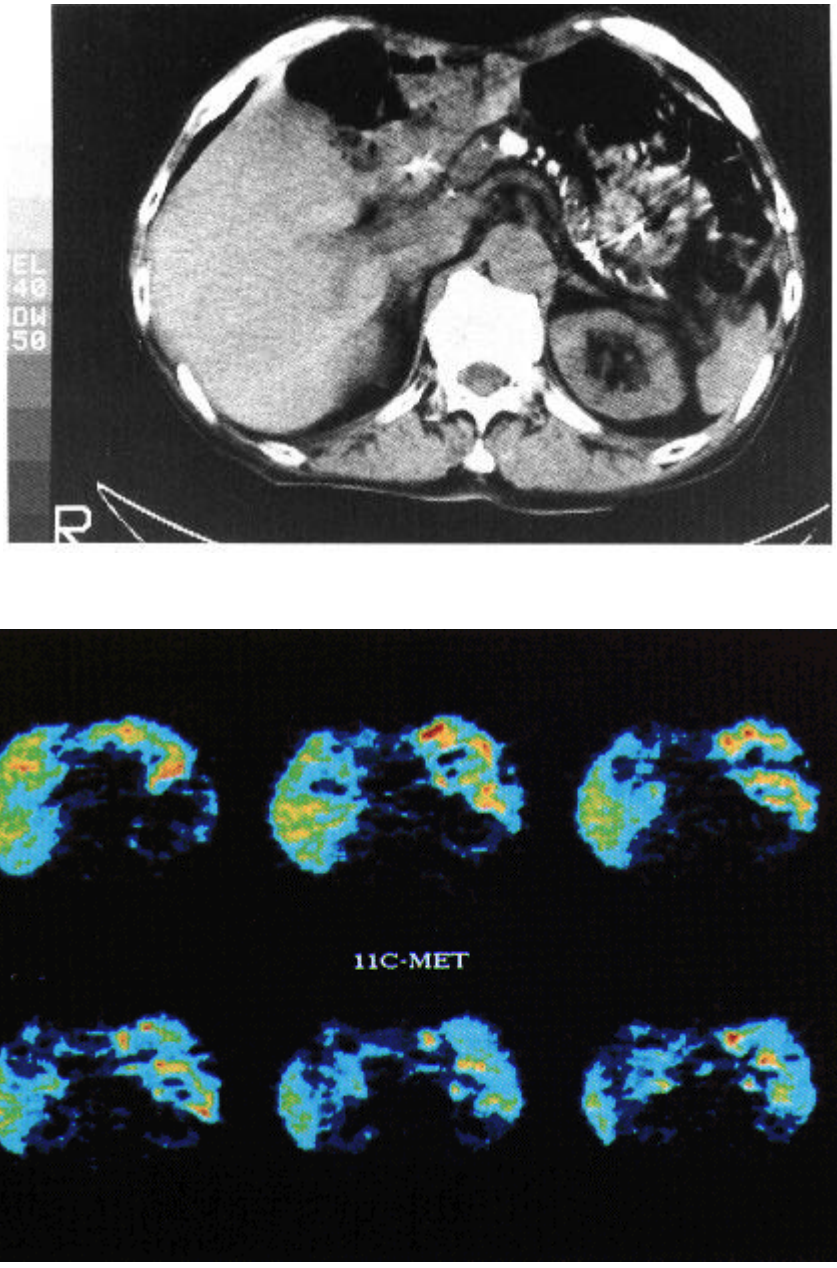

Fig. 5. PET image using ^{11}C-Met. of a 70-year-old male with chronic pancreatitis (Case 7 in Table 2). (A) X-CT: Massive calcification in the pancreas can be recognized. (B) PET: PET image of the left is more cranial than the right, and PET image of the upper line is also more cranial than the lower line. The pancreas can not be visualized.

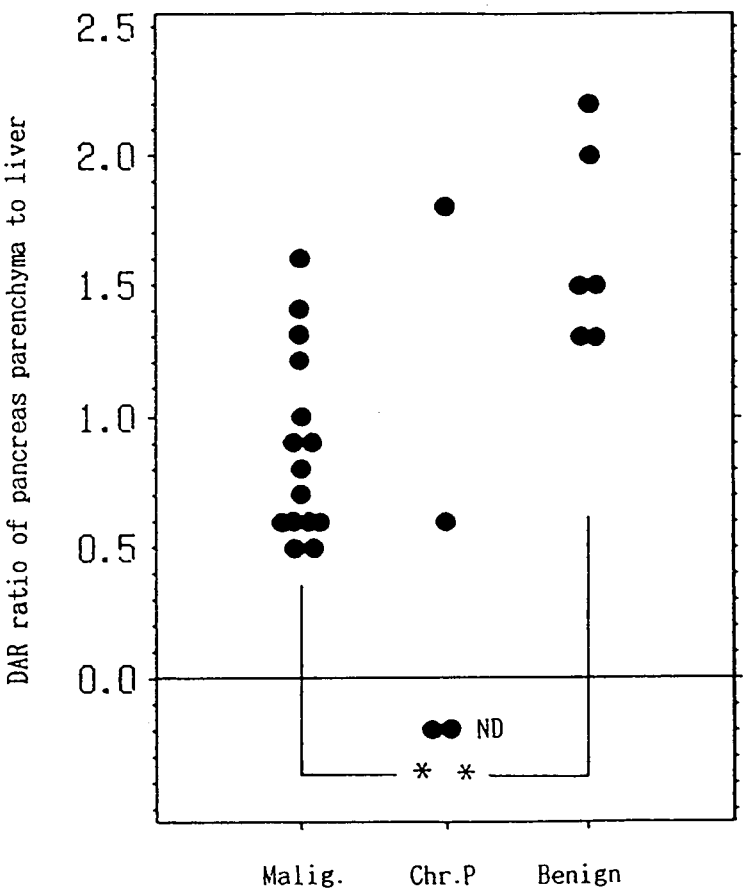

Fig. 6. DAR ratio of pancreas parenchyma to liver with pancreatic diseases in PET using ^{11}C-Met.
Malig. : Pancreatic cancer
Chr. P: Chronic pancreatitis
Benign: Pancreatic benign diseases except chronic pancreatitis and a normal volunteer.
ND : Not detect (the uptake of the pancreas was evaluated low)
** : $P < 0.01$ (student t-test)