The differential diagnosis between benign and malignant cystic tumors of pancreas by Spectral CT imaging

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Aims and objectives

Pancreatic cystic tumor is a rare clinical disease, accounting for about 2.2% ~ 15.9% of the total pancreatic tumor. However, according to the survey of recent in 10 years, its incidence increased significantly, has received the serious threat to human health. Dark position due to growth of the pancreas, pancreatic cystic tumor growth is slower, less early clinical symptoms occur, so it is hard to find in the past. As the updating and development of imaging technology, understanding of pancreatic cystic tumor had greatly improved. Pancreatic cystic tumor according to the pathological nature of the lesion can be divided into benign and malignant and border on generalized cystic tumor including many types, mainly include four kinds: mucinous cystic neoplasms, (MC#, solidpseudopapillary neoplasms(SPN), serous cystic neoplasms, (SCN), in addition, also including the intra- ductal papillary mucinous neoplasms, (IPMN), etc. In recent years, the endoscopic ultrasound, (EUS) guidance, to carry on the fine needle aspiration biopsy, (FNAB) has been widely used in clinical, improves the sensitivity and specificity of diagnosis of pancreatic cystic tumor, at the same time, the imaging doctors gradually began to understand some special types of pancreatic cystic tumor imaging and biological characteristics, including cystic acinar cell neoplasms, intraductal ntraductal tubular neoplasms, (ITN), lymphangioma of pancreas, (LP), angioma - tous neoplasms of the pancreas and euroendocrine neoplasms of the pancreas, (NEN), etc.

The type of tumor is considered a pancreatic cystic tumor and attracted the attention of many scholars.

Pancreatic cystic tumor treatments, rely mainly on the surgical treatment, is not sensitive to radiation therapy and chemical therapy, since the early people of pancreatic cystic tumor don't fully understand, no matter what type, degree of any malignant tumor, uniform implementation of marsupialization, then drainage [3] all change to inline. Until the 1940 s, with the deepening understanding of the different types of pancreatic cystic tumor and surgical technique progress, began to conduct surgical resection of pancreatic cystic tumor.

Because of various biological characteristics of different kinds of tumors and malignant degree is different, there are differences in the choice of operation method. So the identification of benign and malignant pancreatic cystic tumor preoperative, directly related to the choice of tumor resection surgery and postoperative quality of life; The choice of surgical removal of the way different, tumor patients survival time will directly affected: if benign pancreatic cystic tumor resection range is too big, will seriously inhibit the patient’s immune function, in addition, excessive surgical trauma, surgical duration is too long, the patient's prognosis poses a great challenge; If malignant pancreatic cystic tumor excision scope limited choice, surgical removal of impurities, easily lead to tumor metastasis or recurrence; So the benign and malignant pancreatic cystic tumor in patients
with preoperative determination, is of decisive significance to the prognosis of patients with.

By differentiating the status of cystic tumors of pancreas (benign or malignant) with Gemstone Spectral Imaging (GSI) technique and comparing the diagnosis outcome with postoperative pathological results, this study aims to evaluate the application of Spectral CT imaging in the diagnosis between benign and malignant cystic tumors of pancreas and improve the preoperative diagnosis of this disease.

The results will provide valuable and reliable information for preoperative diagnosis, which is in favour of appropriate surgical decision.

In recent years, computed tomography (CT) is widely used in the diagnosis of pancreatic cancer, compared to the traditional diagnosis methods, CT can fully assess the size of tumor, the growth of the location, infiltration degree, the relationship between tumor and adjacent tissue and pancreatic duct expansion, whether lymph node metastasis, etc., have taken place in recent years, more than multi - slice spiral computed tomography, #MSCT) has been widely used, the equipment through multi - slice spiral computed tomography, #MSCT), the tumor locally and around the relationship between the adjacent tissues and organs displayed in clear. At present, a lot of literature reports: MSCT in determining the pancreas cystic benign and malignant tumors, mainly according to the size of the tumor, shape, edge, dilated pancreatic duct, scan and enhanced scan in different periods of CT values to determination and classification of benign and malignant tumor, provide a reliable basis for clinical. However, many boundary tumor CT performance extremely similar, it is very difficult to judge, to clear more row helical CT, there are some limitations, for the determination of pancreatic cystic benign and malignant tumor is not very reliable.

Gemstone CT (American GE company) through the adoption of high and low energy X-ray tube ball instantaneous switch imaging mode: 80 and 140 KVP within 0.5 ms high-speed switching, dual energy acquisition data, Gemstone spectral imaging, #GSI), can realize the material separation and quantitative analysis, has recently become the focus in the new CT technology.

Energy spectrum CT gradually entered people's field of vision, opened up a new era of CT in the diagnosis of disease, all the advantages of the energy spectrum CT combined with MSCT, at the same time, enlarge the traditional CT imaging principle and details of CT examination in the previous single parameters, on the basis of developing multiple imaging parameters, mix before the energy for the development of a single energy imaging. Nowadays, spectral imaging and analysis technology has become a indispensable clinical technology, people began to focus on the material energy attenuation curve of the study, in the future, CT examination must be because of its high sensitivity and specificity can be diagnosis of tumors, benign and malignancy, cancer stage, detection of lymph node metastasis is essential for inspection.
Methods and materials

Nowadays, in the diagnosis of clinical disease, the role of CT examination is essential, in the choice of treatment method, has a certain reference value. Throughout the history of CT, in the early days, can only be used for the head CT scan, after the gradual development of the whole body parts or the whole scanning respectively, CT initially for CT scan, nowadays, there are already multilayer spiral scanning, and widely used in clinical. After decades of development by leaps and bounds of science and technology, medical level with each passing day, CT examination is also realized the leap, Siemens introduced dual-source spiral CT in the field of hegemony over a period of time CT, in 2009, the birth of gemstone CT is of epoch-making significance, this can be instantaneous dual-energy CT switch, and become the first to realize multi-parameter spectral imaging of CT. Gem CT, CT has realized the 5 d (x, y, z, time and energy) imaging, on the one hand, to analyze the chemical composition of tissues, on the other hand by spectral imaging observation and analysis of anatomical and pathological information, update to the development of clinical diagnosis and treatment and scientific research work to provide infinite possibility, as well as the evaluation of benign and malignant tumor provides a new platform for the imaging diagnosis.

Spectral imaging principle, we want to know, the first thing to understand some basic regular physical phenomena: (1) X-ray through material, there are certain attenuation, the energy attenuation can objectively reflect the X-ray line; (2) material and ability to absorb X degree, depends on the size of X-ray energy and the characteristics of material, different material receiving X-ray irradiation, will have their own absorption coefficient, attenuation coefficient and call it, we can use two kinds of "material" to represent all the material in accepting the X-ray attenuation coefficient. Among them, the iodine and water is the base material of spectrum is commonly used in CT examination. Using CT spectral imaging technology, through the post-processing, access to specific spectrum curve of different material, in general, able to express through two energy point characteristic spectrum curve. Voltage is often caused by traditional CT one-way, and receive from high to low continuous spectrum energy of mixing, traditional CT measured CT value usually represent the average absorption coefficient of material, so can not be used for material qualitative. Energy spectrum CT is based on the instantaneous dual-energy monophyletic switching technology, through to a single substance can scan, can get double data, realize the energy spectrum imaging, it has the advantage of multiple parameters, low dose, gradually replaced the traditional CT, opens the field of medicine, imaging diagnostic techniques of a new chapter.

Using spectral imaging technology, all material characteristic spectrum curve can be mapped, through the spectrum curve can be seen that CT values change with keV, through this curve, in 40 to 140 keV different single can within the scope of material can be found by CT value, can draw by calculation, the substance of the effective atomic number, at the same time, the decomposition of two kinds of base material, to obtain
the base material figure, including iodine, water, calcium and so on, to some extent, in this way, can carry on the qualitative and quantitative determination of matter, under this trend, the traditional CT with X-ray attenuation coefficient as a single parameter, the diagnosis model will gradually withdraw from the historical stage.

Spectral CT imaging is characterized by multiple parameters, and able to perform quantitative analysis, through the energy spectrum CT examination, make lesions origin, classification of lesions, decide to be benign and malignancy. In recent years, by leaps and bounds of science and technology, the medical level, changing in clinical work, antiangiogenesis therapy got the attention of the people, when evaluating the effect of tumor antiangiogenesis therapy, use of CT perfusion imaging parameters, make the flow of blood to the tumor tissue state were presented at the microcirculation level, reflect the tumor microvascular density. With precious stones energy spectrum CT can draw out the base figure of iodine, measured tumor contains iodine value, measured results to some extent, can reflect the microvascular density of tumor, can through the content of iodine value, understand the status of tumor angiogenesis, evaluate the effect of antiangiogenesis drugs. So, energy spectrum CT in terms of the nature of the determination of pancreatic cystic tumor, has great application value, can promote the preoperative CT examination to determine the accuracy of the pancreatic cystic tumor nature.

The gemstone CT (Discovery CT750 HDCT#GE-Healthcare) was conducted on 42 patients (26 males and 16 females) with cystic tumors of pancreas. All patients were confirmed by surgical and histological biopsy examinations. The scanning mode was plain scanning plus triple phase-enhanced scanning and GSI scanning was used in arterial phase.

Before examination, all patients are required to practice suffocating to reduce the artifacts. 88ml of contract agent (Omnipaque 300) followed by 10ml of saline were injected intravenously into middle elbow of patient at a rate of 3.0 ml/s. The arterial phase scanning and the portal phase scanning were performed for 30s and 60s after injection, respectively, together with a 120s delay for balance phase. The abdominal aortic CT value (Smart Prep technique) was applied to initiate the arterial phase scanning, with monitoring threshold of 100HU. The routine scanning procedure was carried out, 30s after the arterial phase scanning is the portal phase scanning, followed by balance phase scanning after another 60s. The raw data were sent to adw4.5 workshop for procession and analysis, with focus on the imaging features of pancreatic lesions by plain and triple-phase enhanced scanning. The assessments in differentiation of benign and malignant cystic tumors of pancreas with traditional CT examination include: 1). the density of tumor lesion in plain scanning (CT value); 2). tumor size and morphology; 3). tumor boundaries and surroundings; 4). the existence of tumor calcification, bleeding or necrosis; 5). tumor enhancement level in enhanced scanning; 6). the pancreatic duct dilatation. The tumor spectrum attenuation curve was obtained using GSI software in arterial phase scanning. By comparison with normal pancreatic tissue, it can be concluded that the tumor is benign or malignant.
Fig. 3: For lesions of iodine base figure.

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Fig. 4: Water-based figure for lesions

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Fig. 5: Pancreatic cystic tumor, pancreatic duct expansion, pathology of mucinous cystic neoplasms, benign. Regular scans arterial pancreatic cystic tumor, pancreatic duct expansion, conventional CT diagnosis of pancreas intraductal tubular neoplasms, pathology of mucinous cystic neoplasms, the image of the circle is interested in the selected area.

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Fig. 6: For reaction in a scatter plot of the area of interest, the horizontal, vertical, said the water content and iodine content respectively.

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Fig. 7: For lesions of iodine base figure.

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Fig. 8: Water-based figure for lesions.

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**Fig. 2:** For reaction in a scatter plot of the area of interest, the horizontal, vertical, said the water content and iodine content respectively.
Results

<table>
<thead>
<tr>
<th>Check the method</th>
<th>Consistent with the pathological</th>
<th>Not in conformity with the pathological</th>
<th>Coincidence rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional CT</td>
<td>35</td>
<td>7</td>
<td>83.3%</td>
</tr>
<tr>
<td>Energy spectrum CT</td>
<td>38</td>
<td>4</td>
<td>90.4%</td>
</tr>
</tbody>
</table>

GSI arterial application software, to gain the energy spectrum of the pancreatic cystic tumor and normal pancreas tissue attenuation curve, for statistical classification, review of comparative pathology results.

Control in the surgical resection of tumor tissue pathology results, comparison and analysis of pancreatic cystic tumor spectrum curve diagram, compare the normal pancreatic tissue of energy spectrum diagram. Note: according to the pathological nature of pancreatic cystic tumor classification, grouping statistics, and comparison with the postoperative pathologic results.

42 cases of pancreatic cystic tumor patients accepted the surgery, before surgery, of all patients with precious stones for a CT scan and arterial and venous phase and delayed phase of three phases enhanced scan, at the same time, the tumor, and interested area (normal pancreatic tissue) with conventional CT and energy spectrum CT scan, the results compared with postoperative pathologic results. GSI arterial application software, to gain the energy spectrum of the pancreatic cystic tumor and normal pancreatic tissue attenuation curve, observe its spectrum curve and slope, review compare the postoperative pathologic results. Finally collected data and statistical methods are analyzed.

Benign pancreatic cystic tumor spectrum curve distribution points value is bigger, more than normal pancreatic tissue, curve slope is bigger; Malignant pancreatic cystic tumor of curve distribution points value smaller, less than normal pancreatic tissue, the curve slope is smaller. Application of conventional CT and energy spectrum CT to determine the nature of the pancreatic cystic tumor, after compared with the pathological results, the results show that the use of energy spectrum CT, to determine the highest consistency of results and pathology results, followed by conventional CT in the diagnosis of benign and malignant pancreatic cystic tumor evaluation method. Selected in this study, 42 patients with pancreatic cystic tumor, which respectively for conventional CT and energy spectrum CT scan, will get the results compared with the pathological results, the results show that the energy spectrum of CT and pathology results coincidence rate is highest, at 90.4%, the traditional method of CT: the contrast CT value, observe the strengthening way and degree of the pancreatic duct expansion method of imaging findings coincidence rate was 83.3%, compared with the conventional CT, energy spectrum CT a slight
advantage, apply it in clinical preoperative diagnosis, has certain clinical value, can provide a reference for the choice of operation scheme.
**Fig. 9:** Control in the surgical resection of tumor tissue pathology results, comparison and analysis of pancreatic cystic tumor spectrum curve diagram, compare the normal pancreatic tissue of energy spectrum diagram. Note: according to the pathological nature of pancreatic cystic tumor classification, grouping statistics, and comparison with the postoperative pathologic results.

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Conclusion

In clinical work, the energy spectrum CT has been the attention of the clinicians industries, promote the rapid development of the energy spectrum CT, now has been used to the whole body each organ system diseases, clinical value is bigger, its features include the following four: compared with conventional inspection, avoid the hardening artifacts; it can carry on the comprehensive analysis of energy spectrum check image; image clearer, contrast to noise ratio and the quantitative analysis of the material of the optimization, thus increased the CT to the diagnosis of benign and malignant pancreatic cystic tumor sensitivity, to evaluate benign and malignant pancreatic cystic tumor and determination, the results are compared with postoperative pathological results, thus obtain the consistent with the pathological results coincidence rate and degree, its use in the preoperative diagnosis evaluation, to some extent, improved the benign and malignant pancreatic cystic tumor assessment accuracy.

To improve the quality of the images and the contrast to noise ratio was optimized: a substance to accept a certain energy X-ray, absorb part of the energy of X-ray attenuation, this process can produce images, is a single image, the density of the material itself is different, the X-ray attenuation coefficient is different, so the advantage of the single can image the same material attenuation coefficient is stable, avoid a hardening artifacts, improve image quality. Lesions and substantial differences between the attenuation coefficient of organs, the so-called best kev is at a maximum expand the energy level difference, as far as possible to reduce the noise values at the same time. CT characteristic of spectral imaging is the display of single image and high iodine based image quality. Contrast between the lesions and the background in the best CNR under single can optimize images, is conducive to find small lesions, not easy to damage the omission. Spectral imaging comprehensive analysis: first, energy spectrum CT imaging of single image respectively with different kev, in addition, also can get the base material of density value and its distribution under different kev. In GSI sequence we can get the characteristic energy spectrum curve, the curve is about X line of different tissues and pathological changes, we can be calculated by the curve obtained tissues and pathological changes of effective atomic number. Compared with the conventional CT diagnosis way, using the energy spectrum CT, can apply analysis tools are also more diversified, quantitative indicators can be also will increase at the same time, the related parameters for integrated, and these tools can analysis lesions and different organizational structure, and for some special to differentiate the lesions; When the nature of the lesion, focal origins, different degree of organization densitometer strengthening, spectral imaging parameters of also has difference, Form similar, its essence is still likely to exist difference, therefore, different disease with shadow has been imaging doctor to diagnose disease, facing a big problem in the process of application of energy spectrum CT, microscopic features of the lesions were analyzed, and helps to solve the problem. The nature of pancreatic cystic tumor make accurate judgement is not an easy task, can be accurately determine, will determine the choice...
of the quality plan, the outcomes of patients condition. Through energy spectrum CT imaging, hopefully get tumor shape, size, location, infiltration, whether the pancreatic duct expansion, the presence of lymph node metastasis, whether the information such as distant metastasis, and applied to clinical preoperative diagnosis, improve the level of preoperative diagnosis, provide reference for the choice of treatment. There was statistical difference between the conclusion made from traditional method based on CT values and imaging features of several phases scanning and the conclusion made by pathological examination. (P=0.025<0.05). However, there is no statistical difference regarding the conclusion made from spectral CT imaging and pathological examination. (P=0.316>0.05).

In arterial phase scanning, the spectrum attenuation curve of tumor lesion got from GSI software can be applied for the differentiation of benign and malignant cystic tumors of pancreas, by comparison with normal tissue. The consistency of the conclusion from spectral CT imaging and from postoperative pathological examination is higher than traditional CT scan, indicating that this new technique can provide more accurate information for diagnosis and help doctor make more effective therapeutic strategy.

Energy spectrum CT evaluation of benign and malignant pancreatic cystic tumor of shortcomings#(1) in this study, for patients with pancreatic cystic tumor preoperative imaging studies, and to evaluate tumor nature determination, compared with the postoperative pathological results after, as many pathological classification of pancreatic cystic tumor, is extremely complex, not for a certain degree of benign and malignant pancreatic cystic tumor analysis separately, small sample size, the need to further expand the sample size, in order to improve the precision of the result, so there is a certain degree of error. (2) in the field of medicine, because of benign and malignant pancreatic cystic tumor imaging on the judgement of the lack of uniform diagnostic criteria, in this study, to determine the nature of the tumor target only from several of traditional CT, it's caused by imaging examination to determine the nature of the pancreatic cystic tumor, there are some false negative or false positive.
Fig. 10: Spectral curve (different X-ray energy levels of CT value curve), yellow for tumor curve, red for normal pancreas Woven, malignant tumor smaller value of curve distribution points, less than normal pancreatic tissue, the curve slope is smaller.

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Fig. 11: Spectral curve (different X-ray energy levels of CT value curve), yellow for tumor curve, red represents normal pancreatic tissue, benign tumors (value is bigger, more than normal pancreatic tissue, curve slope is bigger

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