Preliminary clinical study of the 64-slice spiral CT perfusion in gastric stromal tumor

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Abstract: objective To evaluate the value of the 64-slice spiral CT perfusion in gastric stromal tumor. **Material and methods** the CT perfusion images between 10 cases of normal patients and 43 cases of gastric stromal tumor were analyzed, which included time density curve (TDC), Blood Flow, (BF), Blood Volume, (BV), Mean through Time (MTT) and Permeability Surface (PS). **Results** Gastric stromal tumor patients with BV and PS figures were shown as red, yellow and blue color change. The value differences of the BF, MTT, PS were statistically significant between gastric stromal tumor group and normal gastric group ($p < 0.05$), while BV value differences had no statistical significance ($p > 0.05$). There had no statistical significance between low grade group and medium-high grade group in BF, BV, MTT and PS values ($p > 0.05$). **Conclusion** 64 slice spiral CT perfusion imaging can reflect the normal gastric tissue from the level of microcirculation, hemodynamic characteristics of gastric stromal tumor and offer more quantitative information from a functional perspective for the diagnosis of gastric stromal tumor. It also provides an effective means for the further research of oncology therapy, judgment of curative effect and prognosis monitoring.

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Gastric stromal tumor (GST) is the most common non epithelial tumors of the stomach [1]. At present, spiral CT has become a preoperative routine method in diagnosing GST. As a new technology, CT perfusion imaging has been widely used in head, neck, lung, liver, pancreas and kidney [2-7].Relative to the substantive organs, CT perfusion study of the stomach, due to its moving and breathing exercises, has few research reports. This study based on 64-slice spiral CT perfusion imaging of the normal stomach and gastric stromal tumor, aims to evaluate clinical application value of CT perfusion imaging in gastric stromal tumor.

Materials and methods:

1. Clinical data and grouping

43 cases of gastric stromal tumor confirmed by gastroscopy biopsy or surgical pathology were collected from June 2009 to December 2012 .In 43 patients with gastric stromal tumor, (20 male and 23 female, patients aged from 40 to 69 years old, the average age was 51.67 years). According to pathology of tumor cell differentiation degree, the gastric stromal tumors can be divided into: Ⅰ group of 17 cases (low grade), Ⅱ group of 26 cases, (medium-high grade). All cases did not receive any preoperative radiotherapy or chemotherapy, but received the 64-slice spiral CT gastric perfusion scanning in 1 week. Another collection of 10 cases of normal gastric, including 7 male and 3 female, all patients aged from 26 to 70, the average age of 57.00 years, they were all received gastric perfusion CT scanning. All patients signed the "CT perfusion scanning informed consent" before the examination.

2. Scanning methods

The patients needed fast more than 8 ~ 12 h, 10 ~ 15 min prior to the scanning with no contraindications (such as glaucoma, prostatitis, etc.), the patient was injected hydrochloric acid anisodamine (654-2) 10 mg in muscle and took warm water 800 ~ 1200 ml. Breathless training was done before the examination, all subjects were in the supine position, use the GE Lightspeed line 64 - VCT perfusion scanning mode. Specific operation was as follows: firstly, routine abdominal CT scanning, layer thickness, layer spacing of 5 mm, pitch of 0.984:1, the scanning speed of 0.8 SEC. Selected the target level according to the scan image and selected the largest lesion level as the center, and chose eight layers up and down. Perfusion scanning mode: the axial scanning mode, the tube rotation speed: 1 s/circle; Thickness: 5.0 mm, layer spacing 0; 120 kv / 80 ma; Elbow vein rapidly injection contrast medium, adopt the iodine contrast agent (320 mgI/ ml), injection speed is 4 ~ 5 ml/s, dosage of 48 ~ 50 ml, we began the scanning after injection of contrast medium for 7 ~ 10 s, scanning time last 50 s, the total exposure time was 25s. During the scanning, the subjects was tied with the abdominal belt and was instructed breathless 50 s, for the elderly who unable to hold for a long time to calm the breath.

3. Data processing and analysis

We transferred the perfusion data to GE ADW4.3 workstation, using GE CT perfusion - 3 perfusion software package of pancreatic perfusion (Pancreas tumor perfusion) protocol (deconvolution method) to calculate, map, analyse and generate the corresponding perfusion parameter values. We chose the abdominal aorta as input artery with 2 ~ 6 pixel in order to avoid the partial volume effect. Then we defined the threshold with 0 ~ 200 HU, it should get rid of the influence of surrounding bone, fat, air and other groups. Finally the interested area (ROI) was selected. the area of the interest was generally chose larger than 50 pixels and should not reach edge of the target areas, at the same time it should be avoid the great vessels and focal necrosis areas. We got the corresponding time density curve (TDC) and perfusion image through the selected area, and further calculate various perfusion parameter values. The mainly perfusion parameters including Blood Flow, (BF), Blood Volume, (BV), Mean through Time (MTT), Permeability Surface (PS). All measured perfusion parameter values were valued 3 repetitions, take the average value as a result.

The statistical analysis was performed using commercially available software SPSS 15.0(SPSS.Inc.Chicago). The *t* student test was used to compare the two groups of independent samples and P-value of <0.05 was considered as significant.

Results:

1. TDC of 10 cases of normal gastric wall: it can be divided into three parts, flat baseline segment, rising slowly ascending and down slowly horizontal section. TDC of 43 cases of gastric stromal tumor can be divided into two types: Ⅰ type (36 cases), the initial segment rise slowly, and reach the peak showing a slow decline, forming a crest, then showed a horizon trend to the end of perfusion. Ⅱ type (7 cases), the initial segment showed a slight upward trend to a peak level, and then remained the level of the peak until the end of perfusion scan.

2. Gastric stromal tumor patients with BV and PS figures were shown as red, yellow and blue color change.

3. The value of BF,BV,MTT,PS of the 10 cases of normal gastric perfusion were 43.66 + / - 10.44 ml / 100 g/min, 7.82 + / - 2.52 ml / 100 g, 14.82 + / - 6.89 s, 8.06 + / - 2.15 ml / 100 g/min respectively; The value of BF,BV,MTT,PS of the 43 cases of gastric stromal tumor perfusion were 74.83 + / - 18.98 ml / 100 g/min, 8.05 + / - 2.71 ml / 100 g, 10.23 + / - 2.67 s, 15.03 + / - 5.32 ml / 100 g/min respectively. The value differences of the BF, MTT, PS were statistically significant between gastric stromal tumor group and normal gastric group ($p < 0.05$), while BV value differences had no statistical significance ($p > 0.05$). (Table 1).

4. 17 cases of low-grade gastric stromal tumor perfusion parameters of BF, BV, MTT, PS value were 77.28 + / - 25.57 ml / 100 g/min, 7.91 + / - 2.84 ml / 100 g, 7.37 + / - 2.38 s, 13.99 + / - 4.06 ml / 100 g/min respectively; In 26 cases, medium-high grade gastric stromal tumor perfusion parameters of BF, BV, MTT, PS value were 95.13 + / - 29.75 ml / 100 g/min, 8.21 + / - 2.65 ml / 100 g, 7.33 + / - 1.83 s, 14.15 + / - 4.04 ml / 100 g/min respectively. There had no statistical significance between two groups in BF, BV, MTT and PS values ($p > 0.05$). (Table 2, figure 1, 2).

Table 1. Perfusion parameters of gastric stromal tumor group compared with normal gastric group

perfusion parameter (unit)	BF (ml/100g/min)	BV (ml/100g)	MTT (s)	PS (ml/100g/min)
normal gastric group(n=10)	43.66±10.44	7.82±2.52	14.82±6.89	8.06±2.15
stromal tumor group(n=43)	74.83±18.98	8.05±2.71	10.23±2.67	15.03±5.32
t value	-4.592	-0.242	2.474	-3.840
P value	0.000	0.810	0.024	0.001

Table 2. Relationship between perfusion parameters and the differentiation degree in gastric stromal tumor

perfusion parameter (unit)	BF (ml/100g/min)	BV (ml/100g)	MTT (s)	PS (ml/100g/min)
low grade gastric stromal tumor(n=17)	77.28±25.57	7.91±2.84	7.37±2.38	13.99±4.06
medium-high grade gastric stromal tumor(n=26)	95.13±29.75	8.21±2.65	7.33±1.83	14.15±4.04
t value	0.001	0.262	0.840	0.110
P value	0.981	0.612	0.369	0.742

Discussion

As a new technology of function imaging, CT perfusion makes the traditional imaging diagnosis from anatomical morphology transition to functional metabolic state. At present, the application research of

CT perfusion imaging has gradually become hot spots, such as in the head, neck, lungs, liver, pancreas and kidney. Relative to the substantive organs, CT perfusion study of the stomach, due to its moving and breathing exercises, has few research reports.

In 1991, Miles[8-9] first proposed the concept of CT perfusion imaging (CTP), namely to do continuous dynamic scanning for many times at the selected level after intravenous contrast medium, so as to obtain the density of each pixel in the level of time sequence of the process, namely the time density curve (TDC). TDC of the x-coordinate represented perfusion scan time, y-coordinate represented the increased CT value of organization which reflected the contrast medium concentration change trend in the tissues and organs indirectly reflected the perfusion changes. TDC curve of 43 cases of gastric stromal tumor in this study showed horizontally or slow downward trend after the curve peak, reflected the vascular endothelial cells of gastric tumor tissue were not integrity, led wall permeability increase and a lot of contrast extravasating out of the intercellular space, and interstitial space of the tumor tissues was larger than normal, thus causing contrast medium cleaned up slowly.

According to generated TDC curve, we can adopts corresponding suitable mathematical model to calculate the various perfusion parameters, such as blood flow(BF), blood volume(BV), mean transit time of contrast agent (MTT) and capillary permeability surface (PS), etc. Perfusion scan data can be used for the reconstructive image and pseudo color processing [8]. Pseudo color map is based on the pixels in the image received by the calculation, draw perfusion value of each pixel, and set into different colors, so that different colors reflect different perfusion values, the so-called color perfusion function image which through a more intuitive method to measure the blood perfusion areas.

Perfusion functional images usually have red, yellow, blue, green colors, among them, the red color represents the high BF, BV, PS and short MTT, on the contrary, the blue color represents a low BF, BV, PS and long MTT, the Yellow and green color are somewhere in between. The functional perfusion image of CT shows the uneven dyeing of tumor heterogeneity characteristics of internal activity. The BV and PS figure of patients with gastric stromal tumor in this study showed as red, yellow and blue color change prompted the pathological changes of blood flow perfusion and increased vascular permeability. MTT figure showed much pseudo color like red, yellow and green, represented shorter MTT in tumor tissue, may indicate that tumor angiogenesis to stimulate more arteriovenous channels open, which led to a shorter mean transit time of contrast agent.

BF and BV value reflects the number of blood vessels within the tumor tissue. Increase of BF and BV value represent the tumor angiogenesis which is closely related to the tumor invasion and metastasis ability [10-12]. So BF and BV value can reflect to some extent and to assess the biological behavior of tumors. PS value mainly reflect changes in the permeability of blood vessel walls, the higher tumor malignant degree is, the more blood supply needs, the more tumor angiogenesis is, the greater vascular permeability. So the PS value, to a certain extent, can reflect the degree of tumor malignant [13]. According to the results of this study, gastric stromal tumor perfusion parameters of BF, PS value were higher than that of normal stomach tissue, and the difference were statistically significant, showed that tumor tissues of gastric stromal tumor blood perfusion increased and changed the gastric perfusion from original state to high blood flow perfusion status. Gastric stromal tumor of the BV values had no obvious difference compared with normal stomach tissue, showed there was no definite guiding significance in perfusion volume between gastric stromal tumors and normal stomach tissue.

At present, no one can make a clear distinction between benign and malignant gastric stromal tumor [14], because gastric stromal tumor itself has many potential and non directional differentiation in the development. The literature [15] reported part of benign gastric stromal tumors in the postoperative follow-up had still metastasis. Other literatures [16-18] showed there were closely related between benign and malignant tumors in size, morphology and growth mode, therefore we needed integrated a number of factors to determine the benign and malignant of gastric stromal tumor. In this study, BF, BV, MTT and PS value were different between low grade and medium-high grade malignant gastric stromal tumor, but the differences were not statistically significant. CT perfusion imaging can provide quantitative view demonstrates the focal area of gastric stromal tumor blood perfusion, but there is no clear guidance for the different differentiation degree qualitative and differential diagnosis of gastric stromal tumor and remains to be further research.

All in all, 64 slice spiral CT perfusion imaging can reflect the normal gastric tissue from the level of microcirculation, hemodynamic characteristics of gastric stromal tumor and offer more quantitative information from a functional perspective for the diagnosis of gastric stromal tumor. It also provides an effective means for the further research of oncology therapy, judgment of curative effect and prognosis monitoring.

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Figure 1. Female,47years old,low grade gastric stromal tumor

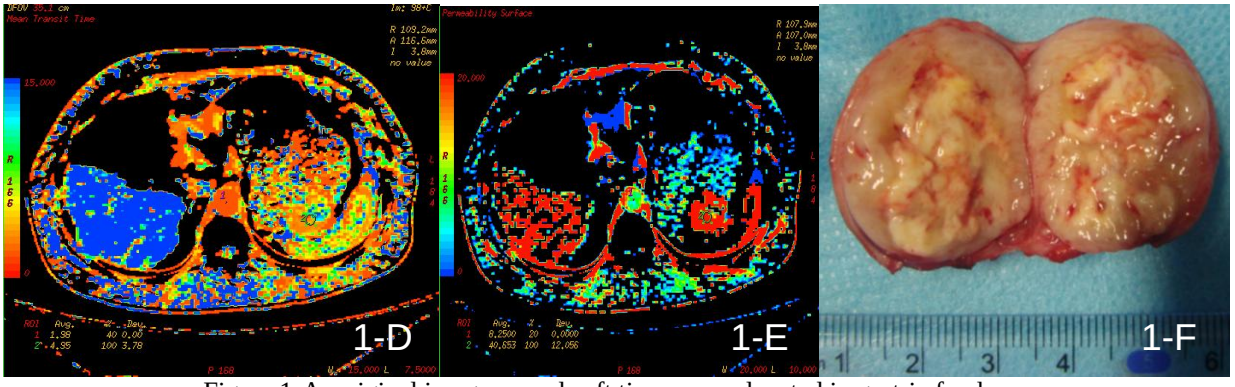

Figure 1-A: original image, round soft tissue mass located in gastric fundus;
Figure 1-B,1-C,1-D,1-E: BF,BV,MTT,PS perfusion images;
Figure 1-F: gross specimen;

Figure 2. Male,47years old,high grade gastric stromal tumor

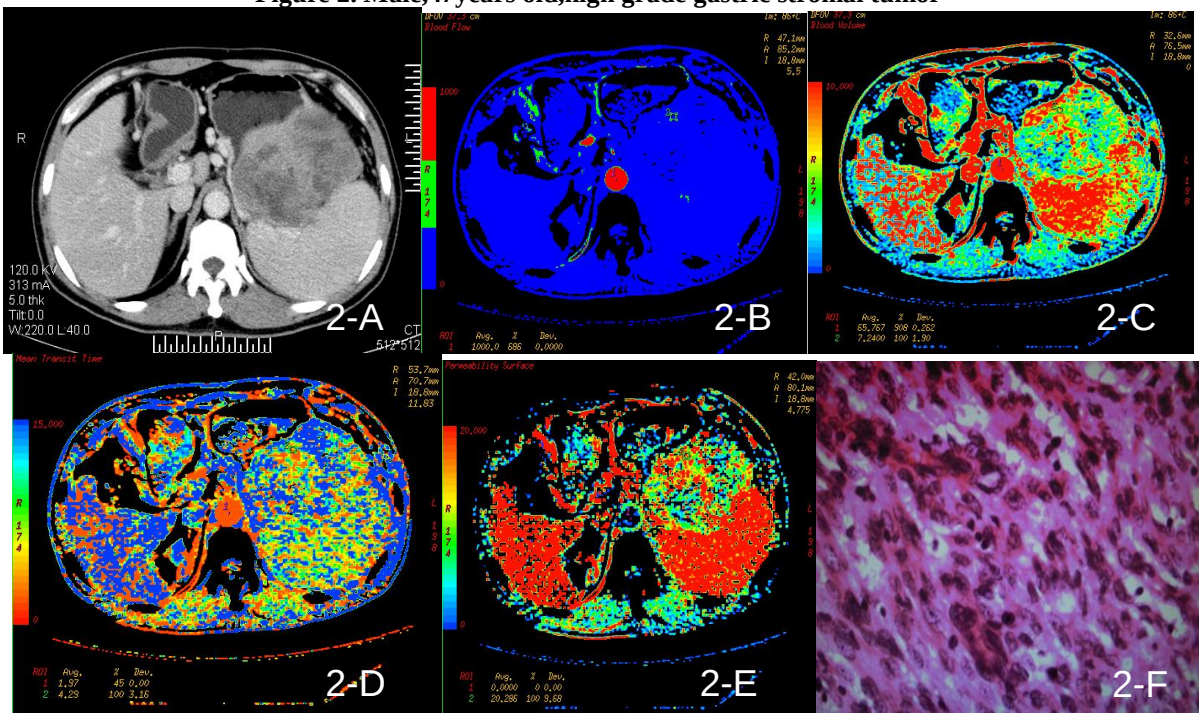

Figure 2-A: original image, huge soft tissue mass located in gastric fundus and body;
Figure 2-B,2-C,2-D,2-E: BF,BV,MTT,PS perfusion images;
Figure 2-F: pathological tissue section HE ×400;