Anatomical factors influencing traditional abdominal examination in Kampo diagnosis: Analysis by computed tomography

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ABSTRACT

Aim: In Japanese-Oriental (Kampo) medicine, the abdominal examination is an important diagnostic method. We examined the influence of anatomical factors in Kampo medicine on the Kampo diagnosis of abdominal aortic pulsation using abdominal computed tomography (CT).

Methods: Our subjects were 67 patients (34 men, 33 women; average age: 61.4 ± 16.3 years) who underwent abdominal CT in the Department of Japanese-Oriental (Kampo) Medicine at Chiba University Hospital. We measured the depth of the abdominal artery from the midline of the body surface and the blood vessel diameter at that point, and calculated the averages of these parameters among all patients at three locations of abdominal aortic pulsation (epigastrium, supra-umbilical region, and infra-umbilical region) on the CT section.

Results: The detection rate of abdominal aortic pulsation was highest in the supra-umbilical region (30%), followed by the epigastrium (21%) and the infra-umbilical region (15%). The average depth of the aorta from the body surface was shallowest in the supra-umbilical region (74.9 mm) and deepest at the epigastrium (103.5 mm). As the depth of the artery decreased at the epigastrium and supra-umbilical region, significant abdominal aortic pulsation was observed (P = 0.006 and P = 0.001, respectively).

Conclusion: Our study demonstrates that abdominal aortic pulsation is anatomically associated with the depth of the artery. The supra-umbilical region appeared to be the most suitable location for evaluating abdominal aortic pulsation, as the aortic artery is shallowest at that point and is least influenced by the depth of the abdominal artery.

KEY WORDS: abdominal aortic pulsation, abdominal CT, abdominal examination, anatomical factors, Kampo medicine

INTRODUCTION

In Japanese oriental medicine (Kampo medicine), the abdominal physical examination is an important diagnostic method for detecting the pathological condition of a patient (Sho, the disease pattern) and prescribing medication [1–4]. However, it is very difficult to learn the Kampo style of abdominal palpation. Yakubo et al. attempted to simplify the learning process by building models of the typical anatomical abdomen for training [5]. Similar simulators are already used in medical education for other phenomena such as cardiac diseases, and are recognized as being useful [6,7]. In order to contribute to models of the abdomen, basic research on the objective diagnosis of abdominal pulsations is considered to be necessary.

Abdominal aortic pulsation is defined as the abdominal artery pulsation detected on the abdominal surface. In Western medicine, abdominal aortic pulsation is examined by having the patient bend his or her knees in the supine position to remove abdominal tension. The examiner detects abdominal aortic pulsation deep within the abdomen and calculates the width of the abdominal aorta, and is then able to determine whether or not an abdominal aneurysm is present and if so, provide a prognosis. The only factor determining the diagnosis is the width of the abdominal aorta; the strength of the abdominal aortic pulsation is not taken.

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Factors of abdominal pulsations

Our subjects were 67 patients (34 men, 33 women, average age: 61.4 ± 16.3 years) who underwent abdominal CT examination in the Department of Japanese-Oriental ‘Kampo’ Medicine at Chiba University Hospital (Table 1).

We reviewed the findings in the patients’ clinical records, such as the presence or absence of abdominal pulsation and the strength of the abdominal wall, which were evaluated by specialists in Kampo medicine within two weeks before or after CT examination. We excluded three cases whose abdominal pulsation findings changed from before to after the CT examination. Patients who suffered nausea attacks or transient hypertension and tachycardia during seizure were also removed from the present evaluation.

First, in order to identify the epigastrium, supra-umbilical region, and infra-umbilical region, the length (L) from the bottom end of the sternum to the umbilicus was measured on an abdominal CT. Referring to diagrams of the abdomen found in previous studies [9–11], we divided the abdomen into three equal parts from the bottom end of the sternum to the umbilicus. We defined the epigastrum to be at L/3 below the bottom end of the sternum, the supra-umbilical region to be at L/6 below the bottom of the sternum, and the infra-umbilical region to be at L/6 below the umbilicus. Pulsation in each of these sections was defined as pulsation in the epigastrum, supra-umbilical region, and infra-umbilical region (Fig. 1), respectively.

Next, in order to examine the relevance of abdominal pulsation and the anatomical features of the abdominal aorta, we carried out various measurements, using abdominal CT as follows. As the abdominal aorta bifurcates approximately at the level of the umbilicus, we used different methods of measurement in the epigastrum, supra-umbilical region, and infra-umbilical region. In the epigastrum and supra-umbilical region, we measured the depth of the ventral part of the abdominal aorta (D) from the body surface and the diameter of the abdominal aorta (Φ) and obtained these two indexes at the midline of the linea alba between the rectus muscles with cross-sectional CT closest to the epigastrum and supra-umbilical region (Fig. 2a). In the measurement of the infra-umbilical region, we measured the depth of the shallower side of the right or left common iliac arteries (A), the diameter of the blood vessel (Φ) and the distance between the right and left common iliac arteries (DA), and obtained average values for these three indexes (Fig. 2b). In cases where the abdominal aorta was not bifurcated into the left and right common iliac arteries, we measured the depth and the diameter of the abdominal aorta.

For statistical analysis, we used the Student’s t-test after confirming equal variances in an F-test, and we examined those equal variances (the depth of the abdominal aorta, the diameter of the abdominal aorta, and the distance between the common iliac arteries) with particular attention to the presence or absence of abdominal pulsation. To assess the relevance of pulsation in the epigastrum or supra-umbilical region to the patient’s physical constitution, we used the χ² test.

This research was approved by the Medical Ethics Committee of the Graduate School of Medicine, Chiba University (No. 2330).

RESULTS

The detection rate of abdominal pulsation was 30% in the supra-umbilical region, 21% at the epigastrium, and 15% in the infra-umbilical region (Table 1).

The average depth from the body surface was least in the supra-umbilical region (74.9 mm) and largest at the
epigastrium (103.5 mm). In general, the average diameter of arteries was found to decrease with distance from the heart. Significant differences were observed in the depth of the artery by gender in the epigastrium and supra-umbilical regions (Table 2). In the epigastrium and supra-umbilical region, the depth of the abdominal artery was significantly less when abdominal pulsation was observed than when pulsation was not observed (p = 0.006 and p = 0.001, respectively). In the infra-umbilical region, no relationship was observed between the depth of the abdominal artery and the presence of abdominal pulsation (Fig. 3). No significant differences were observed regarding the diameter of the abdominal artery and the presence or absence of abdominal pulsation at any location (Fig. 3). The smaller the distance between the common iliac arteries, the more significant positive findings (P = 0.048) were observed in the infra-umbilical region (Fig. 4).

At the epigastrium and in the supra-umbilical region, a positive correlation was observed between the depth of the aortic artery and body mass index (BMI) (Fig. 5). This correlation suggests that the location of the artery becomes deeper as BMI increases and the tendency toward obesity becomes stronger. In cases with BMI \( \geq 25 \), no pulsation was found in any patient in the supra-umbilical region, and only one case of pulsation in the epigastric region was observed. We examined the association between the patient’s physical constitution and the presence or absence of pulsation in the epigastric and infra-umbilical regions (Table 3) in two groups, one with BMI equal to or greater than 25 and one with BMI under 25. A relationship was observed between large body size and the absence of pulsation in the epigastric and infra-umbilical regions (P = 0.01 and P = 0.008, respectively).

**DISCUSSION**

The classical interpretation of abdominal pulsation

In Kampo medicine, it is said that abdominal artery pulsation increases with mental instability. Ogawa and Kinoshita report that many individuals with abdominal pulsation show functional disturbance of the autonomic nervous system [13]. M. Yamada summarizes the theories put forth in numerous old publications written in the Edo or modern period [14].

In Kampo medicine, abdominal artery pulsation can signify any or all of the following:

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**Table 1** | Clinical characteristics of subjects

|                      | Total \((n = 67)\) | Male \((n = 34)\) | Female \((n = 33)\) |
|----------------------|-------------------|-----------------|-------------------|
| **Age (years)**      | 61.4 ± 16.3       | 59.1 ± 17.0     | 63.8 ± 15.1       |
| **BMI (kg/m²)**      | 22.94 ± 5.58      | 24.25 ± 5.47    | 21.59 ± 5.37      |
| ≥25.0 (kg/m²), \(n\) | 18 (27)           | 14 (41)         | 4 (12)            |
| **EP positive**, \(n\) | 14 (21)          | 6 (18)          | 8 (24)            |
| **SU positive**, \(n\) | 20 (30)          | 8 (24)          | 12 (36)           |
| **IU positive**, \(n\) | 10 (15)          | 4 (12)          | 6 (18)            |

BMI, body mass index; EP, pulsation in the epigastrium; SU, the supra-umbilical region; IU, the infra-umbilical region.
1 Qi counter-flow, Honton (severe qi counter-flow), excitement, mental anxiety.
2 Discomfort and distension in the hypochondrium region (one of the abdominal diagnoses in Kampo medicine).
3 Fluid retention (fluid disturbance) fluctuating due to qi movement.
4 Temporary pulsation immediately after sudden exercise or caused by consternation.

In another report, T. Yamada, based on his interpretation of articles in old medical books, concludes that abdominal pulsation indicates a weak constitution, and comments that these patients tend to have a thin layer of abdominal wall muscles and soft tissues and that arterial pulsation in the abdomen could be palpated on the abdominal surface [15].

**Relationship between traditional abdominal examination and anatomical depth**

During the examination of abdominal pulsation in Kampo medicine, unlike in the Western medical approach of measuring the diameter of the deep abdominal aorta by pressing hard on the abdomen, the presence or absence of arterial pulsation is detected by softly touching the surface of the body. Therefore, it is thought that the detection of abdominal pulsation may be affected by anatomical factors, such as the positions of arteries and the patient’s physical constitution. Our analysis revealed that pulsation of the abdominal aorta in the epigastrium and supra-umbilical region is more easily palpated when it is near the body surface, and is less palpable when it is located more deeply. Additionally, pulsation in the supra-umbilical region was observed most frequently, as the artery in that region is the shallowest. These results suggest that pulsation in the supra-umbilical region is the most frequently identified pulsation.

These results indicate that, among anatomical factors that affect the detection of abdominal pulsation, the depth of the abdominal aorta from the body surface has the strongest influence. The present study also revealed that the most sensitive region for evaluating abdominal pulsation is the supra-umbilical region, where the artery is closest to the body surface and the influence of the depth of the abdominal aorta is thus at its lowest.

**Relationship between constitution and abdominal pulsation**

Furthermore, a positive correlation was observed between the depth of the aortic artery and BMI in the epigastric and supra-umbilical regions. Regarding the relationship between constitution and abdominal pulsation, the present results suggest that the difficulty of palpating pulsation in the epigastric and supra-umbilical regions increases with increasing weight. This means that in overweight people (BMI over 25), it is difficult to palpate abdominal pulsation due to the greater depth of the abdominal aorta. These cases might be diagnosed as false negative findings of abdominal pulsation.

Ultrasound echoes may be used to avoid these false negatives and to accurately assess aortic pulsation in patients whose BMI is over 25. With color or pulse-Doppler, we can measure blood flow signals and velocities.

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**Table 2** | Depth of the abdominal aorta from the body surface, aortic diameter, and distance between the common iliac arteries

|                        | EP          | SU          | IU          |
|------------------------|-------------|-------------|-------------|
|                        | Total       | Male        | Female      | Total       | Male        | Female      | Total       | Male        | Female      |
| Depth of the abdominal | 103.5 ± 31.8| 112.0 ± 34.6| 94.7 ± 26.2 | 74.9 ± 32.7 | 86.2 ± 35.7 | 63.1 ± 24.6 | 78.5 ± 29.3 | 80.2 ± 33.9 | 76.8 ± 24.2 |
| aorta from the body    | p = 0.025   | p = 0.003   | p = 0.6     | p = 0.00001 | p = 0.009    |
| Distance between the   |             |             |             |             |             |             |             |             |             |
| common iliac arteries  |             |             |             |             |             |             |             |             |             |

EP, epigastrium; SU, supra-umbilical region; IU, infra-umbilical region.
Furthermore, there may be relatively many obese people with early yin disease. In Kampo medicine, excess and deficiency patterns are typically understood as abdominal distension. In early yin disease, patients tend to show deficiency patterns. It is thought that obese patients must be palpated rather strongly to detect abdominal pulsation. In the present study, the depth of the abdominal aorta from the body surface was significantly greater in males than in females, so the positive rate of abdominal pulsation was lower in males (Table 1). This suggests that there may be more false negative cases in males.

Pathological significance of abdominal pulsation in Kampo medicine

On the other hand, although it is more difficult to detect abdominal pulsation at the epigastrium than in the supra-umbilical region, and detectability at the epigastrium is inferior, the degree of specificity seems to increase when pulsation is detected at the epigastrium. This suggests that pathological significance would be high if abdominal pulsation can be determined by palpation. Keeping in mind the fact that obese people are prone to false negatives, the supra-umbilical region may provide not only the best sensitivity for aortic pulsation, but also the most accurate evaluation of it.

When abdominal pulsation is felt below the umbilicus, there may be some anatomical or physiological significance. Otsuka et al. speculate that, as a factor of abdominal pulsation, ‘if something is wrong in the stomach or intestine, a kind of blood stagnation occurs, conductivity in blood is improved, and rapid pulse could be sensed as pulsation’ [16]. This suggests that abdominal pulsation is associated with
dysfunction caused by blood or water circulation disorders and autonomic dysregulation. M. Yamada reports that aortic pulsation and a splashing sound in the epigastric region, which suggests fluid disturbance, are found together in many cases. He speculates that pulsation of the abdominal aorta is expanded and spreads in water accumulated in the stomach and is transmitted to the superficial area of the abdominal wall. This pulsation is therefore observed as abdominal palpitation [17]. Additionally, a person in whose epigastric region a splashing sound is observed tends to have abdominal distension, and is likely to show abdominal pulsation. Further research is necessary.

Relationship between traditional abdominal examination and the diameter of the artery

Concerning the diameter of the artery, although there have been many reports on the diameters of abdominal aneurysms in Western medicine, there are few reports on the diameter of the abdominal aorta in healthy people. Moreover, most of these reports discuss the thoracic aorta [18–20]. In their study on diameters, Rogers et al. found that the average values of the diameters of the descending thoracic aorta, infrarenal abdominal aorta, and lower abdominal aorta were 25.8 mm, 19.3 mm, and 18.7 mm, respectively, for men, and 23.1 mm, 16.7 mm, and 16.0 mm for women [21]. In our measurements, the diameter of the abdominal aortic artery was smaller in the distal portion in both males and females (Table 2).

At the epigastrium, although the vessel diameter was largest, no significant association was observed between the existence of abdominal pulsation and blood vessel diameter. This may be related to the artery being at its deepest position at the epigastrium. Nor was any significant relationship perceived between the existence of abdominal pulsation and vessel diameter in the supra-umbilical region even where the artery was at its shallowest; it seems that the influence of the diameter of the aortic artery on the diagnosis of abdominal pulsation is small in Kampo medicine.

Conclusion

Abdominal pulsation was most easily palpable in the supra-umbilical region. It is assumed that this is because the abdominal artery is at its shallowest position at that point as determined by anatomical analysis using CT. Therefore, the supra-umbilical region appears to be the most suitable location for evaluating abdominal pulsation. Moreover, when abdominal pulsation is felt at the epigastrium, there may be several anatomical and/or physiological factors that can be invaluable in diagnosing disease. However, in people with a

| Table 3 | Relationship between body mass index (BMI) and the existence of pulsation in the epigastrium (EP) and the supra-umbilical region (SU) |
|---------|-------------------------------------------------|
|         | EP positive | EP negative | Total |
| BMI $\geq$25 | 0          | 18          | 18    |
| BMI <25  | 14         | 35          | 49    |
| Total    | 14         | 53          | 67    |
| $\chi^2 = 6.5$ ($P = 0.01$) |

|         | SU positive | SU negative | Total |
|---------|-------------|-------------|-------|
| BMI $\geq$25 | 1          | 17          | 18    |
| BMI <25  | 19         | 30          | 49    |
| Total    | 20         | 47          | 67    |
| $\chi^2 = 6.9$ ($P = 0.008$) |

Figure 5 | Relationship between arterial depth and BMI with the existence of pulsation in the epigastrium (EP) and the supra-umbilical region (SU).
BMI over 25, it is difficult to palpate increased abdominal pulsation anatomically, and there is a possibility of obtaining a false negative. Therefore, it is important to consider the patient’s constitution when examining and diagnosing abdominal pulsation. Auxiliary tests such as ultrasound echo tests may be useful to accurately assess the patient’s aortic pulsation and avoid false negatives. These findings may contribute to the construction of typical anatomical abdomen models for training.

ETHICS

This research was approved by the Medical Ethics Committee of Chiba University (No.2330).

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare regarding the present article.

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