Finger temperature fluctuations of a COVID-19 patient

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Abstract: In recent years, studies have found that rapid temperature fluctuations can be observed by measuring and recording infrared temperature on different fingers even if the patient does not alternate between feeling hot and cold. After the COVID-19 epidemic spread widely in China, a similar result was also found in a COVID-19 patient: the infrared temperature on the ulnar side of the ring finger and the radial side of the little finger appeared to fluctuate with an amplitude greater than 0.5 degrees every minute. At this time, the temperature of other fingers (including the ulnar side of the little finger) fluctuated only slightly or did not fluctuate at all. In addition, as the condition changed, the aforementioned phenomenon disappeared, and the infrared temperature curve on the radial side of the thumb changed slowly and greatly, but the infrared temperature changes in the other fingers were much smaller. These phenomena are difficult to explain in terms of thrombus or changes in blood temperature/flow velocity. In contrast, it may be more reasonable to assume that the heat generated by Qi changes when the flow of Qi is obstructed.

Keywords: infrared temperature fluctuation, Covid-19, traditional Chinese medicine, alternating cold and hot

I Introduction

Although body temperature is an important parameter of human health, research on body temperature has been insufficient compared to other parameters such as blood oxygen, blood sugar, blood pressure, and heart rate. When measuring body temperature, armpit temperature or rectal temperature is generally selected to obtain stable and comparable results. Doctors generally only care about the highest value measured, and do not care about the temperature differences in different parts of the body or temperature variations over time. This practice is used even in situations like hot flashes.

In contrast, traditional Chinese medicine (TCM) has a unique understanding of body temperature. For example, TCM believes that there are two completely different body temperature fluctuations: tidewater hot(most of the hot flashes in modern medicine are tidewater hot) and alternating cold and hot (feeling cold for a while, then feeling hot for a while). Furthermore, *Shang Han Lun* (*Treatise on febrile disease caused by cold*) pointed out that if a patient's Shaoyang meridian (channels that carry nutrition to all parts of a human body) is damaged, there may be alternating cold and hot, together with other symptoms like palpitations, bitterness in mouth, rib pain, dizziness, vomiting, thirst, and abdominal pain (there are many symptoms because the Shaoyang meridian participates in water circulation and passes through many parts of a human body). At this time, Xiao Chaihu Tang(Decoction) should be used to cure the disease[1]. However, most of these symptoms are non-specific except for alternating cold and hot (that is, these symptoms may need to be treated with other traditional Chinese medicine formulas). In contrast, alternating cold and hot is a highly specific symptom. The reason is that the Shaoyang meridian is a pivot. If the Shaoyang meridian gets damaged, Qi (substance running in a meridian) cannot flow smoothly from the upstream meridian to the downstream meridian, and people will feel cold for a while and hot for a while. Therefore, it is very likely that Xiao Chaihu Tang(Decoction) should be used when alternating cold and hot appears.

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In recent years, studies[2] have found that even if a patient does not feel alternating cold and hot, if high-frequency temperature fluctuations are observed in several (not necessarily all) fingers, Xiao Chaihu Tang(Decoction) should also be used. What is unique about this study is that the temperature changes in some fingers are correlated, but temperature changes in other fingers may be completely independent. This phenomenon is difficult to explain by changes in blood temperature/flow rate (or thrombus). But the meridian theory of traditional Chinese medicine can give a satisfactory explanation. However, the study mentioned the therapeutic effect of traditional Chinese medicine, but it lacked large-scale randomized controlled trials, so it has not been published.

Since December 2022, China has relaxed its strict control over the COVID-19 epidemic, and the epidemic swept the country in the following weeks. Consequently, the author had the opportunity to measure COVID-19 patients. The measurements showed that likewise temperature waveform was also found in a patient with COVID-19 infection. Not only that, the patient felt short of breath one week after the fever subsided, and the measurement found that the temperature fluctuation of the finger corresponding to the lung meridian was significantly larger than that of other fingers, which may reflect lung damage. Given that subsequent large-scale measurements show that the proportion of these two phenomena is quite high, this article introduces these two physiological phenomena for the reference of relevant researchers.

II Measuring device and measurement results

The measurement device used in this paper is the same as the one used in [2]. The device uses Arduino Due/Mega2560 as the hardware platform, and the CPU in the device communicates with multiple infrared probes every 6 seconds to obtain the infrared temperature and body surface temperature of the body part where the probe is placed. The data is then packaged and uploaded via Bluetooth to monitoring software inside a smart phone. The monitoring software shows the trend and records the data so that the trend can be displayed for future analysis.

The measurement method is as follows: multiple infrared temperature probes of the device are pasted on the sides of the middle segments of multiple fingers with adhesive tape. The specific fingers are determined according to the course of the meridians described by traditional Chinese medicine theory. Then the software on the mobile phone is used to continuously record the infrared temperature and body surface temperature measured by the probe. The measurement usually lasts for 30 minutes to an hour.

During the measurement, a room with a constant temperature and basically no air circulation is selected. However, since this condition cannot always be met, it is sometimes modified by covering the hand with an additional layer of insulation (a single layer of clothing or thin cloth), which can also effectively prevent the ambient temperature variation from affecting the measurement results.

The measurement results are 6 pairs of temperature curves, corresponding to the six meridians on the hand. Different colors are used to distinguish temperatures obtained by different probes during analysis, namely the radial side of the thumb-gray, the radial side of the index finger-yellow, the ulnar side of the middle finger-green, the ulnar side of the ring finger-pink, the radial side of the little finger-purple, and the ulnar side of the little finger-black. In addition, different line styles are used to distinguish the two temperatures: the solid line is the infrared temperature, and the dotted line is the body surface temperature. Because the former is calculated from infrared radiation, the latter is measured by thermal resistance, and the emissivity of infrared radiation changes continuously with the seepage of Qi in meridians[3], the two are not synchronized, and the difference between the two also keeps changing.

III Finger temperature waveform of a COVID-19 patient

1. Alternating cold and hot

The female patient (the author's wife, 43 years old) was infected with COVID-19 on December 14, 2022. She had a fever of 38.4 degrees, was afraid of cold, and had no sweating. She did not experience alternating cold and hot, coughing or wheezing. To select the appropriate traditional Chinese medicine, a measurement was taken (Fig. 1), and the waveform is shown in Fig. 2.

Figure 1: The patient was taking measurement

It can be observed from Fig. 2 that both the purple and pink solid curve (infrared temperatures) fluctuate synchronously and at a relatively fast rate (the frequency is about once per minute). The magnitude of fluctuation is between 0.5 degrees and 1 degree. This is the Shaoyang syndrome of alternating cold and hot described in [2], and should be treated with Xiao Chaihu Tang(Decoction). However, most of the measurements taken before that day showed that the black and purple curve fluctuate synchronously (this is not because they are both located on the little finger, but because the meridian corresponding to the black curve is downstream of the meridian corresponding to the purple curve), but this is not the case in Fig. 2, so there is also the possibility that the Qi and blood in the radial side of the little finger (the Shaoyin meridian of the hand) cannot smoothly reach the ulnar side of the little finger (the Taiyang meridian of the hand). For this reason, the patient was given Xiao Chaihu Tang(Decoction) combined with Sini San(Powder), and the patient's fever subsided the next morning. Later, as the patient still had an itchy throat, Wuling San(Powder) was added to Xiao ChaiHu Tang(Decoction) and Sini San(Powder) to cure the deficiency of Qi and blood in the Taiyang meridian of the hand. After taking it for two days, she partially recovered and could do most of the housework.

It should be noted that the aim of the previous description is not to prove that the prescriptions given are effective (otherwise a large-sample randomized controlled trial is required), but to illustrate the situation of the measured object.

2. Abnormality of Qi of lung

The patient developed chest tightness 7 days after the fever subsided. According to the theory of traditional Chinese medicine, chest tightness may be caused by various reasons, and Chinese medicine formulas can only be chosen after the exact reason is pinpointed. Therefore, a measurement was taken. The results are shown in Fig. 3. It can be seen from the figure that the phenomenon of alternating cold and hot no longer exists, but the infrared temperature fluctuations on the radial side of the thumb are significant (the fluctuations of the gray curve are obviously larger than other curves). In TCM theory, the lung meridian runs from the lung to the radial side of the thumb. Therefore, the conclusion should be that although Xiao Chaihu Tang(Decoction) and other prescriptions cured the fever, the virus was still slowly damaging her lungs. For this reason, Qingfei Paidu Tang(Decoction)[4] was used instead, and the chest tightness was relieved after taking it for several days. The results of the re-measurement are shown in Fig. 4. Note that the fluctuation of the gray curve disappears (However, the fluctuations of the black curve were obviously larger in Fig.4, which means further treatment was needed).

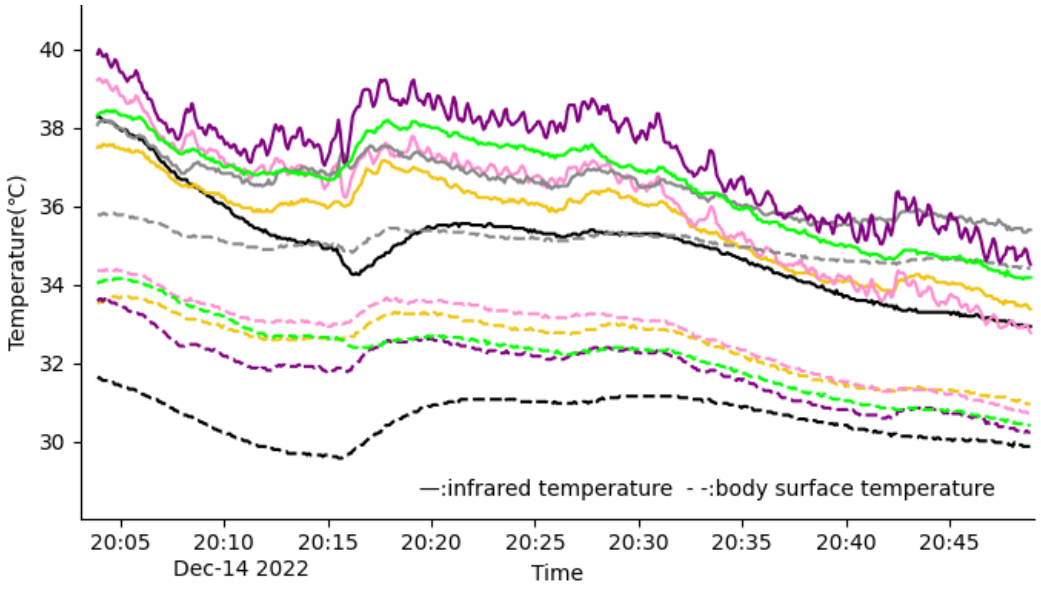

Figure 2: The waveform that shows alternating cold and hot

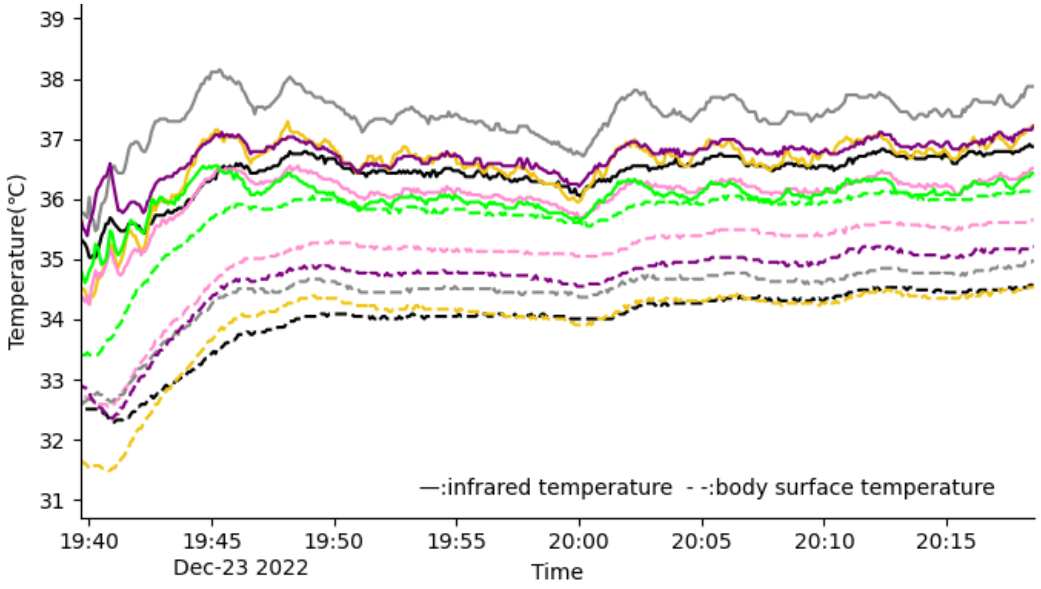

Figure 3: The waveform that shows abnormality of Qi of lung

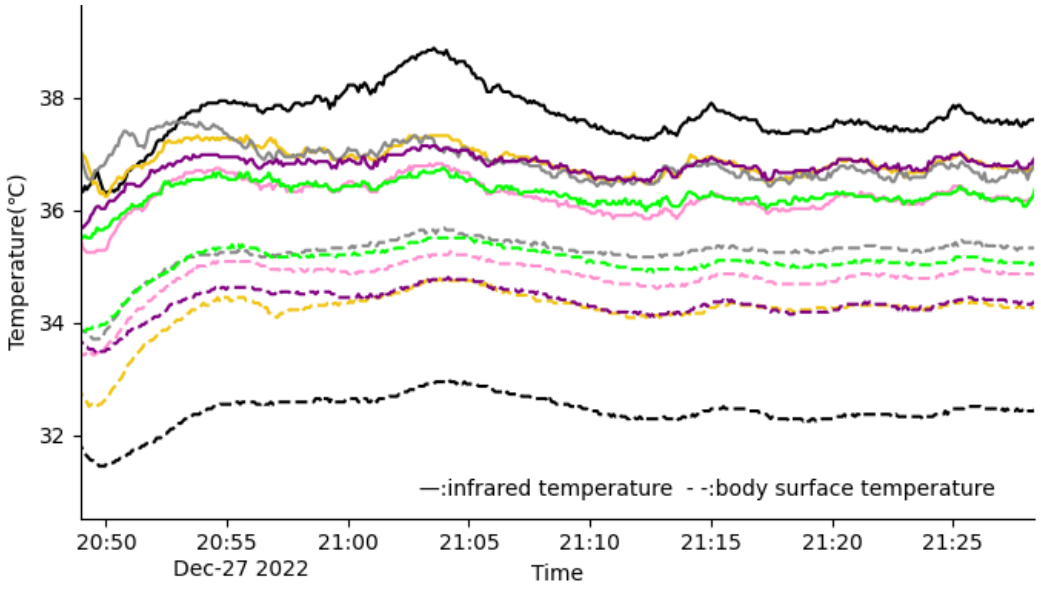

Figure 4: The abnormality of Qi of lung disappeared

IV Discussion

The author does not have the conditions to obtain measurement results from a sufficient number of COVID-19 patients, so it is difficult to determine whether the above phenomenon is caused by COVID-19. However, according to TCM theory, if a patient does not receive proper treatment, the meridian damage will persist (this may also be the cause of many COVID-19 sequelae), so measuring patients with COVID-19 sequelae should provide a greater chance of observing temperature anomalies (note that not all people will have the same meridian damaged in the same way by the COVID-19 virus; in fact, when the author was infected by the virus, there was no alternating cold and hot as in Fig. 2). For this reason, the author took the opportunity of a hospital to carry out physical examinations for customers, and carried out measurement in the hospital in February 2023. The participants were mainly volunteers among the examiners (most of whom experienced shortness of breath, heart palpitations or other discomforts) and patients with chronic diseases. The measurement work collected 88 samples, and the results showed that 23.9% of the samples exhibited high-frequency temperature fluctuations as shown in Fig. 2, and 36.4% of the samples showed infrared temperature fluctuations on the radial side of the thumb as shown in Fig. 3 (details will be disclosed in another paper). Of course, this result still cannot prove that the aforementioned phenomenon is caused by COVID-19. But these percentage values at least show that the phenomenon described in the previous section is common.

Because the fluctuations of the infrared temperature curve appearing in Fig. 2 cannot be explained by a rare disease (or special physiological structure), it should be explained by existing knowledge of physiology. Since the measurement position is on the finger, and the subject is in a static state, the infrared temperature fluctuation caused by the blood flow rate and/or temperature is mainly considered. But further analysis shows that this fluctuation is not caused by changes in the temperature of arterial blood reaching the forearm (otherwise, the infrared temperatures of multiple fingers would fluctuate synchronously). Therefore, only changes in blood flow rate should be considered, which suggests the influence of thrombus.

However, since the temperature of the ulnar side of the ring finger and the radial side of the little finger fluctuate synchronously in Fig. 2, the thrombus should appear at the junction of the corresponding finger veins (but not closer to the heart, otherwise, the ulnar side of the little finger will also fluctuate synchronously), and the thrombus should not be too small (i.e. not the micro clots described in [5]), otherwise, it will be difficult to result in a heating and cooling rate of 0.5 degrees per minute. However, there are several problems with this explanation: first, the patient has no swelling or pain. Moreover, the patient did not take any traditional Chinese medicine to eliminate blood clots (the patient did not take any chemical drugs during the treatment of COVID-19 either), and the alternating cold and hot phenomenon disappeared. Second, if there is a high probability (23.9%) of a thrombus occurring in the palm, the chance of developing deep vein thrombosis in the upper and lower extremities will be much higher, and eventually, a large number of patients with COVID-19 sequelae will be found to have deep vein thrombosis. However, only micro clots can be found in most patients with COVID-19 sequelae[5].

Based on the above analysis, the author believes that the temperature fluctuation in Fig. 2 cannot be explained by thrombus, but the explanation in [3] needs to be adopted, that is, the substances (Qi) in the meridians will generate heat when they ooze out, and the products of this process will block infrared rays. According to this explanation, when there is a problem in the meridians, the circulation of Qi is blocked or the flow rate is constantly changing, resulting in fluctuations of the infrared temperature shown in Fig. 2 or Fig. 3. In addition, because the influence of blockage can only affect certain

upstream and downstream meridians (but may sometimes affect further meridians through bypass), not all meridians will show temperature fluctuations, and the fluctuations of the corresponding infrared temperature curve (obtained on corresponding fingers) will be much smaller.

Of course, the author's explanation may not be the correct explanation, but in any case, it is an objective fact that there is a high probability of infrared temperature fluctuations in those who feel uncomfortable after COVID-19. Today, as the causes and treatment methods of most COVID-19 sequelae are unknown, and laboratory results of many patients with COVID-19 sequelae are normal, the academic community should not overlook this physiological phenomenon. It could potentially provide a new understanding of alternative medicine.

V Conclusion

In this paper, six infrared temperature probes were attached to the sides of the middle segment of five fingers using adhesive tape. The probes were distributed on the radial side of the thumb, the radial side of the index finger, the ulnar side of the middle finger, the ulnar side of the ring finger, the radial side of the little finger, and the ulnar side of the little finger. Then the body surface temperature and the infrared temperature at the probes were read every 6 seconds. The measurement generally lasted for 30 minutes to an hour, and finally obtained 6 pairs of temperature curves.

This article takes a COVID-19 patient as an example to describe two typical manifestations. The first type is that the infrared temperature curves of the ulnar side of the ring finger and the radial side of the little finger fluctuate quickly and repeatedly. The fluctuation frequency is about once per minute, and the fluctuation range is above 0.5 degrees. At this time, the temperature of other fingers (including the ulnar side of the little finger) fluctuates only slightly or does not fluctuate at all. The second type is that the infrared temperature curve on the radial side of the thumb shows slow and large changes, but the infrared temperature changes on the other fingers are much smaller. The author believes that it's difficult to explain such phenomena by changes in blood temperature or velocity. In contrast, it may be more reasonable to believe that heat production will change when the flow of Qi in the meridians is hindered (if there really are meridians in a human body).

Resources

The program (and other resources) needed to reproduce the measurement results can be found at https://github.com/woodwei/DIYRes

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