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Special Topic for 973 Program

Study on the thermesthesia features of heat-sensitive acupoints in patients with knee osteoarthritis

膝骨关节炎患者热敏腧穴温度觉特征的研究

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Abstract

Objective: To observe the thermesthesia thresholds of the heat-sensitive acupoints in patients with knee osteoarthritis (KOA), and to provide scientific evidence for acupoint selection based on acupoint sensitization.

Methods: Forty-six patients with KOA of swelling type were recruited. By using the quantitative thermesthesia testing, the thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance at Xuehai (SP 10), Neixiyan (EX-LE 4) and Yinlingquan (SP 9) were detected. The subjects were then divided into heat-sensitive groups and non-heat-sensitive groups according to whether there was a phenomenon of heat-sensitive moxibustion sensation at each acupoint, to compare the thermesthesia thresholds between the two groups.

Results: The thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance were respectively (38.21±2.03) ℃, (44.47±1.86) ℃ and (48.59±0.74) ℃ in the heat-sensitive group of Xuehai (SP 10), versus (36.76±1.93) ℃, (42.91±2.05) ℃ and (46.95±1.14) ℃ in the non-heat-sensitive group of Xuehai (SP 10); the thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance were respectively (37.47±1.77) ℃, (44.55±1.63) ℃, and (47.48±0.47) ℃ in the heat-sensitive group of Neixiyan (EX-LE 4), versus (35.92±1.69) ℃, (42.72±1.94) ℃ and (45.53±0.41) ℃ in the non-heat-sensitive group of Neixiyan (EX-LE 4); the thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance were respectively (37.30±2.23) ℃, (44.39±1.92) ℃ and (47.76±0.58) ℃ in the heat-sensitive group of Yinlingquan (SP 9), versus (36.06±1.86) ℃, (42.63±1.88) ℃ and (45.91±0.72) ℃ in the non-heat-sensitive group of Yinlingquan (SP 9). The statistical analyses showed that the thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance of each heat-sensitive group (all the three acupoints) were significantly higher than those of each corresponding non-heat-sensitive group ($P<0.01$).

Conclusion: There were differences in the thermesthesia thresholds between heat-sensitized and non-heat-sensitized acupoints in patients with KOA of swelling type; and the thermal sensation threshold, thermal pain threshold, and threshold of thermal pain tolerance of the heat-sensitized points were significantly higher than those of the non-heat-sensitized ones.

Keywords: Moxibustion Therapy; Moxa Stick Moxibustion; Osteoarthritis, Knee; Points, Lower Extremities; Thermosensing

【摘要】目的：观察膝骨关节炎(knee osteoarthritis, KOA)患者热敏态腧穴温度觉阈值特征，为临床依据腧穴敏化状态取穴提供科学依据。**方法：**纳入肿胀型 KOA 患者 46 例，应用温度觉定量测定技术，分别测定患者血海、内膝眼、阴陵泉的热觉阈、热痛阈、热耐痛阈，根据每个腧穴是否出现热敏灸感分为热敏组和非热敏组，比较两组温度觉阈值差异。**结果：**血海热敏组的热觉阈、热痛阈和热耐痛阈值分别为(38.21±2.03) ℃、(44.47±1.86) ℃和(48.59±0.74) ℃，非热敏组分别为(36.76±1.93) ℃、(42.91±2.05) ℃和(46.95±1.14) ℃；内膝眼穴热敏组的热觉阈、热痛阈和热耐痛阈值分别为(37.47±1.77) ℃、(44.55±1.63) ℃和(47.48±0.47) ℃，非热敏组为(35.92±1.69) ℃、(42.72±1.94) ℃和(45.53±0.41) ℃；阴陵泉穴热敏组的热觉阈、热痛阈和热耐痛阈值分别为(37.30±2.23) ℃、(44.39±1.92) ℃和(47.76±0.58) ℃，非热敏组为(36.06±1.86) ℃、(42.63±1.88) ℃和(45.91±0.72) ℃；经统计学处理，热敏组三个穴位(血海、内膝眼和阴陵泉)的热觉阈值、热痛阈值和热耐痛阈值均高于非热敏组同名穴位的相应测量值，差异均具有统计学意义($P<0.01$)。**结论：**肿胀型 KOA 患者热敏态腧穴与非热敏态腧穴具有不同温度觉阈值特征，热敏态腧穴热觉阈、热痛阈和热耐痛阈值均高于非热敏态腧穴。

【关键词】灸法；艾条灸；骨关节炎，膝；穴位，下肢；热敏
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Knee osteoarthritis (KOA), a chronic articular disease often affecting the middle-aged and older people, is mainly characterized by cartilage damage in knee joint due to various causes. It's majorly manifested as chronic pain and dysfunction of knee joint[1]. The key technique point in heat-sensitive moxibustion is to apply moxibustion to the heat-sensitive acupionts to effectively warm and unblock meridians and collaterals, expel cold and relieve spasm, resolve swelling, alleviate pain, and improve blood circulation. That's why heat-sensitive moxibustion can achieve significant efficacies in treating KOA[2-4]. The heat-sensitive acupoints are a group of specific acupoints in moxibustion therapy, as they are sensitive to the heat produced in moxibustion, presenting heat penetration, heat extension, heat transmission, no heat or mild heat in local area but significant heat in distant area, no heat or mild heat in superficial layer but significant heat in deeper layer, and/or other sensations rather than heat; the non-heat-sensitive acupoints can only produce heat sensation in local and superficial areas[5-6]. So far, there are no reports telling whether the thermal sensation features of the heat-sensitive acupoints are related to the change of thermesthesia thresholds. In this study, we adopted quantitative thermesthesia testing to detect the thermesthesia thresholds of the relevant acupoints in patients with KOA of swelling type and compared the thermesthesia thresholds between the heat-sensitive and non-heat-sensitive acupoints, to observe the thermesthesia features of the heat-sensitive acupoints in KOA patients and provide scientific evidence for acupoints selection in clinic. The results are given as follows.

1 Clinical Materials

1.1 Diagnostic criteria

By referring the diagnostic criteria of KOA in the *Guiding Principles for Clinical Study of New Chinese Medicines*[7]: ① Frequent knee joint pain occurred during the previous month; ② X-ray revealed the formation of osteophyte; ③ laboratory examinations confirmed osteoarthritis; ④ age ≥ 38 years old; ⑤ morning stiffness ≤ 30 min; ⑥ bone crepitation occurred with the movement of knee joint. KOA can be diagnosed when items ①+② or ①+③+⑤+⑥ or ①+④+⑤+⑥ were met.

1.2 Inclusion criteria

Conforming to the above diagnostic criteria and accompanied by swelling of knee joint; able to clearly describe the moxibustion sensation; aged between 40-70 years old, without sex predilection; willing to receive the quantitative thermesthesia testing and having signed the informed consent form.

1.3 General data

The 46 subjects recruited in this study were all from the Affiliated Hospital of Jiangxi University of Traditional Chinese Medicine (TCM). There were 16 males and 30 females, aged from 40 to 70 years old. The subjects were divided into heat-sensitive groups and non-heat-sensitive groups based on the occurrence of heat-sensitive moxibustion sensations, i.e. heat-sensitive group of Xuehai (SP 10) (n=25) and non-heat-sensitive group of Xuehai (SP 10) (n=21); heat-sensitive group of Neixiyan (EX-LE 4) (n=26) and non-heat-sensitive group of Neixiyan (EX-LE 4) (n=20); heat-sensitive group of Yinlingquan (SP 9) (n=27) non-heat-sensitive group of Yinlingquan (SP 9) (n=19). Statistical analyses showed that there were no significant differences in comparing the general data such as gender and age between each heat-sensitive group and its corresponding non-heat-sensitive group ($P>0.05$).

2 Methods

2.1 Detection of heat sensitization of acupoints

Patients were asked to take a supine posture and expose the knees. By following the moxibustion sensation method reported by Chen RX, *et al*[8], the doctor held an ignited moxa stick specially for heat-sensitive moxibustion (fine moxa stick 2.2 cm in diameter and 16 cm in length, manufactured by the Affiliated Hospital of Jiangxi University of Traditional Chinese Medicine) to apply mild moxibustion to Xuehai (SP 10) for 20 min with about 3 cm away from the skin. The patients would be included into the heat-sensitive group of Xuehai (SP 10) if any of the following sensations occurred: heat penetration, heat extension, heat transmission, no heat or mild heat in local area but significant heat in distant area, no heat or mild heat in superficial layer but significant heat in deep layer, and/or other sensations rather than heat; they would be recruited into the non-heat-sensitive group of Xuehai (SP 10) if heat was only produced in local or superficial areas. The detection of Neixiyan (EX-LE 4) and Yinlingquan (SP 9) followed the same way, and the grouping results were recorded. The locations of the involved acupoints were based on the location criteria in the *Science of Acupuncture and Moxibustion*, published by China Press of Traditional Chinese Medicine[9].

2.2 Quantitative thermesthesia testing

Thermesthesia analyzer TSA-2001 (Israel) was adopted and the square-surface stimulator probe of 5 mm in length of side was selected. The measurement mode used was critical analysis, with the change rate of stimulating temperature at 0.1 ℃/s, temperature range 0-50 ℃; during the testing, the detection room

should be kept quiet, with the room temperature maintained between 22 ℃ and 24 ℃. The subjects were asked to take a comfortable sitting posture and fully expose their knees.

The measurement was shown below.

Pre-testing: The subjects received a pre-testing prior to the formal one to well-master the operation of the analyzer and to differentiate the relevant feelings.

Measurement of Thermesthesia thresholds: The basic temperature of the probe was 32 ℃, increased by 0.1 ℃/s. The button was pressed to deliver a signal when the subject felt the heat, and the value shown on the screen was the thermal sensation threshold. The detection was repeated 4 times, with a 5-second interval, and the average value was then calculated.

Measurement of thermal pain threshold: The basic temperature of the probe was 32 ℃, increased by 0.1 ℃/s. The button was pressed to deliver a signal when the subject got thermal pain sensation, and the value shown on the screen was the thermal pain threshold. The detection was repeated 3 times, with a 10-second interval, and the average value was then calculated.

Measurement of the threshold of thermal pain tolerance: The basic temperature of the probe was 32 ℃, increased by 0.1 ℃/s. The button was pressed to deliver a signal when the subject was unable to endure the thermal pain, and the value shown on the screen was the threshold of thermal pain tolerance. The detection was repeated 3 times, with a 10-second interval, and the average value was then calculated.

2.3 Detection time points

The heat sensitization of acupoint was detected during 9:00-12:00 in the morning for each subject, and the thermesthesia thresholds were tested the next morning during 9:00-12:00. The whole process of the trial was shown in Figure 1.

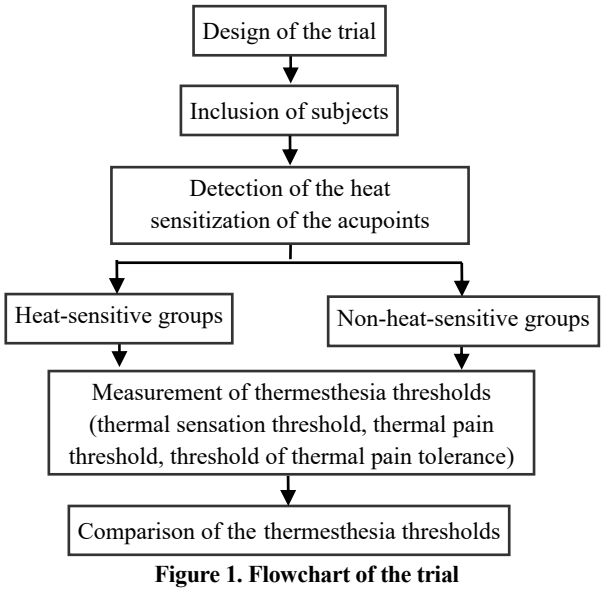

Figure 1. Flowchart of the trial

2.4 Collection and statistical analyses of data

The data were all collected and processed by the SPSS 14.0 version statistical software. The data analyses were performed by *t*-test. $P<0.05$ indicated a statistical significance, and $P<0.01$ indicated a high statistical significance.

3 Results

3.1 Comparison of the thermesthesia thresholds of Xuehai (SP 10)

The thermal sensation threshold, thermal pain threshold, and the threshold of thermal pain tolerance in the heat-sensitive group of Xuehai (SP 10) were significantly higher than those of the corresponding non-heat-sensitive group ($P<0.01$), (Table 1).

Table 1. Comparison of the thermesthesia thresholds of Xuehai (SP 10) ($\bar{x}$ ±*s*, ℃)

Group	*n*	Thermal sensation threshold	Thermal pain threshold	Threshold of thermal pain tolerance
Heat-sensitive	25	38.21±2.03[1)]	44.47±1.86[1)]	48.59±0.74[1)]
Non-heat-sensitive	21	36.76±1.93	42.91±2.05	46.95±1.14

Note: Compared with the non-heat-sensitive group, 1) $P<0.01$

3.2 Comparison of the thermesthesia thresholds of Neixiyan (EX-LE 4)

The thermal sensation threshold, thermal pain threshold, and the threshold of thermal pain tolerance in the heat-sensitive group of Neixiyan (EX-LE 4) were significantly higher than those of the corresponding non-heat-sensitive group ($P<0.01$), (Table 2).

Table 2. Comparison of the thermesthesia thresholds of Neixiyan (EX-LE 4) ($\bar{x}$ ±*s*, ℃)

Group	*n*	Thermal sensation threshold	Thermal pain threshold	Threshold of thermal pain tolerance
Heat-sensitive	26	37.47±1.77[1)]	44.55±1.63[1)]	47.48±0.47[1)]
Non-heat-sensitive	20	35.92±1.69	42.72±1.94	45.53±0.41

Note: Compared with the non-heat-sensitive group, 1) $P<0.01$

3.3 Comparison of the thermesthesia thresholds of Yinlingquan (SP 9)

The thermal sensation threshold, thermal pain threshold, and the threshold of thermal pain tolerance in the heat-sensitive group of Yinlingquan (SP 9) were significantly higher than those of the corresponding non-heat-sensitive group ($P<0.01$), (Table 3).

Table 3. Comparison of thermesthesia thresholds of Yinlingquan (SP 9) ($\bar{x}$ ±*s*, ℃)

Group	*n*	Thermal sensation threshold	Thermal pain threshold	Threshold of thermal pain tolerance
Heat-sensitive	27	37.30±2.23[1)]	44.39±1.92[1)]	47.76±0.58[1)]
Non-heat-sensitive	19	36.06±1.86	42.63±1.88	45.91±0.72

Note: Compared with the non-heat-sensitive group, 1) $P<0.01$

4 Discussion

KOA belongs to the scope of Bi-impediment syndrome, and is mainly caused by blocking of meridians qi and blood due to insufficient kidney qi and attack of pathogens such as wind, cold and dampness. Via applying moxibustion to the heat-sensitive points, the heat-sensitive moxibustion works better to improve topical microcirculation, resolve inflammatory edema of local soft tissues, expel cold and relieve spasm, strengthen the structural stability of knee joint, and thus mitigate the symptoms. As a group of special points, the heat-sensitive acupoints present a high reaction towards the heat produced by moxibustion, manifested as 6 phenomena: heat penetration, heat extension, heat transmission, no heat or mild heat in local area but significant heat in distant area, no heat or mild heat in superficial layer but significant heat in deep layer, and/or other sensations rather than heat; the non-heat-sensitive acupoints only produce heat in local or superficial areas. Chen RX, *et al*, conducted an investigation on the heat sensitization of acupoints in 20 diseases such as cervical spondylosis, lumbar intervertebral disc herniation, KOA, and bronchial asthma as well as in healthy subjects, finding that there is a link between the heat sensitization of acupoints and diseased condition in human body[8]. Therefore, it's supposed that the heat sensitization of the above acupoints should be related to the change of the thermesthesia thresholds in local areas.

Quantitative sensory testing (QST) is a technique for measuring the stimulation intensity of specific sensations. As a non-invasive electroneurophysiological technique, QST can be used for quantitative measurement of thresholds of light touch, pressure, vibration, thermesthesia (cold and thermal), and algesia (cold pain and thermal pain). Critical analysis is commonly used in QST, often for the measurement of thermesthesia thresholds. During the measurement, the stimulation is applied to skin beginning with a neutral temperature based on a linear or idempotent increase or decrease. Once the subject gets a specific sensation (e.g. warm sensation, cold or cool sensation), the button will be swiftly pressed to deliver a signal, and the temperature value shown on the screen will be taken as the threshold. These thermesthesia thresholds can reflect the sensitivity of the detected skin area towards temperature. The application of this technique has been reported in China. Lü HY, *et al*, found that this method can help diagnose the damage of fibrils in peripheral neuropathies. The peripheral nerves contain a variety of fibers of various diameters and functions[10]. The sensation of cold is mainly transmitted via fiber Aδ, while the thermal sensation and thermal pain sensation are via fiber C, and the cold pain sensation is associated with Aδ and C pain receptors. Detection of different sensations can reflect the functions of different fibrils in peripheral nerves. In peripheral neuropathies, the fibers may be affected alone or together. Electromyography test can tell the pathological change of big fibers, and QST can reflect that of tiny fibrils. Shi XL, *et al*, held that thermesthesia measurement can be adopted to detect the functional state in temperature-related neuralgia[11]. Wang L, *et al*, believed that the change of thermesthesia thresholds can reflect the damage of peripheral nerves, and the QST should be the only technique that is focused on the function of fibrils as it can quantitatively evaluate the thermesthesia[12].

There is little published information about the measurement of acupoint thermesthesia. The current study based on KOA patients revealed that the thermal sensation threshold, thermal pain threshold, and the threshold of thermal pain tolerance of heat-sensitized Xuehai (SP 10), Neixiyan (EX-LE 4), and Yinlingquan (SP 9) were significantly higher than those of the non-heat-sensitized ones. It indicates that the thermesthesia features of the heat-sensitized acupoints were different from those of the non-heat-sensitized ones in KOA patients. In clinic, when suspended moxibustion is applied to the heat-sensitized acupoints, patients will not only experience heat-sensitive moxibustion sensations, but also favor of heat, comfort, relaxation, and joy[13-16]. The biological evolution tells us that if an external stimulation makes the organism feel comfortable or joyful, this stimulation will then be considered to have a positive biological meaning. The increases of thermesthesia thresholds of the heat-sensitive acupoints are in accordance with the features of the heat-sensitive acupoints such as favor and tolerance of heat. By initially using the quantitative measurement of thermesthesia thresholds to unveil the high thermesthesia thresholds of the heat-sensitive acupoints, the current study has provided scientific evidence for the detection of heat-sensitive acupoints and the application of heat-sensitive moxibustion.

Conflict of Interest

The authors declared that there was no potential conflict of interest in this article.

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Statement of Informed Consent

Informed consent was obtained from all individual participants included in this study.

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