

Design of Electronic Moxibustion Instrument for Umbilical Therapy and Preliminary Analysis of Temperature Field

Haiyan Shao^{1,*}, Zhaocui Han¹, Xiaohui Wang¹, Zhibin Dong², Chao Geng¹ and Ruilan Song¹

¹School of Mechanical Engineering, University of Jinan, Jinan,250022, China and ²Institute of ACUMOX and TUINA, Shandong University of Traditional Chinese Medicine, Jinan,250355, China

Abstract: Moxibustion has a history of thousands of years. Umbilical moxibustion achieves prevention and treatment of diseases through moxibustion at the golden section of the human body-the umbilicus. It has enough clinical practice experience. Traditional treatment methods have problems such as irritating smoke, uncontrollable temperature, experience-based, and difficult to quantify. Based on the principle of traditional umbilical moxibustion, a structural design of an electronic smokeless umbilical moxibustion instrument is proposed, which belongs to indirect moxibustion and has the advantages of smokeless, electric heating, portability, temperature monitoring and controllability. The internal heat transfer process of the moxibustion instrument is mainly heat convection and heat radiation. Based on ANSYS software, the internal temperature field of the moxibustion instrument is analyzed, and the steady-state temperature distribution and the temperature change characteristic curve of different positions with time are obtained to verify the rationality of the structural design. At the same time, lay a research foundation for the measurable and quantifiable effects of moxibustion on umbilical therapy.

Keywords: Umbilical therapy; Moxibustion; Acupoints; Heat transfer; Temperature field; Quantitative research.

1. INTRODUCTION

Moxibustion belongs to the category of Chinese medicine. It has a history of thousands of years in China. It is an external treatment method, and its therapeutic effect has been verified by countless clinical practices [1-2]. The principle of moxibustion is to stimulate acupuncture points or specific parts of the human body through the heat generated by the burning of moxa to achieve the purpose of preventing and curing diseases. From ancient times to the present, the main material of moxibustion is wormwood leaf. Wormwood leaf is bitter, pungent, warm in nature, flammable, and has mild firepower. Moxa is made by crushing and beating wormwood leaf. When performing moxibustion, it is necessary to add medicine to moxa according to the needs of treatment.

Umbilical therapy[3] is to apply the medicine into the appropriate dosage form (paste, powder, pill, ointment, etc.) on the umbilicus, or to give some physical stimulation to the umbilicus (such as moxibustion, acupuncture, cupping, etc.) to treat the disease. It can also be said that umbilical therapy is to use medicine or stimulate acupoints at the umbilicus to stimulate the meridians, dredge the meridians, promote the circulation of blood, and regulate the body's yin and yang and viscera functions. The umbilicus is medically called the Shenque acupoint [4]. Essentially, the umbilicus is the

scar left after the umbilical cord falls off after the fetus is born. The diameter is about 1.0 cm to 2.0 cm. The ratio of the length from the umbilicus to the foot to the length from the umbilicus to the top of the head is 0.618, which is the golden ratio of the human body [5]. The umbilicus communicates with the five internal organs and is connected to the meridians throughout the body. Modern medicine proves that the umbilicus is the last closed and thinnest position of the abdominal wall, which is most conducive to drug penetration and absorption. According to folklore and medical records, the umbilical therapy had been applied as early as the Yin and Shang period in ancient China. During the Spring and Autumn Period and the Warring States Period, Qin and Han Dynasties, preliminary theoretical explorations began. The masterpiece was "The Yellow Emperor's Internal Classic". Through all generations, by the time of the Ming Dynasty, the application of umbilical therapy was more extensive and active. The representative work-Li Shizhen's "Compendium of Materia Medica" recorded many umbilical therapy prescriptions. In the Qing Dynasty, it had been widely used.

Umbilical moxibustion is to perform moxibustion treatment on the navel. By adding different kinds of drugs, acting on Shenque acupoint, to treat diseases, especially in the fields of beauty, health care and prevention of diseases [3]. For patients who are ineffective in modern medical treatment, who cannot tolerate long-term oral Chinese medicine, and are afraid of acupuncture, especially pediatric patients who have difficulty in oral medicine and who cannot tolerate

*Address correspondence to this author at the School of Mechanical Engineering, University of Jinan, Jinan,250022, China; Tel: 15215310628; E-mail:me_shaohy@ujn.edu.cn

acupuncture, or for diseases that urgently require painless treatment, moxibustion for umbilical cord therapy particularly applicable and one of the best treatment methods. Umbilical moxibustion occupies an important position in the development of medicine and has enough clinical practice experience. The traditional method is to use the moist dough as a support to support the burning moxa (as shown in Fig. 1), and at the same time have the effect of heat insulation. Adjusting the height of the dough can adjust the temperature to the skin. The Affiliated Hospital of Shandong University of Traditional Chinese Medicine has good clinical effects, but moxa fume is produced during the treatment process, which can easily cause discomfort. In short, traditional umbilical moxibustion has some shortcomings, for example: when moxa burns, it produces thick smoke with a strong irritating smell; the temperature is uncontrollable, and the patient is easily burned; it requires a specialized doctor to take care of the patient; experience-based, difficult to achieve quantification etc. Electronic moxibustion apparatus appeared in this situation, it belongs to warm moxibustion and device moxibustion, that is, moxibustion is performed with moxibustion apparatus specially made. At present, the electronic moxibustion apparatus in China has not been specially developed specifically for the umbilicus. Existing moxibustion instruments can be roughly divided into two categories: one is large multifunctional moxibustion instruments with warm probes [6-9]; the other is small moxibustion boxes those are easy to carry around [10-11].



1. Dough; 2. Moxa; 3. Towel

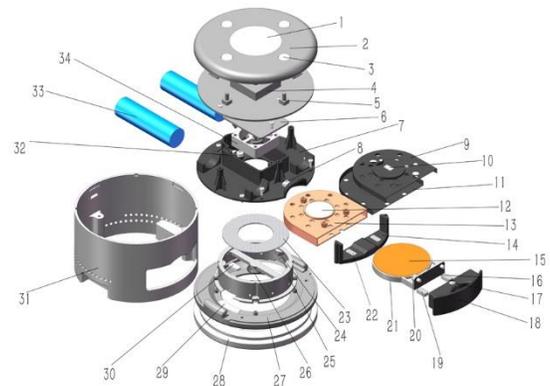
Figure 1: Clinical umbilical-moxibustion.

This paper consists of five parts. The first part is introduction, introducing the history of moxibustion and umbilical therapy, and the development status of umbilical moxibustion. The second part is the structural design, which introduces the structural design and principle of the electronic umbilical moxibustion instrument. The third part describes the theoretical basis of

temperature field analysis. The fourth part is the temperature field simulation, which simulates the internal temperature distribution of the moxibustion instrument and the temperature of the key parts and obtains the temperature curve with time. Finally, the last part is the conclusion and outlook.

2. STRUCTURAL DESIGN

Based on the traditional umbilical moxibustion method, an electronic umbilical moxibustion instrument is designed from the perspective of functionalization, intelligence, convenience and light weight [12]. The structure of the Umbilical Moxibustion Apparatus is roughly divided into the upper cover part, the heating core part, the chassis part and the outer shell.



1. Display panel; 2. Upper cover; 3. Button pad; 4. Display screen; 5. Buttons; 6. Air duct cover; 7. Heat insulation frame; 8. Hall sensor; 9. Upper heat shield; 10. Temperature sensor; 11. Lower heat shield; 12. Upper heating film; 13. Heating chamber; 14. Support base; 15. Moxa and medicinal powder; 16. Heat insulation sheet; 17. Round strong magnet; 18. Handle; 19. Upper strong magnet; 20. Heating plate heat insulation gasket; 21. Heating plate; 22. Lower strong magnet; 23. Filter; 24. Infrared light; 25. Diversion shield; 26. Wide-angle camera; 27. Chassis; 28. Silicone pad; 29. Body temperature sensor; 30. Near-skin temperature sensor; 31. Outer shell; 32. Heating chamber heat insulation gasket; 33. Lithium battery; 34. Fan.

Figure 2: Structure diagram of the umbilical moxibustion instrument

The upper cover part is used for real-time temperature display and user control. It mainly includes upper cover, display panel, buttons, and main circuit board components (including button pads, display screen, and lithium battery). The upper cover is made of heat-resistant and rigid material.

The heating core part in the middle is mainly to imitate the combustion of moxa, which mainly includes heat insulation rack, fan, heating chamber, heating film, heat shield, heating plate, handle, air duct cover, support seat, strong magnetism and diversion shield.

The heat-insulation frame is made of heat-resistant materials, which plays a role in heat insulation and fixed installation of other components. The heating chamber is made of purple copper, with high thermal conductivity and low heat loss. The installation grooves for heating films are reserved on the upper and lower sides. The annular array of holes facilitates air flow up and down. The surface is surrounded by mica heat insulation plates to reduce heat loss. The heating plate is made of aluminum alloy, which can quickly heat up and cool down, and can quickly heat the medicine in the plate; high-temperature gaskets and mica heat insulation sheets are added to the connection with the handle to isolate the heat from being transferred to the handle. The structure with the heating plate facing upwards ensures that both cake-like and powder-like medicines are suitable and are not easy to fall or spill. In the case of powdered medicines, a honeycomb auxiliary structure is placed in the heating plate. There are two strong magnets at the bottom of the handle, and the support base has two strong magnets at the same position to ensure that a pair of strong magnets are attracted after the handle is pushed in, and its position is fixed to prevent it from sliding out during heating. At the same time, the Hall sensor detects the position of the heating plate and stops heating immediately after accidentally sliding out to ensure safety and reliability. The function of the diversion cover is to concentrate the hot air flow to the skin contact area and use high temperature resistant materials to isolate it from the rest of the space in the shell.

The chassis part is used to support and carry sensors. It mainly includes several temperature sensors, cameras, infrared lights, chassis, and silicone pad. The temperature sensors include body temperature sensors and a near-skin temperature sensor. The camera is fixed in the middle of the top of the diversion cover to monitor the condition of the skin. The near-infrared rays emitted by the infrared lights can assist heating around the umbilicus, which is conducive to the absorption of medicinal properties and at the same time provides illumination for the camera. The silicone pad is made of medical silicone, which can be in direct contact with the skin.

In summary, the electronic umbilical moxibustion instrument has a light structure and is suitable for medical powders and medical cakes; it adopts smokeless electric heating, which can simulate the moxa burning of traditional umbilical moxibustion; it has the advantages of real-time temperature detection and real-time observation of the skin condition around the umbilicus.

3. THEORETICAL BASIS FOR TEMPERATURE FIELD ANALYSIS

According to records of ancient medical books and the research of modern moxibustion [13-18], moxibustion is mainly infrared heat radiation stimulation, followed by pharmacological effects. Ding Guanghong and others [13] have tested and compared the infrared radiation spectra of multiple acupoints in human body and the infrared radiation spectra of different moxibustion treatment methods, and obtained the radiation peak of the normalized spectrum of infrared radiation of different acupoints in human body was about $7.5\mu\text{m}$. The spectral shapes and radiation peaks of the three kinds of indirect moxibustion such as ginger moxibustion were almost the same as those of human acupoints. These studies proved that indirect moxibustion was effective and provided basis for the development of electronic umbilical moxibustion apparatus.

According to the law of conservation of energy, the energy transmitted in the traditional indirect moxibustion treatment process comes from the energy released by the burning of moxa, mainly heat radiation. The heat in the working process of the electronic umbilical moxibustion instrument comes from the energy produced by heating the moxa and the medicine on the heating plate. The heat transfer includes heat conduction, heat convection and heat radiation. In order to promote heat transfer during the structural design process, a fan was added. Heat convection and heat radiation dominate the heat transfer process.

Forced convection heat transfer is calculated based on the Newtonian cooling formula [19]:

$$q = h\Delta t \quad (1)$$

$$\Phi = hA\Delta t \quad (2)$$

where q is heat flux, W/m^2 ; Δt is the temperature difference between object and fluid, K ; h is convective heat transfer coefficient, $W/(m^2 \cdot K)$. In the case of forced gas convection, the approximate value range of h is $20 \sim 100 W/(m^2 \cdot K)$. A is contact surface area, m^2 .

The heat of thermal radiation is calculated according to Stefan-Boltzmann's law [19]:

$$\Phi = \varepsilon A \sigma T^4 \quad (3)$$

where T is the thermodynamic temperature of the black body, K ; σ is Stefan-Boltzmann constant, $5.67 \times 10^{-8} W/(m^2 \cdot K^4)$; A is Radiation surface area, m^2 ; ε is the emissivity or blackness of the object.

The above formula is the heat radiated by the object itself. When expressing radiative heat transfer, the above formula should be expressed as: an object with a surface area of A_1 , a surface temperature of T_1 , and an emissivity of ε_1 is contained in a large cavity with a large temperature surface of T_2 . Then the radiant heat transfer [19] between the object and the cavity surfaces is:

$$\Phi = \varepsilon_1 A_1 \sigma (T_1^4 - T_2^4) \quad (4)$$

Because of the lack of quantitative parameters for umbilical moxibustion, this paper does not conduct an in-depth theoretical analysis of the temperature field, mainly based on the structure model to simulate the temperature distribution.

4. TEMPERATURE FIELD SIMULATION

In order to study the thermal performance of the moxibustion instrument during its working process and better perform thermal analysis [20-21], this paper uses fluid simulation software to simulate the internal temperature field of the moxibustion instrument based on the existing structural model, focusing on the overall temperature distribution in the cavity, temperature change under the silicone pad in contact with the skin around the navel and the temperature of the plane under the circuit board. Based on this judgment, whether the temperature is within the safe range of normal operation of the circuit board and human skin tolerance, and then verify the rationality of the structure and the feasibility of the scheme.

Since the heating chamber is at a certain distance from the skin, in order to prevent the stratification of the hot and cold air currents and avoid the upper temperature being too high and the bottom temperature being too low to achieve the effect of moxibustion, a fan is used to enhance heat circulation. The fan blows the hot and cold mixed airflow in the air duct to the upper layer of the heating chamber. The airflow enters the heating chamber through the upper ventilation holes of the heating chamber. After heating, the hot airflow mixed with moxa molecules and medicinal molecules passes through the vent holes at the bottom of the heating chamber and enters the diversion cover through the filter. Most of the hot airflow acts on the skin, a small part of the hot air enters the annular space inside the shell, and a part of the hot air enters the outside through the vent holes of the shell. At the same time, the cold air flow from the outside enters the shell through the ventilation holes on the shell, and hot air flow are mixed into mixed air flow into the fan through

the air duct, thereby forming a heat circulation[12] (as shown in Fig. 3, 35 is the lower heating film. →hot air flow, →cold air flow and →mixed air flow).

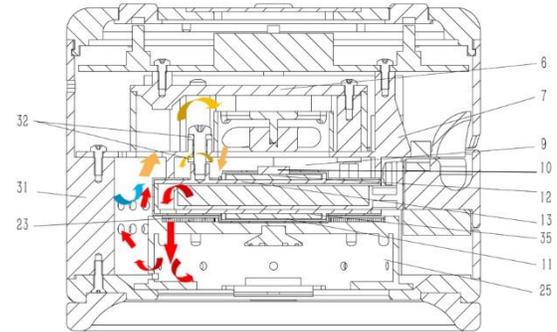


Figure 3: Schematic diagram of heat circulation

A. Model Simplification

Simplify the model in the Solidworks software. The reserved parts include upper cover, outer shell, chassis, silicone pad, circuit board, battery, air duct cover, heat insulation rack, fan, heat insulation sheet assembly, heating chamber, heating plate, heating film, diversion shield and filter. The various holes, bosses, chamfers, and rounded corners in the reserved parts are removed, and the shell is simplified as shown in Fig. 4 (the upper figure is before the simplification, and the lower one is after the simplification). After the model simplification is completed, through the DesignMolder module under the ANSYS Workbench platform, the simplified model of Solidworks is imported into the ANSYS Icepak module for thermal simulation. In the DesignModeler module, extract the inner runner and set the opening. In the Icepak module, set the boundary conditions, the materials of each part and the corresponding parameters, and perform the calculation after meshing the model.

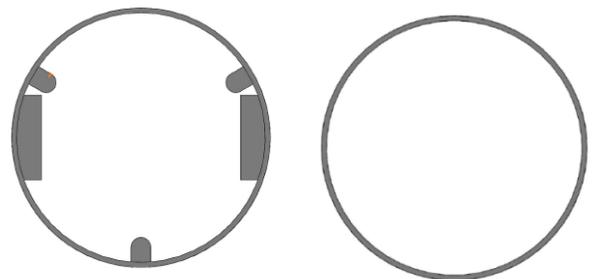


Figure 4: Outer shell shapes before and after model simplification

Two simplified models are proposed (Fig. 5), Model 1 and Model 2. The difference between them is that the heating chamber and the heating plate are closed in

Model 2 (shown in the red box of Fig. 5). The material parameters of parts and components are shown in Table 1. The volumetric flow and pressure difference characteristic curves of the fan are shown in Fig. 6.

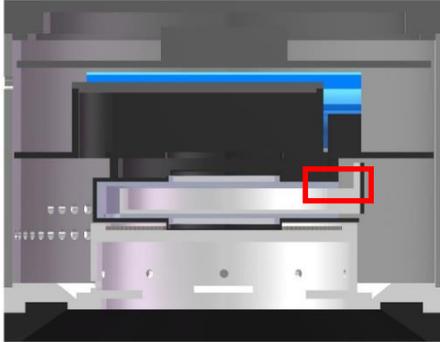


Figure 5: Simplified model

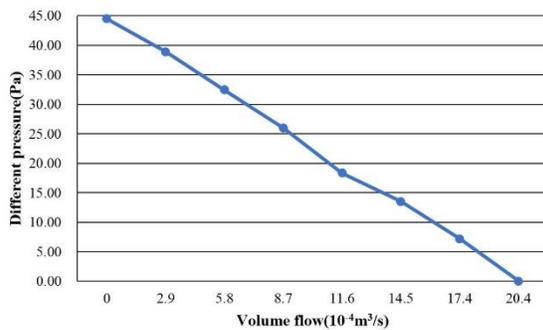


Figure 6: The volume flow and different pressure characteristic curve of the fan

B. Simulation Experiment Conditions

- a) Heat transfer form: heat conduction, heat convection, heat radiation;

- b) Fluid: air, initial temperature 20°C;
 c) The initial temperature of the parts: if not specified in the experiment description, the default temperature is 20°C;
 d) Heating film power: 6W.

C. Temperature Distribution at Steady State

For Model 1 and Model 2, two sets of simulation experiments were carried out respectively, one heating film, the temperature in the figure was in steady state. In 1-1 and 2-1, the bottom of the silicone pad is in direct contact with the air and is not closed, that is, the bottom is opened. In 1-2 and 2-2, a 37°C constant temperature heat source is added to the bottom of the silicone pad, and the bottom is closed. The temperature distribution is shown in Table 2.

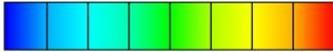
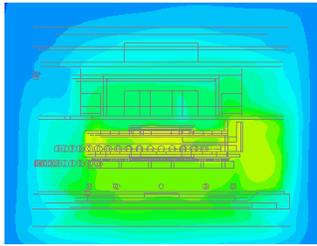
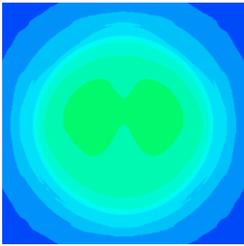
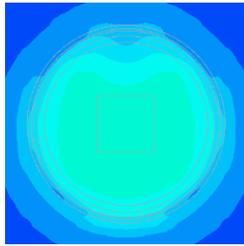
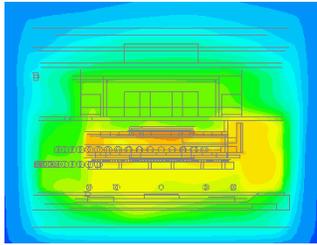
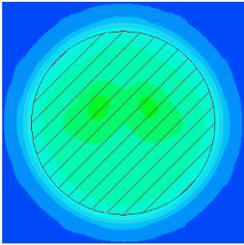
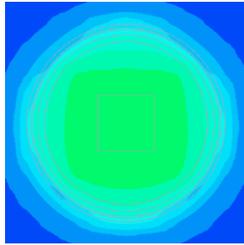
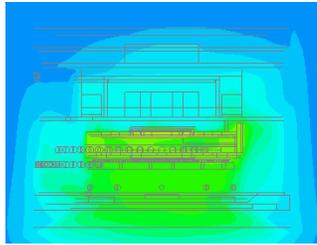
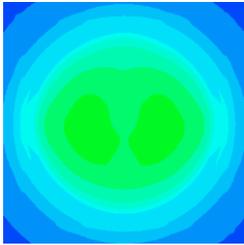
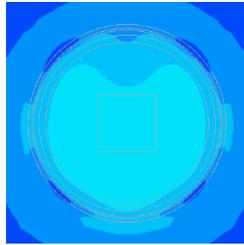
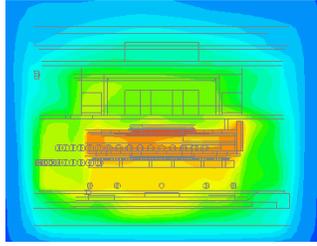
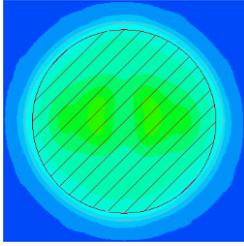
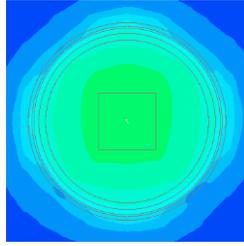
D. Transient Analysis

In order to better observe the temperature distribution over time, transient analysis of model 2 is carried out. The experimental conditions were as follows: the bottom of the silicone pad was sealed with a cover, the cover material was the same as the silicone pad, and the initial temperature was set to 37°C. Record the temperature changes of the 6 monitoring points inside the moxibustion instrument over time. The positions of the monitoring points are shown in Fig. 7 (●Circuit board, ●Insulation frame, ●Heating film, ●Diversion shield, ●Silicone pad, ●Bottom seal cover). The curve of temperature at the monitoring point with time is shown in Fig. 8. In Fig. 8, data1-data6 respectively represent the temperature of the monitoring points (●Heating film, ●Diversion shield,

Table 1: Material Parameter of Parts and Components

Parts and Components	Material	Mass Density (kg/m ³)	Specific Heat (J/(kg·K))	Thermal Conductivity (W/(m·K))
Silicone pad	Rubber	930	2092	0.14
Circuit board	FR-4	1250	1300	0.35
Battery	Lithium battery	2800	900	205
Insulation sheet components	Aluminum silicate ceramic fiber	200	800	0.115
Heating chamber	Purple copper	8933	Curve	387.6
Heating plate	Aluminum alloy	2700	900	200
Heating film	Alumina (99.9)	3960	850	30
Filter	Stainless steel 304	8000	500	16
Others	Polyphenylene oxide (PPO)	1060	2950	0.22

Table 2: Steady-State Temperature Distribution of Multiple Planes Under Different Experimental Conditions

NO.	YOZ Plane	Lower Surface of Silicone Pad**	Lower Surface of the Circuit Board
	Temperature (°C)  15 22.5 30 37.5 45 52.5 60 67.5 75		
1-1	 Maximum temperature* 60.948°C	 Maximum temperature 42.4138°C	 Maximum temperature 36.0183°C
1-2	 Maximum temperature 71.2697°C	 Maximum temperature 44.9632°C	 Maximum temperature 42.4695°C
2-1	 Maximum temperature 55.6608°C	 Maximum temperature 44.399°C	 Maximum temperature 29.8453°C
2-2	 Maximum temperature 74.3875°C	 Maximum temperature 48.0887°C	 Maximum temperature 41.9157°C

* The maximum temperature in Table 2 refers to the highest temperature on the corresponding plane.

** In 1-2 and 2-2, the lower surface of the silicone pad actually refers to the plane with the lower surface up to 1mm (the original lower surface of the silicone pad coincides with the 37°C constant temperature heat source).

●Silicone pad, ●Insulation frame, ●Bottom cover, and ●Circuit board) in Fig. 7 changes with time.

Through the above simulation analysis, the temperature distribution of the two simplified models is not

much different, indicating that an appropriate gap is allowed during processing or installation. The internal temperature distribution of the moxibustion instrument is reasonable, and the temperature of the lower surface of the silicone pad and the lower surface of the circuit

board meets the safety requirements. From the perspective of simulation speed and simplicity, Model 2 is selected for temperature field simulation analysis.

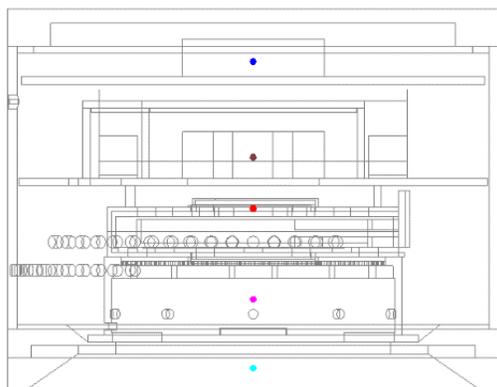


Figure 7: Location of temperature monitoring points.

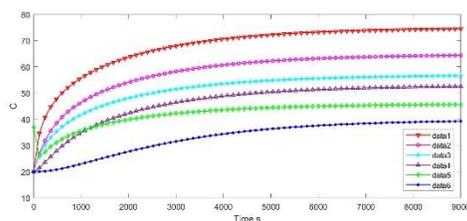


Figure 8: Temperature change curves of monitoring points with time.

5. CONCLUSION

The organic combination of umbilical moxibustion and modern science is of special significance for overcoming the shortcomings of traditional treatment methods and realizing quantification. Based on the structural design of the electronic smokeless umbilical moxibustion instrument, this paper demonstrates the feasibility of the structural design scheme and the rationality of the temperature field distribution through the analysis of the internal temperature field and the temperature change characteristic curve over time.

To apply the electronic umbilical moxibustion instrument to the clinic, it is necessary to strictly verify the effectiveness of its treatment effect and the safety and reliability of its use. In the next step, research will be carried out from the aspects of heat distribution and change during traditional moxibustion for umbilical therapy, electric heating to produce similar burning effects of moxa and quantitative parameters, etc., which provides theoretical basis and clinical support for the quantitative research of umbilical moxibustion.

ACKNOWLEDGEMENT

This work was supported by the Independent Innovation Team Project of Jinan City under Grant 2019GXRC013, the Science and technology support plan for Youth Innovation of colleges and universities in Shandong under Grant 2019KJB018.

REFERENCES

- [1] Zhou Yunfeng, Yang Jianyu, Wang Guang'an. A complete illustration of traditional Chinese medicine for pre-treatment and health maintenance. Umbilical therapy[M]. Henan Science and Technology Press, 2019.8
- [2] Liu Xusheng, Deng Lili. Practical Handbook of Moxibustion [M]. China Press of Traditional Chinese Medicine, 2017.3
- [3] Gao Shuzhong. An Encyclopedia of Traditional Chinese Medicine Umbilical Therapy[M]. Jinan Publishing House, 2019.11
- [4] General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Standardization Administration of the People's Republic of China. Nomenclature and Location of Acupuncture Points (GB/T 12346-2006). Beijing: Standards Press of China, 2006.
- [5] Gao Yong. The golden section of human health [J]. Medicines and People, 2011, 24(06): 55.
- [6] DAJ Multifunctional Moxibustion Apparatus [J]. Qiqihar North Chinese Medical Instrument Factory, Heilongjiang Province, 2002-01-01.
- [7] Li Hongjuan, Cui Xuewei. Research on the thermal effect difference between DAJ-4 multi-function moxibustion instrument and traditional moxibustion[J]. Chinese Acupuncture & Moxibustion, 2013, 33(01): 71-74.
- [8] Zeng Fangyue. clinical research on CAJ moxibustion therapeutic instrument for treatment of knee osteoarthritis [D]. Guangzhou University of Chinese Medicine, 2015.
- [9] Yang Xu-ming, Tang Jia-ming. Preparation of an electronic moxibustion apparatus which simulates the mechanism of traditional moxibustion: application security and environmental effects [J]. Chinese Journal of Tissue Engineering Research, 2016, 20(42):6337-6342.
- [10] Keai Smokeless Intelligent Moxibustion Apparatus [EB/OL]. Jingdong Online Mall, 2017-09-12 [2021-02-10]. <https://item.jd.com/15109070281.html>
- [11] Zuodian Smart Moxibustion Box [EB/OL]. Jingdong Online Mall, 2018-09-14[2021-02-10]. <https://item.jd.com/100008881582.html>
- [12] Shao Haiyan, Wang Na, Sun Xuan, Geng Chao, Wu Tao. An intelligent portable Chinese medicine moxibustion instrument for umbilical therapy: China, CN111643357A[P]. 2020-09-11.
- [13] DING Guang-hong, SHEN Xue-yong, CHU Jun-hao, HANG Zhi-ming, Yao Wei, LIU Hui, WANG Sheng-zhang, Fei Lun. Research on infrared radiation spectrum of moxibustion and acupoints in human body in traditional Chinese medicine[J]. Chinese journal of biomedical engineering, 2002,21(04):356-360.
- [14] Hong Wenxue, Cai Jianhong, Jing Jun. A research on heat radiation spectrum characteristics of moxibustion therapy[J]. Applied Optics, 2004, 25(04): 1-3+44.
- [15] Yuan Zhongqin, Zhuang Xiaoli. Traditional Chinese medicine moxibustion therapy[J]. Medical and Health Equipment, 1995(1): 24-26.
- [16] Chen Zhihong, Jiang Guotai, Huang Chunquan. Estimation of indirect moxibustion's temperature field distribution[J]. Beijing Biomedical Engineering, 2010, 29(03): 221-224.

- [17] Zhang Hongliang, Chen Shitu, Liu Yuping. Analysis of Chinese moxibustion in visible and infrared spectra in process of clinical application[J]. Spectroscopy and Spectral Analysis, 1999, 19(03): 344-346.
- [18] Xue K, Xing QJ, Wang YQ, et al. Electronic moxibustion apparatus and traditional moxibustion in treating knee osteoarthritis: a randomized controlled trial. J Acupunct Tuina Sci, 2020, 18(4): 286-294
- [19] Tao Wenquan. Heat Transfer (Fifth Edition) [M]. Higher Education Press, 2019.07
- [20] Zhi-peng Liu, Tao Yin, Xiao-guang Guan. Thermodynamic model and experimental validating on thermal field distribution of traditional moxibustion[J]. Chinese Journal of Clinical Rehabilitation, 2003, 7(20): 2818-2819+2907.
- [21] Zhang De-yi, Jiang Nan, Zhang Lin-jie, LING Hong-cai, WANG Qi. Invention and thermal field analysis of moxibustion instrument with automatic temperature regulation and equilibrium[J]. Science Technology and Engineering, 2019, 19(5): 136-141

Received on 27-11-2020

Accepted on 25-12-2020

Published on 30-12-2020

DOI: <https://doi.org/10.31875/2409-9694.2020.07.3>

© 2020 Shao *et al.*; Zeal Press.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.