**Original Article**

# Thermal Properties of Indirect Ceramic Moxibustion

Lim Jin-woong[1], Kim Hyun-ho[3], Park Young-bae[3] and Lee Sang-hoon[2]

[1]Dept. of Oriental Medicine, College of Oriental Medicine, Kyung Hee University
[2]Dept. of Acupuncture and Moxibustion, College of Oriental Medicine, Kyung Hee University
[3]Dept. of Diagnostics and Biofunctional Medicine, College of Oriental Medicine, Kyung Hee University

## 국문초록

# 온구기의 연소 특성에 관한 고찰

**임진웅[1], 김현호[3], 박영배[3], 이상훈[2]**

**[1]경희대학교 한의과대학 한의학과**
**[2]경희대학교 한의과대학 침구학교실**
**[3]경희대학교 한의과대학 진단생기능의학교실**

**목적** : 뜸 연소 실험을 통해 간접구의 일종인 온구기의 연소 특성을 조사하였다.

**방법** : 온구기를 유리판 위에 놓고 연소하여 50분간 온도 데이터를 수집하였다. 총 20개의 뜸봉을 연소하여 수집된 데이터를 분석하여 평균 온도, 최고 온도, 최고 온도 도달 시간, 최고 온도 지속 시간을 계산하였다. 또 혈류량을 증가시킨다고 보고된 온도(38℃)에 도달하는 시간, 그 이상의 온도로 지속되는 시간, C-fiber의 활성화를 통해 치료효과를 나타내는 것으로 보고된 온도(42-50℃)에 도달하는 시간과 그 범위 내의 지속시간을 계산하였다.

**결과** : 평균 최고온도는 50.4℃이고 평균 도달시간은 1,007초, 평균 지속시간은 27초였다. 평균최고 온도는 보고된 다른 간접구와 유사하였으나 평균 도달시간은 더 길었다. 38℃에 도달하는 평균시간은 410초이고 지속시간은 1,813초였다. 42-50℃에 도달하는 평균시간은 521초이고 지속시간은 990초였다.

**결론** : 온구기는 연소 특성이 보고된 다른 종류의 뜸보다 더 오랜 시간 동안 안정적인 열자극이 가능하여, 뜸치료의 임상 활용의 폭을 높일 수 있을 것으로 사료된다.

**핵심 단어** : 온구기, 연소 특성, 열치료, indirect ceramic moxibustion, thermal properties, thermotherapy

* This work was supported by the Undergraduate Research Program (URP) grant funded by Kyung Hee University College of Oriental Medicine and by a grant of the Oriental Medicine R&D Project, Ministry for Health & Welfare & Family Affairs, Republic of Korea (B090004)
· Acceptance : 2011. 12. 30. · Adjustment : 2012. 1. 19. · Adoption : 2012. 1. 19.
· Corresponding author : Lee Sang-hoon, Dept. of Acupuncture and Moxibustion, College of Oriental Medicine, Kyung Hee University #1 Hoegi-dong, Dongdaemun-gu, Seoul, 130-702, Republic of Korea
TEL : 02-958-9209 E-mail : shlee777@gmail.com

# Ⅰ. Introduction

Moxibustion has been employed for therapeutic purposes in East Asia for thousands of years and, in recent years, has been studied in clinical trials[1]. Although there is insufficient evidence to clarify the efficacy of moxibustion[2], current trials and reviews suggest that moxibustion treatment has positive effects on breech presentation[3-6], ulcerative colitis[7], and Bell's palsy[8].

While acupuncture uses needles inserted into the skin to stimulate acupuncture points, moxibustion uses heat generated by burning mugwort herb (called *moxa* in Chinese)[9]. It is important to measure the thermal properties of moxibustion in order to regulate its therapeutic effects and minimize adverse effects such as burns[10]. Recently, reports have been published concerning the thermal characteristics of various moxibustion methods. Yi examined the thermal properties of direct and indirect moxibustion using appropriate air flow and slices of garlic to control temperature[11]. Other studies have investigated the thermal properties of moxa sticks[12], moxa cones made of barley and jujube seed[13], commercial and traditional indirect moxibustion[14], the thermal and antiradical properties of indirect moxibustion[15], a thermodynamic model of moxibustion[16], and the biophysical characteristics of traditional moxibustion with infrared radiation[17].

Literatures contain reports that assess the thermal characteristics of moxibustion through different methodologies, including most types of moxibustion used clinically. However, indirect moxibustion using containers that retain heat and steadily emit it has not been studied. Since the relatively new form of indirect moxibustion using ceramic containers is used therapeutically, its thermal characteristics need to be analyzed and reported. Therefore, the aim of this research was to assess the thermal properties of a new type of indirect moxibustion that employs both moxa and ceramic, as well as to consider its feasibility as an alternative method of thermotherapy.

# Ⅱ. Materials and methods

## A. Materials

We examined the thermal characteristics of a form of indirect moxibustion newly developed in Korea (Shinkigoo, Haitnim Co., Incheon, Korea). The moxibustion unit was comprised of 3 parts : a cone-shaped moxa, a ceramic container for the moxa, and a netted safety cover (Fig. 1). The average weight of moxa was 1.7 g and the volume was 2.1 $cm^3$. The ceramic container was made of traditional red clay earthenware and had a space inside under the moxa as a buffer to prevent the skin from being burned.

Fig. 1. Components of indirect ceramic moxibustion
From left : conical moxa, net-shaped cover, and the moxa with ceramic container.

## B. Experimental set-up

The assembled moxibustion units were placed on a single glass plate and a thermocouple of a datalog thermometer (Giltron GT309, Seoul, the Republic of Korea) was installed underneath the unit in the center to record temperature. All windows and doors were closed to block air flow. The experimental set-up is shown in Fig. 2.

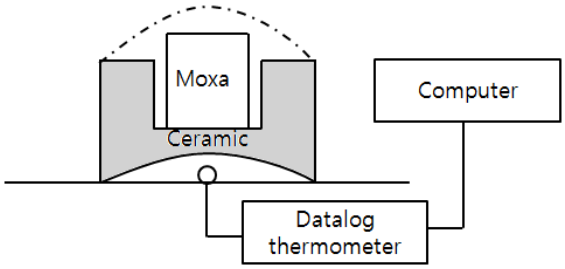


Fig. 2. A schematic diagram of indirect moxibustion and the experimental set-up

### C. Procedure

We performed the procedure at Kyung Hee Medical Center, Seoul, the Republic of Korea. We recorded temperature each second for 50 minutes (3,000 sec). To ensure consistency, all moxibustion was performed immediately after bottom temperature reached around 27°C ; temperature recording was also initiated at this point. Two or three moxibustion units were burned simultaneously. We collected 20 data curves of temperature for analysis.

### D. Analyzing the thermal properties of indirect moxibustion

To analyze thermal characteristics, we calculated the mean, maximum, and minimum temperature each second. We also assessed the mean and standard deviation of the maximum temperature of 20 moxibustions, the time to reach the maximum temperature, and its retention time. Also, for clinical correlation, we calculated the mean time to reach 38°C and the time sustained over 38°C, which has been reported to increase blood flow when applied with a heating pad[18,19]. We repeated these calculations with the range of 42-50°C, which is considered therapeutic due to the activation of C fibers[14,20,21].

## Ⅲ. Results

### A. Temperature curves of indirect moxibustion

Fig. 3 shows all temperatures of 20 moxibution units with two criteria. The temperature graph showed that this type of ceramic moxibustion retained heat longer both before and after the peak temperature than other types of indirect moxibustion (e.g., those using ginger, garlic, and so on)[11,13,14]. Major thermal properties of each moxibustion in previous reports are compared with our data in Table 1. We selected one representative value from each article which was measured in as similar condition as possible.

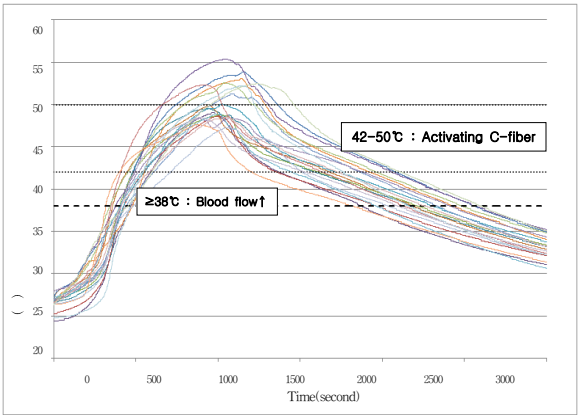


Fig. 3. Temperature curves of 20 moxibustion units

### B. Arithmetical thermal properties of indirect moxibustion

As shown in Table 1, the mean maximum temperature was 50.4°C. It took an average of 1,007 sec to reach the maximum temperature, which lasted for 27 sec. The indirect ceramic moxibustion showed slightly higher maximum temperature and longer duration to peak temperature, consequently longer combustion time in compared with the previously reported data (Table 1).

Table 1. Comparison of Thermal Properties of Indirect Ceramic Moxibustion with Others (Peak Temperature, Time to Reach Peak Temperature, and Retention Time at Peak Temperature are Shown)

| Moxibustion | Material beneath moxibustion | Peak(℃) | Time to peak(sec) | Duration of peak(sec) |
|---|---|---|---|---|
| Indirect ceramic moxibustion | Glass plate | 50.4±2.3 | 1,007±101 | 27±12 |
| Indirect garlic moxibustion[11] | Aluminum hot plate | n.r. | <300 | n.r. |
| Indirect moxibustion (*Ganghwa* minimoxa)[13] | Hot plate(34℃) | 36.1±1.4 | 186.7±26.9 | n.r. |
| Indirect commercial moxibustion[14] | Human body | 45.23±3.99 | n.r. | n.r. |

Values are shown as mean±SD or <(maximum value). n.r. : not reported.

It took 410 sec to reach 38°C ; temperatures over 38°C lasted for 1,813 sec. Additionally, it took 521 sec to reach the lower end of the therapeutic temperature range (42-50°C), and the temperature remained within that range for 990 sec (Table 2).

Table 2. Duration and Time to Reach 38°C and Therapeutic Range (42-50°C)

| Criteria | Over 38°C(sec) | Therapeutic range (42-50°C)(sec) |
|---|---|---|
| Duration maintaining each criterion | 1,813±236 | 990±160 |
| Time to reach each criterion | 410±46 | 521±74 |

Values are shown as mean±SD. The therapeutic window is defined as 42-50°C, which is considered to exert a therapeutic effect by activating C fibers.

# Ⅳ. Discussion

The aim of this study was to examine the thermal properties of a new type of indirect moxibustion and provide initial evidence for further studies. Although there are many reports on the thermal characteristics of moxibustion, most involve direct moxibustion cones and sticks or traditional indirect moxibustion using garlic or ginger.

In our study, the maximum temperature (50.4°C) was similar to that of other types of indirect moxibustion[14]. We found the unique feature of ceramic moxibustion to be a longer retention time compared to other forms. Although there is a limitation that each article used a different material beneath moxibustion which could affect the outcome, we can assume that this experimental difference is not enough to reverse the large gap with our data.

This thermal characteristic has important clinical implications. First, both practitioners and researchers have greater freedom in choosing the duration of heat stimulation. In contrast to traditional moxibustion, which generates heat for approximately 300 seconds[11], ceramic moxibustion can maintain an optimal temperature level for over 900 seconds.

Secondly, the characteristics of indirect ceramic moxibustion support its use as an alternative method of thermotherapy. Thermotherapy is defined as a therapeutic method using heat to increase tissue temperature. Thermotherapeutic methods include hydrocollator packs, paraffin baths, ultrasound, and heat lamps[22]. According to Stauffer and Goldberg[23], thermotherapy may be accomplished with at least three distinct protocols of temperature elevation : long-term, low-temperature treatment 40-41°C for 6-72 h for a cumulative thermal dose less than 5 minutes at 43°C (CEM43) ; moderate-temperature hyperthermia (42-45°C for 15-60 min or 15-240 CEM43) ; and high temperature thermal ablation (>50°C for >4-6 min or >512 CEM43). Additionally, several studies have shown that topical heat stimulation over 38°C increases blood flow[18,19]. In

light of our results, indirect ceramic moxibustion clearly has merit as a form of thermotherapy.

One of the challenges in moxibustion is controlling the maximum temperature, as temperatures over 50°C can damage tissue and induce coagulation necrosis of the muscle[24]. Although the peak temperature was over 50°C in 9 of 20 moxibustions in this study, the mean was approximately 50°C. To prevent thermal injury, the temperature must remain lower than 50°C. With careful observation, this new type of indirect moxibustion can be of great use in research and treatment due to its longer duration in the therapeutic temperature range than other forms of moxibustion.

# Ⅴ. References


1. Zhao B, Wang X, Lin Z, Liu R, Lao L. A novel sham moxibustion device : a randomized, placebo-controlled trial. Complement Ther Med. 2006 ; 14(1) : 53-60 ; discussion 1. Epub 2006/02/14.
2. Lee MS, Kang JW, Ernst E. Does moxibustion work? An overview of systematic reviews. BMC Res Notes. 2010 ; 3 : 284. Epub 2010/11/09.
3. Li X, Hu J, Wang X, Zhang H, Liu J. Moxibustion and other acupuncture point stimulation methods to treat breech presentation : a systematic review of clinical trials. Chin Med. 2009 ; 4 : 4. Epub 2009/ 02/28.
4. Coyle ME, Smith CA, Peat B. Cephalic version by moxibustion for breech presentation. Cochrane Database Syst Rev. 2005(2) : CD003928. Epub 2005/04/23.
5. Cardini F, Weixin H. Moxibustion for correction of breech presentation : a randomized controlled trial. JAMA. 1998 ; 280(18) : 1580-4. Epub 1998/11/20.
6. Cardini F, Lombardo P, Regalia AL, Regaldo G, Zanini A, Negri MG, Panepuccia L, Todros T. A randomised controlled trial of moxibustion for breech presentation. BJOG. 2005 ; 112(6) : 743-7. Epub 2005/06/01.
7. Kim SY, Chae Y, Lee SM, Lee H, Park HJ. The Effectiveness of Moxibustion : An Overview During 10 Years. Evid Based Complement Alternat Med. 2009. Epub 2009/10/15.
8. Li Y, Liang FR, Yu SG, Li CD, Hu LX, Zhou D, Yuan XL, Xia XH. Efficacy of acupuncture and moxibustion in treating Bell's palsy : a multicenter randomized controlled trial in China. Chin Med J(Engl). 2004 ; 117(10) : 1502-6. Epub 2004/10/23.
9. Joos S, Brinkhaus B, Maluche C, Maupai N, Kohnen R, Kraehmer N, Hahn EG, Schuppan D. Acupuncture and moxibustion in the treatment of active Crohn's disease : a randomized controlled study. Digestion. 2004 ; 69(3) : 131-9. Epub 2004/ 04/29.
10. Park JE, Lee SS, Lee MS, Choi SM, Ernst E. Adverse events of moxibustion : a systematic review. Complement Ther Med. 2010 ; 18(5) : 215-23. Epub 2010/11/09.
11. Yi SH. Thermal properties of direct and indirect moxibustion. J Acupunct Meridian Stud. 2009 ; 2(4) : 273-9. Epub 2010/07/17.
12. Pach D, Brinkhaus B, Willich SN. Moxa sticks : thermal properties and possible implications for clinical trials. Complement Ther Med. 2009 ; 17(4) : 243-6. Epub 2009/07/28.
13. Kim YH, Lee SH, Yeo SJ, Choe IH, Kim YK, Lim S. The Study on Temperature Measurement for the Standardization of Moxibustion. J Korean Acupunct Moxibustion Soc. 2008 ; 25(2) : 129-38.
14. Jang MK, Kim EJ, Jung CY, Yoon EH, Hwang JH, Kim KS, Choi IH, Lee SD. A Study of Comparing Thermal Stimulation between Commercial Indirect Moxibustion and Traditional Indirect Moxibustion. J Korean Acupunct Moxibustion Soc. 2010 ; 27(3) : 35-45.
15. Chiba A, Nakanishi H, Chichibu S. Thermal and antiradical properties of indirect moxibustion. Am J Chin Med. 1997 ; 25(3-4) : 281-7. Epub 1997/01/01.
16. Zhipeng L, Tao Y, Xin L, Ying L. Thermodynamics model and experimental validating on thermal field distribution of traditional moxibustion.

Conf Proc IEEE Eng Med Biol Soc. 2005 ; 5 : 4951-4. Epub 2007/02/07.
17. Shen X, Ding G, Wei J, Zhao L, Zhou Y, Deng H, Lao L. An infrared radiation study of the biophysical characteristics of traditional moxibustion. Complement Ther Med. 2006 ; 14(3) : 213-9. Epub 2006/08/17.
18. Reid RW, Foley JM, Prior BM, Weingand KW, Meyer RA. Mild topical heat increases popliteal blood flow as measured by MRI. Med Sci Sports Exer. 1999 ; 31 : S208.
19. Erasala GN, Rubin JM, Tuthill TA, Fowlkes JB, de Dreu SE, Hengehold DA, Weingand KW. The effect of topical heat treatment on trapezius muscle blood flow using power Doppler ultrasound. Physical Therapy. 2001 ; 81 : A5.
20. Tepperman PS, Devlin M. Therapeutic heat and cold. A practitioner's guide. Postgrad Med. 1983 ; 73(1) : 69-76. Epub 1983/01/01.
21. Habash RW, Bansal R, Krewski D, Alhafid HT. Thermal therapy, part 1 : an introduction to thermal therapy. Crit Rev Biomed Eng. 2006 ; 34(6) : 459-89. Epub 2007/08/30.
22. Nadler SF, Weingand K, Kruse RJ. The physiologic basis and clinical applications of cryotherapy and thermotherapy for the pain practitioner. Pain Physician. 2004 ; 7(3) : 395-9. Epub 2006/07/22.
23. Stauffer PR, Goldberg SN. Introduction : thermal ablation therapy. Int J Hyperthermia. 2004 ; 20(7) : 671-7. Epub 2005/01/29.
24. Landsberg R, DeRowe A, Katzir A, Shtabsky A, Fliss DM, Gil Z. Laser-induced hyperthermia for treatment of granulation tissue growth in rats. Otolaryngol Head Neck Surg. 2009 ; 140(4) : 480-6. Epub 2009/03/31.