



Original Article

An Experimental Study on the Relationship Between Temperature and Pressure Inside the Cup During Cupping Procedures



Ha Lim Lee¹, Soo Kwang An¹, Jae Yong Lee¹, Dong Wook Shim¹, Byung Ryul Lee^{2,3}, Gi Young Yang^{2,3,*}

¹ School of Korean Medicine, Pusan National University, Yangsan, Korea

² Department of Acupuncture and Moxibustion Medicine, Pusan National University Korean Medicine Hospital, Yangsan, Korea

³ Division of Clinical Medicine, School of Korean Medicine, Pusan National University, Yangsan, Korea

ABSTRACT

Article history:

Submitted: October 09, 2020

Revised: November 23, 2020

Accepted: December 02, 2020

Keywords:

Cupping Therapy,
Korean Traditional Medicine,
Hyperthermia, Pressure,
Temperature

Background: Pressure changes related to temperature variation during cupping may lead to dropout. This study aimed to investigate pressure changes related to temperature variations in the cup during the cupping procedure.

Methods: Changes in temperature and pressure were measured for 15 minutes after the procedure was performed using the alcohol rub method with glass cups and with the addition of infrared irradiation. Changes in temperature and pressure were also measured for 15 minutes after pumping 3 times using the valve suction method, and with the addition of infrared irradiation.

Results: In a comparison between the alcohol rub method with glass cups and with the addition of infrared irradiation, the negative pressure increased over time in the absence of infrared irradiation, whereas it decreased when performed with infrared irradiation $p = 0.094$. However, in a comparison between pumping 3 times using the valve suction method, and with the addition of infrared irradiation, the negative pressure decreased in both cases, but this was more significant with infrared irradiation $p = 0.172$. There was a significantly higher temperature in the glass cups ($p = 0.004$) and the valve cups ($p = 0.001$) exposed to infrared radiation, compared with no infrared irradiation.

Conclusion: The reduction in negative pressure inside the cups exposed to infrared radiation was greater than without infrared irradiation. Temperature increases inside the cup can lead to the risk of dropout.

<https://doi.org/10.13045/jar.2020.00346>
pISSN 2586-288X eISSN 2586-2898

©2021 Korean Acupuncture & Moxibustion Medicine Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Cupping is a type of therapeutic modality in Korean Medicine that stimulates the human body via the induction of negative pressure in a cup which has been placed on the surface of the skin. Cupping can be divided into wet cupping which draws blood to form negative pressure, and dry cupping which also forms negative pressure causing congestion but without letting blood out. Cupping is widely used in clinical practice to treat or prevent conditions/diseases through physical stimulation. As a clinical technique, cupping is easy, safe, and effective. Cupping therapy has been widely used for thousands of years as a remedy in many civilizations around the world, and was later incorporated into mainstream traditional medicine [1].

Cupping therapy has been covered by the Korean National Health Insurance since 1987. In a survey of Korean medicine doctors in 2008, 94.4% of the respondents reported using dry cupping and 90.8% applied wet cupping in their practice, making this procedure an important technique in Korean medicine [2].

During the cupping procedure using the valve suction method, negative pressure inside the cup is reduced. However, in comparison with the fire-cupping technique, the valve suction method showed a substantial negative pressure reduction. As a result, while fire cupping involved a gradual reduction in temperature from the beginning of the procedure, the valve suction method often did not show changes in temperature after the initial negative pressure was formed.

Infrared radiation is occasionally used in the cupping procedure

*Corresponding author. Yang Gi Young

Division of Clinical Medicine, School of Korean Medicine, Pusan National University, 20 Geumo-ro, Mulgeum-eup, Yangsan, 50612, Korea

E-mail: ygy@pnu.edu

ORCID: Ha Lim Lee <https://orcid.org/0000-0002-4032-5841>, Soo Kwang An <https://orcid.org/0000-0003-3150-2938>, Jae Yong Lee <https://orcid.org/0000-0003-3395-8234>, Dong Wook Shim <https://orcid.org/0000-0003-4429-2562>, Byung Ryul Lee <https://orcid.org/0000-0002-3782-7445>, Gi Young Yang <https://orcid.org/0000-0002-9468-8904>

©2021 Korean Acupuncture & Moxibustion Medicine Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

in the clinic for thermotherapeutic purpose [3]. The infrared irradiator used in Korean medical institutions, uses the proximal infrared rays generated when electrical energy is applied to a halogen lamp with a coating of a ceramic radiator. Infrared radiation causes physiological vasodilation increasing local blood flow, an elevation of the metabolic rate increasing body temperature, and is analgesic reducing pain in the nerve endings of the skin when applied to a large area of skin. In addition, the thermal action of infrared rays on the skin directly stimulates percutaneously into the neck muscles, and the meridian system, and may influence meridian warming, and communication [4]. However, with the use of infrared irradiation, cupping may drop out due to the reduction in negative pressure with an increase in temperature.

In this study, the impact of infrared irradiation upon the negative pressure inside the cup used for cupping was determined by statistically analysing the relationship between temperature and pressure during the cupping procedure.

Methods and Materials

Materials

Glass cups (No. 5, Anjinmed, China) and valve cups (No. 1, Hansol, Korea; Fig. 1) specifications are shown in Table 1. The volume of the cups were measured using 95% ethanol and the outer diameter values were the average values for 5 measurements. The volume and the outer diameter of the cups were measured using a digital calliper (DC150-2; CAS, Korea). The resolution of the digital calliper was 0.01 mm.

Experimental device

To measure the temperature and pressure inside the cups used for cupping, a model simulating the human skin was created which

was based on a 3-mm-thick silicon plate model [5], to which a 20-mm nitrile-butadiene rubber (NBR) was added under the 3-mm silicon plate (to mitigate the impact of the glass cupping process). During the measurement process, acrylic (360 × 360 × 10 mm) was placed on the top and bottom of the silicone plate and NBR to enhance the stability of the skin model. A hole was drilled in the skin model, and a digital thermometer (Tpi342/c1; SUMMIT, Korea) and a digital pressure gauge (Tpi665; SUMMIT, Korea) were installed using a 7-mm outer diameter pipe and a silicone tube (inner diameter 5.84 mm and outer diameter 9.98 mm) on the bottom to measure the temperature and pressure (Fig. 2). The pressure and temperature measurements in this study were calibrated by an accredited calibration institution. The airtightness of the skin model, syringe, and silicone tube was maintained using adhesives (SUPER XG, CEMEDINE, Japan), and the airtightness of the temperature sensor in the silicone tube was maintained by using clamps and cable ties. Airtightness was maintained at more than 90% of the maximum pressure for 10 minutes according to KS P ISO. A cupping pump (DB303; Dongbang Medical, Korea) was used for suction cupping, and an infrared irradiator (OMEGA-302; ENS Tech, Korea) was used for infrared irradiation (Fig. 3.)

Methods

Experimental methods

Since temperature and humidity can affect the results, direct sunlight was blocked and a temperature of $30 \pm 5^\circ\text{C}$ and a humidity of $40 \pm 10\%$ was maintained. The temperature of the skin model was set to be similar to body temperature (36.5°C). In this study, the alcohol rub method and the valve suction method of cupping were used.

Table 1. Specifications of the Cups Used in the Cupping Procedures.

	Volume (mL)	External diameter (mm)
Glass cup (no. 5)	393.0 ± 2.5	71.97 ± 0.41
Valve cup (no. 1)	71.58 ± 1.92	53.84 ± 0.05

Data are presented as mean \pm SD.

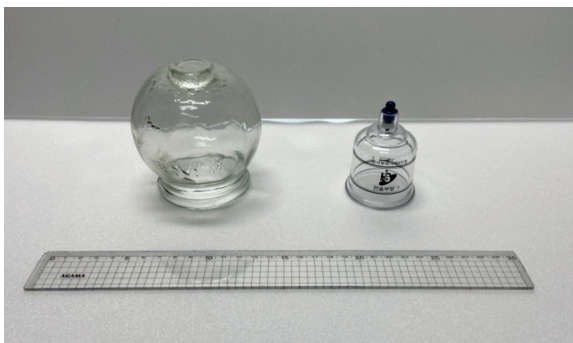


Fig. 1. A glass cup (left) and a valve cup (right).



Fig. 2. (A) Skin model. (B) Digital thermometer 1: Temperature inside the cup & skin model. (C) Digital thermometer 2: Temperature at the skin model surface. (D) Digital manometer. (E) Infrared irradiator. (F) Glass cup. (G) Valve cup



Fig. 3. Infrared irradiator.

In the alcohol rub method, a practitioner holds the cotton wool soaked in alcohol, locked in forceps. The cotton ball is lit, and the flame is rubbed inside the bottom of the cup. Simultaneously, the practitioner turns the cup over on to the desired location. In valve suction method, the operator places the cup in the desired location, inserts the pump into the valve on the cup, and proceeds to pump air out of the cup to create suction [1]. Changes in temperature and pressure were measured for 750 seconds after the procedure was performed using the alcohol rub method with glass cups, and with the addition of infrared irradiation. Changes in temperature and pressure were measured for 750 seconds after pumping 3 times using the valve suction method, and with the addition of infrared irradiation. For all conditions, temperature and pressure were measured at 10-second intervals, and each condition was repeated 3 times. The number of repetitions used for pumping in the valve suction method of cupping was based on a previously published article [2]. Infrared light irradiated downwards from a source positioned 30 cm above the skin model.

To determine the impact of infrared irradiation upon the temperature and negative pressure inside the cup, statistical analysis was conducted using the Student *t*-test, to assess the difference between the means of the temperature difference and pressure difference between the 2 groups. The first comparison was between a glass cup without infrared irradiation and a glass cup with infrared irradiation, and the second comparison was between a valve cup without infrared irradiation and valve cup with infrared irradiation.

Results

Alcohol rub method with glass cups (without infrared irradiation)

After the procedure using the alcohol rub method with glass cups had been set up, changes in temperature and pressure were observed for 750 seconds, this was repeated 3 times, and the pressure increased each time as the temperature decreased. The temperature reductions were 7.1°C, 8.7°C, and 6.3°C, and the mean temperature difference was $-7.37 \pm 1.22^\circ\text{C}$. The increments in negative pressure were 13.7 mmHg, 13.3 mmHg, and 5.5 mmHg, respectively, and the mean pressure difference was 22.17 ± 22.15 mmHg. The temperature and pressure changes over time are shown in Fig. 4 and are representative.

Alcohol rub method with glass cups using infrared irradiation

After the procedure using the alcohol rub method with glass cups had been set up, changes in temperature and pressure were observed for 750 seconds under infrared irradiation. This was repeated 3 times, and the temperature decreased and then increased each time, and the pressure decreased. The final temperatures had increased by 0.5°C, decreased by 2.4°C, showing no change, and the mean temperature difference was $-6.33 \pm 1.55^\circ\text{C}$. The reductions in negative pressure were 11.7 mmHg, 18.5 mmHg, and 16.8 mmHg, respectively, and the mean temperature difference was -6.33 ± 1.55 mmHg. The temperature and pressure changes over time are shown in Fig. 5. and are representative.

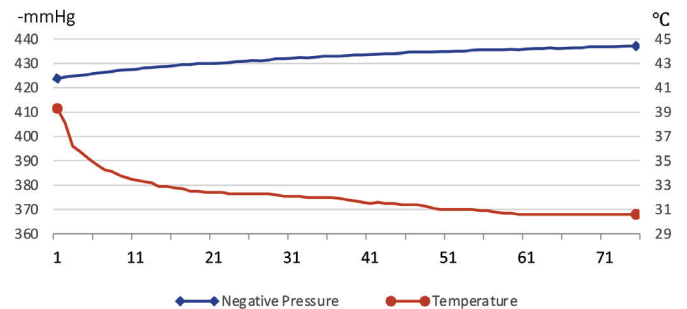


Fig. 4. Negative pressure and temperature in the glass cup whilst using the alcohol rub method of cupping without infrared irradiation.

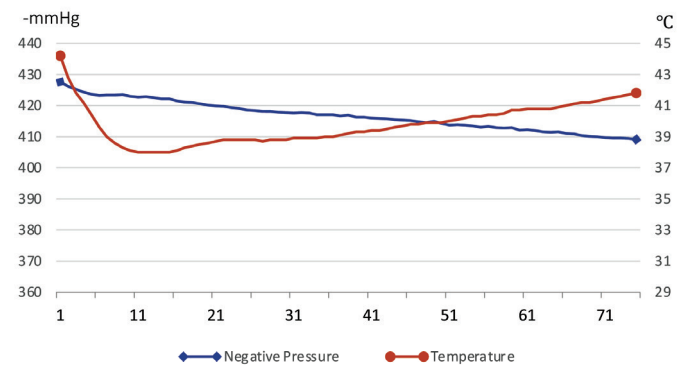


Fig. 5. Negative pressure and temperature in the glass cup whilst using the alcohol rub method of cupping with infrared irradiation.

Valve suction method (without infrared irradiation)

After pumping 3 times using the suction valve method, changes in temperature and pressure were observed for 750 seconds. This was repeated 3 times, and the temperature change each time was minimal whilst the pressure decreased. The temperature increased by 1.3°C, 0.2°C, and 0.3°C, and the mean temperature difference was $0.60 \pm 0.61^\circ\text{C}$. The negative pressure decreased by 16.2 mmHg, 14.2 mmHg, and 17.2 mmHg, respectively, and the mean of pressure difference was 15.87 ± 1.53 mmHg. The temperature and pressure changes over time are shown in Fig. 6 and are representative.

Valve suction method using infrared irradiation

After pumping 3 times using the suction valve method, changes in temperature and pressure were observed for 750 seconds under infrared irradiation. This was repeated 3 times, and the temperature increased each time and pressure decreased. The temperature increased by 9.3°C, 12.7°C, and 12.4°C, and the mean of temperature difference was $11.47 \pm 1.88^\circ\text{C}$. The negative pressure decreased by 23.1 mmHg, 40.2 mmHg, and 21.5 mmHg, respectively, and the mean of pressure difference was -28.27 ± 10.37 mmHg. The temperature and pressure changes over time are shown in the Fig. 7 and are representative.

Overall

In general, the glass cup and the valve cup without infrared irradiation differed. Specifically, in the alcohol rub method, over time the temperature inside the glass cup reduced, and the negative pressure increased (Fig. 4). On the other hand, in the valve suction method, the temperature inside the valve cup reduced, and the negative pressure decreased (Fig. 6). Therefore, the effect of infrared irradiation on cupping method should be considered.

In the alcohol rub method the initial temperature and last temperature measured, and the temperature difference, and the initial pressure and last pressure measured, and the pressure difference was recorded (Table 2). The Student *t*-test was conducted between a glass cup with infrared irradiation and a glass cup without infrared irradiation using the temperature difference and the pressure difference. There were significantly

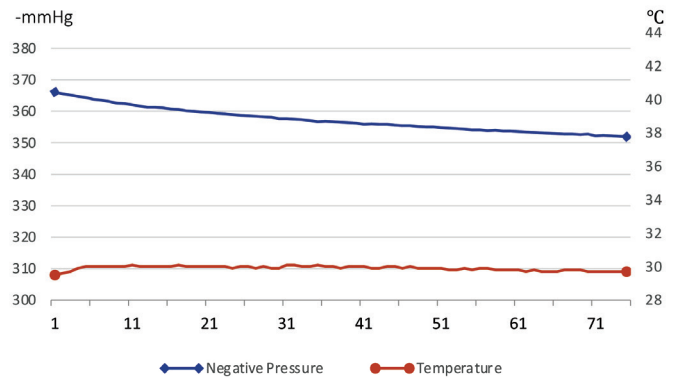


Fig. 6. Negative pressure and temperature in the valve cup whilst using the valve suction method of cupping without infrared irradiation.

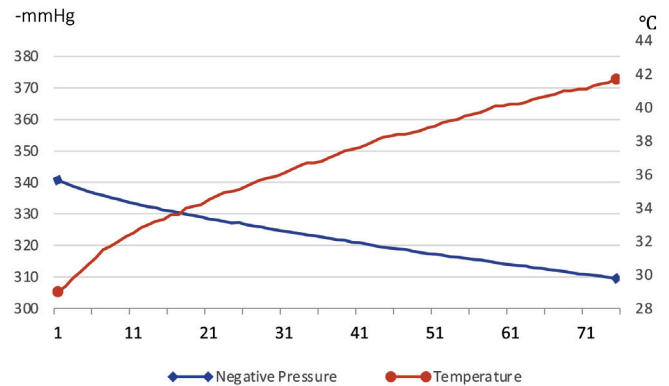


Fig. 7. Negative pressure and temperature in the valve cup whilst using the valve suction method of cupping with infrared irradiation.

Table 2. Cupping Using the Alcohol Rub Method with Glass Cups.

		Glass cup				Glass cup + IR				Statistical analysis
		1	2	3	mean ± SD	1	2	3	mean ± SD	
Temp (°C)	IT	37.7	39.3	36.4	37.80 ± 1.45	41.1	44.2	41.7	42.33 ± 1.64	t = -5.908, p = 0.004
	TT	30.6	30.6	30.1	30.43 ± 0.29	41.6	41.8	41.7	41.70 ± 0.10	
	Delta	-7.1	-8.7	-6.3	-7.37 ± 1.22	0.5	-2.4	0	-6.33 ± 1.55	
Pressure (-mmHg)	IP	383	423.8	415.6	407.47 ± 21.58	379.9	427.6	420.6	409.37 ± 25.76	t = 2.922, p = 0.094
	TP	396.7	471.1	421.1	429.63 ± 37.93	368.2	409.1	403.8	393.70 ± 22.24	
	Delta	13.7	47.3	5.5	22.17 ± 22.15	-11.7	-18.5	-16.8	-15.667 ± 3.54	

IR, infrared radiation; IT, initial temperature; TT, terminal temperature; IP, initial pressure; TP, terminal pressure; Delta, temperature difference or pressure difference.

Table 3. Cupping Using the Valve Suction Method.

		Valve cup				Valve cup + IR				Statistical analysis
		1	2	3	mean ± SD	1	2	3	mean ± SD	
Temperature (°C)	IT	32.1	29.5	29.4	30.33 ± 1.53	37.3	29	29.4	31.90 ± 4.68	t = -9.514, p = 0.001
	TT	33.4	29.7	29.7	30.93 ± 2.14	46.6	41.7	41.8	43.37 ± 2.80	
	Delta	1.3	0.2	0.3	0.60 ± 0.61	9.3	12.7	12.4	11.47 ± 1.88	
Pressure (-mmHg)	IP	372.2	366.1	381.5	373.27 ± 7.76	366.9	349.7	358.3	358.39 ± 8.60	t = 2.050, p = 0.172
	TP	356	351.9	364.3	357.40 ± 6.32	343.8	309.5	336.8	330.03 ± 18.12	
	Delta	-16.2	-14.2	-17.2	-15.87 ± 1.53	-23.1	-40.2	-21.5	-28.27 ± 10.37	

IR, infrared radiation; IT, initial temperature; TT, terminal temperature; IP, initial pressure; TP, terminal pressure; Delta, temperature difference or pressure difference

higher temperatures observed in the glass cups exposed to infrared radiation compared with the glass cups which were not exposed ($t = -5.908$, $p = 0.004$), and significantly lower pressures in glass cups exposed to infrared radiation compared with the glass cups which were not exposed ($t = 2.922$, $p = 0.094$).

In the valve suction method the initial temperature, and last temperature measured, and the temperature difference, and the initial pressure and last pressure measured, and the pressure difference was recorded (Table 3). The Student t -test was conducted between a valve cup with infrared irradiation and a valve cup without infrared irradiation using the temperature difference and the pressure difference. There were significantly higher temperatures observed in the valve cups which were exposed to infrared radiation compared with those valve cups which were not exposed ($t = -9.514$, $p = 0.001$), and the decrease in pressure was significantly greater in the valve cups which were exposed to infrared radiation compared with valve cups which were not exposed ($t = 2.050$, $p = 0.172$).

Discussion

This study aimed to investigate the pressure changes related to the temperature variations in the cup during cupping. Using the alcohol rub method with glass cups, a comparison of the negative pressure inside the cup was made between exposure or not to infrared radiation. Negative pressure increased with time in the absence of infrared irradiation, whereas it decreased with infrared irradiation. However, in the valve suction method with valve cups, a comparison of negative pressure inside the cup decreased with and without infrared irradiation, but the negative pressure decreased more significantly with infrared irradiation compared to without infrared irradiation.

Overall, infrared irradiation affected the temperature and pressure inside the glass cups and the valve cups. Infrared irradiation decreases the negative pressure inside the cup which can lead to drop out of suction of the cup.

The skin model used in this study was valid according to the KS P ISO standard, but actual skin contains factors that can affect the temperature and pressure within the cup, such as body hair, pores, and moisture, which limited reproducibility in the model. In this study, the alcohol rub method with glass cups and the valve suction method with valve cups were used, but cupping in clinical practice

is performed using various approaches therefore, for other types of cupping, follow-up studies outlining the changes in the pressure according to temperature are required. In addition, the number of times used to pump the valve cups in the valve suction method of cupping may be outdated since this method was described in 2008 [1]. Ideally the pump number, the associated time, and the procedure interval during the valve suction method should be standardized.

Conclusion

Our findings suggested that in both glass and valve suction cups, the extent of reduction in negative pressure when exposed to infrared radiation was greater than without exposure to infrared radiation. The decrease in negative pressure was not drastic enough to cause dropout of suction of the cup. However, according to the KS P ISO standard, during cupping, a cup must be able to maintain 90% or more of the maximum pressure for 10 minutes. Therefore, the use of infrared irradiation during the cupping procedure should be performed with care.

An increase in the temperature inside the cup can lead to the risk of dropout. In valve suction cups, additional pumping may be required during the procedure to address the drop in negative pressure during infrared irradiation. However, glass cupping using the fire cupping method is based on the principle that the negative pressure increases as the temperature decreases. Thus, it is highly affected by differences in the temperature, unlike suction cupping, and measures such as additional pumping to prevent dropout are impossible. Therefore, more attention is required in such cases.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Acknowledgments

This work was supported by a 2-year research grant of Pusan National university.

References

- [1] Chirali IZ. Traditional Chinese Medicine Cupping Therapy-E-Book. Elsevier Health Sciences; 2014. 372 p.
- [2] Lee BY, Song YK, Lim HH. Literature Investigation Regarding Cupping Therapy and Analysis of Current Professional's Cupping Treatment. J Orient Rehabil Med 2008;18:169-191. [in Korean].
- [3] Kim H, Cho JH, Kim KW, Chung WS, Park JH, Shin WC et al. An Investigation on the Effects of Wet Cupping on Wisu (BL21) for Non-acute Low Back Pain: A Pilot Randomized Controlled Trial. J Orient Rehabil Med 2018;28:21-32.
- [4] Hwang EH, Shin BC, Shin MS, Cho HW, Jung YL, Sul JU. An Effect of Infrared Therapy on Acupoints: Randomized Controlled Trials Review. J Orient Rehabil Med 2011;21:203-210. [in Korean].
- [5] Yi SH, Kim EJ, Shin KH, Nam DW, Kang JW, Lee SD et al. Original Article: Study on Developing Assessment Guideline for Safety and Performance of Electric Cupping Apparatus. J Acupunct Res 2009;26:101-110. [in Korean].