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An Experimental Study on the Pressure Range of Fire Cupping Method

Soo Kwang An [1], Ku Weon Kim [1], Ha Lim Lee [1], Tae Wook Lee [1], Eun Seok Kim [2, 3], Byung Ryul Lee [2, 3], Gi Young Yang [2, 3,*]

1 School of Korean Medicine, Pusan National University, Yangsan, Korea
2 Division of Clinical Medicine, School of Korean Medicine, Pusan National University, Yangsan, Korea
3 Department of Acupuncture and Moxibustion Medicine, Pusan National University Korean Medicine Hospital, Yangsan, Korea

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ABSTRACT

Background: Standardized procedures for the clinical application of fire cupping methods have not been established. In particular, the pressure parameters have not been fully characterized and described. Therefore, using various materials, this study investigated the pressure range exerted during fire cupping therapy.
Methods: In this study, 3 differently sized (small, medium, large) glass and bamboo cups were used in the cotton ball fire cupping procedure to measure the pressure inside the cup applied to a human skin model. The pressure in each cup was measured 15 times for a total of 90 measurements.
Results: A small bamboo cup had the minimum overall pressure (-305.4 mmHg), whereas the large glass cup exerted the maximum pressure (-401.3 mmHg), followed by the medium glass cup, large bamboo cup, small glass cup, and medium bamboo cup. The average pressure exerted by the cotton ball method for all cups ranged from -348.715 mmHg to -358.694 mmHg (95% confidence interval). Overall, the glass cups had a greater pressure than the bamboo cups in all groups ($p < 0.001$). Among the glass cups used, the larger the size of the cup, the higher the average pressure detected (-381.947 mmHg to -391.973 mmHg; $p < 0.05$).
Conclusion: Large glass cups which are widely used in clinical practice, when used in the fire cupping method exerted pressure ranging from -381.947 mmHg to -391.973 mmHg (95% CI).

Introduction

Cupping therapy is used in a variety of clinical circumstances for treating or preventing conditions/diseases. This therapy is typically performed by placing a cup on the surface of the human body with or without drawing blood, and creating negative pressure inside the cup promoting physical stimulation which relieves blood congestion. The origin of cupping therapy is unknown, but it has long been used as a treatment in both Eastern and Western medicine [1].

Cupping therapy includes a variety of methods, including suction, fire, and water, and the application of a particular method is generally dependent on a practitioner's proficiency and propensity. Currently, in clinical practice, the most common cupping therapies used are the cotton ball method which creates negative pressure by burning alcohol-soaked cotton balls inside the cup, and the suction cupping method which creates negative pressure inside the cup using an aspirator i.e., the exhaust pump [2].

Cupping therapy is a medical procedure that has been covered by the National Health Insurance of Korea since 1987. A survey in 2008 of Korean medicine doctors reported that dry cupping (94.4%) and the wet cupping (90.8%) were often used to treat various diseases in the field of Korean medicine [3]. Despite its wide use, there currently is no standard level of pressure to be applied in cupping therapy. Therefore, the clinics and researchers have used different levels of pressure ranging from -750 mmHg to -30 mmHg [4,5].

The pressure used in suction cupping is controlled by the number of pumps applied to the manual cupping gun [3], but the pressure applied is often inconsistent [2]. When using the electric cupping pump, it is possible to calculate the maximum pressure applied, although, it is difficult to accurately control the delivery of low pressure [6]. During clinical procedures, application of excessive pressure and exposure time can lead to side effects such

*Corresponding author. Gi Young Yang
Division of Clinical Medicine, School of Korean Medicine, Pusan National University 20 Geumo-ro, Mulgeum-eup, Yangsan, 50612, Korea
Email: ygy@pnu.edu
ORCID: Soo Kwang An https://orcid.org/0000-0003-3150-2938, Ku Weon Kim https://orcid.org/0000-0003-4520-8000, Ha Lim Lee https://orcid.org/0000-0002-4032-5841, Tae Wook Lee https://orcid.org/0000-0003-4882-2233, Eun Seok Kim https://orcid.org/0000-0002-9342-3082, Byung Ryul Lee https://orcid.org/0000-0002-3782-7445, Gi Young Yang https://orcid.org/0000-0002-9468-8904

as blisters [3]. Therefore, it is important to set out a standard pressure range for use in cupping therapy.

To identify the potential pressure range exerted in cupping therapy for clinical applications, this study calculated the pressure elicited during the cotton ball-based fire cupping on a human skin model.

Materials and Methods

Materials

In this study, the pressure which was elicited by glass and bamboo cups of 3 differences sizes was measured: glass small (GS; No. 3, Anjinmed, China), glass medium (GM; No. 4, Anjinmed, China) glass large (GL; No. 5, Anjinmed, China) bamboo small (BS; China), bamboo medium (BM; China), and bamboo large (BL; China; Fig. 1). The specifications of the 6 cups are shown in Table 1. The volume and external diameter of the cups are represented as average values calculated from 5 measurements. Ethanol (95%) was used to measure the glass volume and a digital caliper (DC150-2, CAS, Korea) was used to measure the external diameter. The resolution of the digital caliper was 0.01 mm.

Equipment

To measure the pressure inside the cup, a skin model with characteristics similar to that of human skin was used [7]. The skin model was made by supplementing the shortcomings of the existing 3-mm thick silicon plate model [7]. The skin model [7], used in previous studies, is structurally different from human skin, which consists of an epidermis and the dermis, which results in a stability problem during testing procedures. To compensate these shortcomings, a modified skin model was developed. The skin model used in this study was made of 2 layers of a silicon plate and a 20 mm thick nitrile-butadiene rubber plate to create a structure similar to that of real skin; compared with the existing skin model, the present model could alleviate the impact of attaching the cupping cup. In addition, 10 mm thick acrylic plates were fixed with screws at the top and bottom, to ensure the stability of the skin model during the measurement process.

Two methods of measuring pressure were considered: (1) connecting a manometer to the skin model; and (2) connecting a manometer to the cup itself. Connecting the manometer to the skin model itself was advantageous in measuring pressure from various types of cupping cups. Since some materials are difficult to drill and seal, the method of connecting a manometer directly to the skin model was adopted, which is similar to previously used methods [7,8]. A hole was drilled into the combined skin model and connected to a digital manometer (Tpi665, SUMMIT, Korea) using a cylinder (external diameter, 7 mm) and a silicone tube (internal diameter, 5.84 mm; external diameter, 9.98 mm; Fig. 2). To reduce the uncertainty of the measurement process, the pressure measurement in this study was performed using a digital manometer that was calibrated by an accredited calibration institution to ensure accuracy and the pressure was measured using 3 separate manometers. An adhesive (SUPER

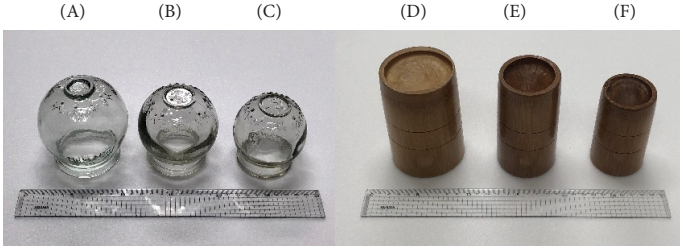

Fig. 1. Types of cupping cups. (A) Glass large; (B) glass medium; (C) glass small (D) bamboo large; (E) bamboo medium; (F) bamboo small.

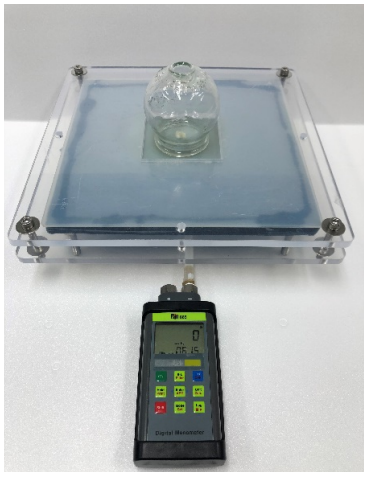

Fig. 2. Skin model with digital manometer and glass cup large.

Table 1. Characteristics of the Cupping Cups.

	GL	GM	GS	BL	BM	BS
Material	Glass	Glass	Glass	Bamboo	Bamboo	Bamboo
Size	Large	Medium	Small	Large	Medium	Small
Volume (mL) (mean ± SD)	393.0 ± 2.5	261.0 ± 1.6	197.6 ± 0.9	357.6 ± 1.1	243.6 ± 1.9	160.0 ± 1.0
External diameter (mm) (mean ± SD)	71.97 ± 0.41	65.52 ± 0.59	59.64 ± 0.22	77.67 ± 0.70	64.59 ± 0.33	57.19 ± 0.40

GL, glass large; GM, glass medium; GS, glass small; BL, bamboo large; BM, bamboo medium; BS, bamboo small.

XG, CEMEDINE, Japan) was used to maintain an airtight seal between the skin model, cylinder, and silicone tube. The pressure holding performance was adjusted to maintain at least 90% of the maximum pressure, for 10 minutes, according to Korean Industrial Standards P International Organization for Standardization.

Experimental procedure

Since temperature and humidity can affect the experimental results, special care was ensured to block direct sunlight and maintain a temperature of 25 ± 5°C and a humidity of 40 ± 10%.

The researcher performed the cupping therapy using the cotton ball method with 6 types of cups. The cotton ball method is a procedure in which the practitioner uses forceps to pick up an alcohol-soaked cotton ball, ignites it, burns it inside the cup, and then quickly puts the cup on the treatment site, which promotes natural adsorption by creating negative pressure (Fig. 3) [1]. After the procedure, the flaming cotton balls are put into a basket filled with water to be extinguished. The procedure was performed 15 times for each cup used (total, 90 times). Using a digital manometer, the pressure inside the cup was measured 10 seconds after the cup was attached onto the skin model. In all trials, 3 pieces of 5 cm gauzes (DHG-228B, Zhende Medical, China) were soaked in 95% ethanol.

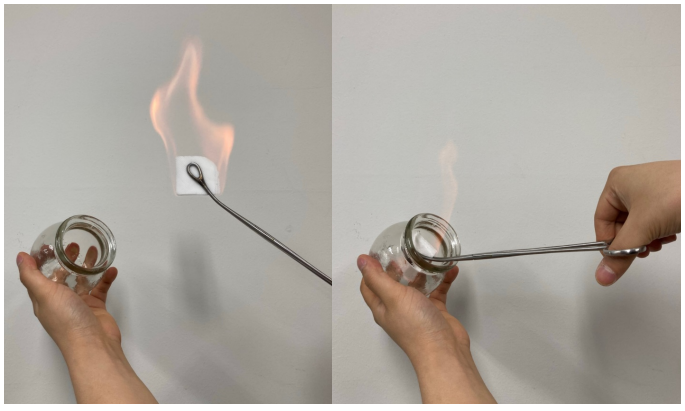

Fig. 3. Cotton ball method.

Statistical analysis

Descriptive statistics were used to quantify the pressure range. Student *t* test was used to compare the pressure levels according to the cup used. Analysis of variance was used to compare the differences in pressure level according to the cup size, and Bonferroni post-hoc analysis was used to determine between-group differences. All values are expressed as mean ± standard deviation, and statistical significance level was set at $p < 0.05$. All data were analyzed using the SPSS statistical software Version 18.0 (IBM, Armonk, NY).

Results

Total pressure level

The researcher measured the pressure generated by the cotton ball method 90 times with 6 cupping cups (15 times for each cup). All the data are summarized and compared according to the type of cup material and size of the cup used. The minimum value of pressure exerted was -305.4 mmHg; 1st quartile (Q1), -335.175 mmHg; median, 355.7 mmHg; 3rd quartile (Q3), -373.025 mmHg; and the maximum value, -401.3 mmHg. The minimum pressure was exerted by the BS cup, whereas the maximum value was exerted by the GL cup. Using the measured data, the average pressure inside the cup using the cotton ball method was estimated using the 95% confidence interval (CI) and was determined to be within -348.715 mmHg to -358.694 mmHg.

Pressure level exerted inside each cup

The researcher measured the pressure exerted by each cup 15 times (Table 2, Fig. 4). The average pressure and maximum pressure were determined: GL > GM > BL > GS > BM > BS.

Pressure level by cup material

The 6 cups used in the study were classified according to their size. GL and BL cups were classified as large, GM and BM as medium, and GS and BS as small. The results were analyzed by group. Glass cups exerted greater negative pressure than the bamboo cups across all sizes (GL > BL, GM > BM, GS > BS; $p < 0.001$).

Table 2. Pressure Levels Elicited by Each Cupping Cup.

		GL	GM	GS	BL	BM	BS
Mean ± SD	(mmHg)	386.96 ± 9.05	364.01 ± 14.70	353.38 ± 8.13	361.94 ± 8.64	330.27 ± 14.51	325.67 ± 12.47
SE		2.34	3.80	2.10	2.23	3.75	3.22
Min	(mmHg)	372.9	341.1	341.0	348.9	309.6	305.4
Q1	(mmHg)	378.9	350.9	345.3	357.6	320.4	313.1
Median	(mmHg)	387.7	360.3	354.1	359.9	328.8	325.8
Q3	(mmHg)	395.9	377.0	360.2	369.8	335.5	336.0
Max	(mmHg)	401.3	385.9	366.8	376.8	351.3	348.1

GL, glass large; GM, glass medium; GS, glass small; BL, bamboo large; BM, bamboo medium; BS, bamboo small.

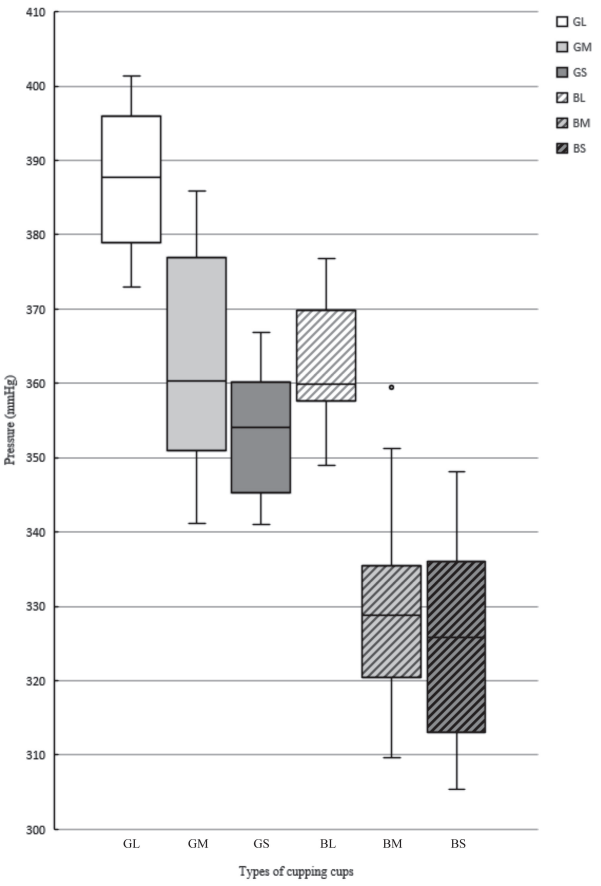

Fig. 4. Pressure levels elicited in each cupping cup.
GL, glass large; GM, glass medium; GS, glass small; BL, bamboo large; BM, bamboo medium; BS, bamboo small.

Pressure level by cup size

The 6 cups used in the study were classified according to the cup material. For the glass cups, the larger the size, the larger the average pressure which was exerted inside the cup (GL > GM > GS; $p < 0.05$). For the bamboo cups, the pressure exerted by the large cup was greater than both the medium and small cups (BL > BM, BL > BS; $p < 0.001$). However, there was no significant difference in the pressure exerted between the medium and small cups ($p > 0.05$).

Discussion

Given that there is no standardized procedure for the clinical application of cupping therapy, this study was conducted to assess the pressure elicited by materials traditionally used for this technique. The commonly used cotton ball method of fire cupping was employed, using cups made of glass or bamboo. The study may help towards establishing the appropriate range of pressure to be used for the clinical application of cupping therapy.

Using the fire cupping method with 6 types of cups, and following the measurement of pressure inside those cups 90 times, the minimum pressure was determined to be -305.4 mmHg, and the maximum value was -401.3 mmHg. Owing to the nature of cupping therapy, where the material and size of cups may differ, the amount of pressure delivered by cupping therapy will vary. In this study, the results showed that the larger the size of the glass cup, the greater the pressure exerted, which is in contrast to the suction cupping method, in which there is an absence of a relationship between cup volume and maximum pressure [9]. Compared with bamboo cups, glass cups exerted a greater negative pressure using the fire cupping method. The large glass cups, which are used the most in clinical practice for its ease of cleaning and sterilization, exerted the highest average pressure among 6 types of cups [-381.947 mmHg to -391.973 mmHg (95% CI)].

The side effects of cupping therapy arise because of the use of high pressure, whereas low pressure can lead to poor adhesion of cups; thus, when calculating the optimal pressure needed for cupping therapy, it is important to accurately gauge the maximum and minimum pressure, rather than the average value. Although there have been previous study on the dropout pressure of cupping [8], inconsistent results warrant the need for follow-up assessments.

Cupping therapy plays a role in discharging pathological products from the body, such as phlegm-retained fluid and blood stasis, using the partial pressure difference between the surface of the skin and the tissue beneath. Through this process, cupping improves the body's constitution and helps prevent conditions/diseases and promotes overall health. Additionally, in pathological conditions, the application of this procedure is not limited to external diseases; is also widely used for internal diseases, to enhance healing through the purification of non-physiological fluids for improvement of systemic circulation, and for enhancing metabolism [3,10,11]. Recently, a number of studies characterized the principles and the efficacy of cupping therapy [11,12]. Moreover, since 1987, the National Health Insurance of Korea has approved cupping therapy, and the cupping therapy has been used for various conditions/diseases as a medical procedure [3].

A survey in 2008 of Korean medical doctors reported that 90% of the medical doctors surveyed are performing cupping therapy; however, standardization of the procedure has not been established and there is no consensus on many details, such as the number of pumps needed during the suction cupping method, operating time, interval of application, and the disinfection method for the cups [3]. Importantly, there is no consistency in the pressures applied in the procedure, which could influence its efficacy [4,5]. A recent study investigated the dropout pressure based on bloodletting during the wet cupping procedure [8], however, because this is only one of the limited reports describing this detail, additional studies on the procedure pressure are warranted. Incorrect application of pressure can cause side effects during the procedure, especially strong pressure, which tends to generate blisters that can cause discomfort to the patient [13]. A survey in 2008 of Korean medical doctors reported that 38.3% of the surveyed doctors believed that blisters which occurred after cupping could be seen as an adverse side effect of an inappropriate level of pressure within the cups [3]. Additionally, western medicine practitioners and layperson patients, who lack knowledge in oriental medicine, view blistering as a result of mecical error as well [13].

The proficiency and propensity of the practitioner determines the levels of pressure within the cups. Therefore, it should be noted that the observations in this study may be dependent upon a practitioner's previous experience. In subsequent studies, it is necessary to consider selecting an appropriate operator who can produce consistent results.

This study has some limitations. Firstly, a skin model similar to human skin was used. Results from trials conducted on human skin may vary depending on the patient's age, sex, skin temperature, and skin condition. Therefore, to accurately measure the pressure applied to skin during the cupping procedure, it is necessary to

conduct a follow-up study using patients. Secondly, the study was performed using ready-made cups (which are widely available and used in clinical practice) because there is no regulation on the size of cups to use for cupping. If a standard size of the cupping cup is defined in the future, a follow-up study is needed to calculate the pressure exerted by that particular cup size. Thirdly, trials using cups of various materials and additional sizes should be performed to observe the exact relationship between volume and pressure. Finally, practitioners using fire cupping aim to produce the maximum pressure inside the cups therefore, the combustion time of a cotton ball inside the cups should be determined because it may not be consistent. For a clear relationship between volume and pressure, the combustion time needs to be a constant variable.

Conclusion

It is necessary to establish standard procedures and pressure parameters for the clinical application of the fire cupping method. The results in this study indicated that after multiple samplings, the pressure ranged from -305.4 mmHg to -401.3 mmHg. These findings clearly indicate the need for discussion on the appropriate procedure to produce the appropriate level of pressure inside the cups. A greater level of pressure was elicited by the glass cups compared with the bamboo cups, and the larger the size of the glass cup used, the greater the average level of pressure exerted. In future studies, it is important to consider that operator selection is important because measured values vary greatly depending on the practitioner's skill level or ability.

Conflicts of Interest

Gi Young Yang has been the editor of Journal of Acupuncture Research since 2017, but had no role in the decision to publish this original article. No other potential conflict of interest relevant to this article was reported.

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References

[1] Textbook Compilation Committee of Korean Acupuncture and Moxibustion Medicine Society. Acupuncture Medicine. Seoul (Korea): Hanmi Medical Publishing Co.; 2020. 119 p.
[2] Im JD, Lee CW. A Study on the Brief History and Treatment Technique of Cupping Methods. J Haehwa Med 1993;2:297-318. [in Korean].
[3] 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].
[4] Kim KW, Lee TW, Lee HL, An SK, Park HS, Choi JW et al. Pressure Levels in Cupping Therapy: A Systemic Review. J Acupunct Res 2020;37:28-34.
[5] Kwon OS, Lee SH, Choi SM, Ryu YH. A Study of Research Patterns for Standardization of Cupping Therapy. Korean J Acupunct 2012;29:250-259. [in Korean].
[6] Yi SH, Kim EJ, Shin KH, Nam DW, Kang JW, Lee SD et al. Study of Mechanical Characteristics of Electric Cupping Apparatus in Korea for Suggestion of its Assessment Guideline. J Korean Acupunct Moxib Soc 2010;27:1-10. [in Korean].
[7] Yi SH, Kim EJ, Shin KH, Nam DW, Kang JW, Lee SD et al. Study on Developing Assessment Guideline for Safety and Performance of Electric Cupping Apparatus. J Korean Acupunct Moxib Soc 2009;26:101-110. [in Korean].
[8] Kim DH, Bae EK, Park JH, Kim SY, Lee SH. Change in Risk of Dropout Due to Bleeding during Bloodletting-Cupping Therapy. Korean J Acupunct 2018;35:41-45. [in Korean].
[9] Kim YJ, Kim DH, Yeom SC, Lim BC, Choi YS, Lee GH et al. Experimental Study on the Pressure Characteristics in the Cupping Therapy. J Korean Acupunct Moxib Soc 2008;25:121-130. [in Korean].
[10] Park HJ, Hwang KS, Park HA, Lee CH, Park HH, Song SC et al. Clinical Effect of Cupping Therapy on Cerebral Infarction Patients with Hyperlipidemia. J Korean Acupunct Moxib Soc 2008;25:41-49. [in Korean].
[11] Chirali IZ. Traditional Chinese medicine Cupping Therapy, 3rd ed. London (UK): Elsevier; 2014. p. 47-64.
[12] Kim SC, Kim E, Jung GH, Lee SH, Kim JG. The Hemodynamic Changes During Cupping Therapy Monitored by Using an Optical Sensor Embedded Cup. J Biophotonics 2019;12:e201800286.
[13] Yun HY, Kwon SO, Kim ST, Park HJ, Hahm DH, Lee HJ. The Study of Blister Caused by Cupping Therapy. Korean J Acupunct 2011;28:141-150. [in Korean].