Translated Articles from JJSAM

Core temperature of a burning moxa ball and temperature when dropped from a moxa needle

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Abstract

[Objective] The aim of this study was to prevent accidental burns caused by touching a heated needle shaft or by a burning moxa ball falling from a moxa needle. Therefore, we measured the central temperature (Tc) of a burning moxa ball and the temperature at the landing point (Td) of a falling moxa ball.

[Methods] Stainless steel acupuncture needles and unrefined moxa for moxa needles were used. The moxa balls weighed 0.15 g (diameter, 13 ± 1 mm), 0.30 g (diameter, 16 ± 1 mm), and 0.60 g (diameter, 24 ± 1 mm). To measure the Tc of a moxa ball, a K-type thermocouple temperature probe was inserted into the centre of the ball. The Td of a moxa ball was measured by placing the probe 2 mm directly below the moxa ball. At each point in time, the moxa ball was forced to drop after ignition. Each measurement was repeated 5 times. The data were expressed as mean ± standard deviation.

[Results] The maximum Tc of the 0.15, 0.30, and 0.60 g moxa balls was 569 ± 26°C at 72 ± 8 s after ignition, 606 ± 26°C at 109 ± 4 s, and 624 ± 48°C at 167 ± 14 s, respectively. Tc of each ball decreased to less than 45°C at 180 ± 8 s, 225 ± 4 s, and 345 ± 13 s after ignition, respectively. When a 0.15 g moxa ball was dropped 30 s after ignition, Td measured 1, 5, and 10 s after the drop was 60 ± 6°C, 97 ± 7°C, and 137 ± 31°C, respectively. Td was less than 45 degrees 120 seconds after ignition. When a 0.30 g moxa ball was dropped 120 s after ignition, Td measured 1, 5, and 10 s after the drop was 66 ± 7°C, 96 ± 6°C, and 129 ± 2°C, respectively. Td was less than 40 degrees 120 seconds after ignition. Td was less than 45 degrees 180 seconds after ignition. When a 0.60 g moxa ball was dropped 180 s after ignition, Td measured 1, 5, and 10 s after the drop was 69 ± 3°C, 96 ± 14°C, and 135 ± 20°C, respectively. Td was less than 45 degrees 270 seconds after ignition.

[Conclusion] For 0.15, 0.30, and 0.60 g moxa balls, if Tc, that is the temperature of the probe, is considered to be the temperature of the needle shaft, burns may be caused by touching the heated shaft up until about 180, 240, and 360 s after ignition, respectively. Furthermore, there is a risk of burns caused by dropping a burning 0.15, 0.30, or 0.60 g moxa ball before 120, 180, or 270 s after ignition, respectively.

Key words: *moxa needle, safety, moxa ball dropping, heat injury, temperature*

I. Introduction

Needle moxa or moxa on acupuncture needles, which is a practice of invasive mechanical stimulation combined with noninvasive thermal stimulation, involves putting a moxa ball onto the upper end of an acupuncture needle that is inserted into the flesh and burning the moxa. It is said that this technique was first introduced in the side reader of *"Shinkyu Ryoho Taisei* (The Great Compendium of Moxibustion Practice)" by Sasakawa Tomooki in 1935. It is used for omalgia, lower back pain, and sensitivity to cold in extremities and aims to mitigate muscle pain and improve muscle tone[1].

We administered a questionnaire survey on adverse events in clinical acupuncture and moxibustion, and reported that burns which were not intended by the practitioner were caused by falling moxa, excessive stimulation, or unexpected drop of a moxa ball during needle

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moxa treatment[2]. Among these causes, burns due to dropping of a moxa ball were most severe, and since these left marks from moxibustion remains, it is an error that requires special attention.

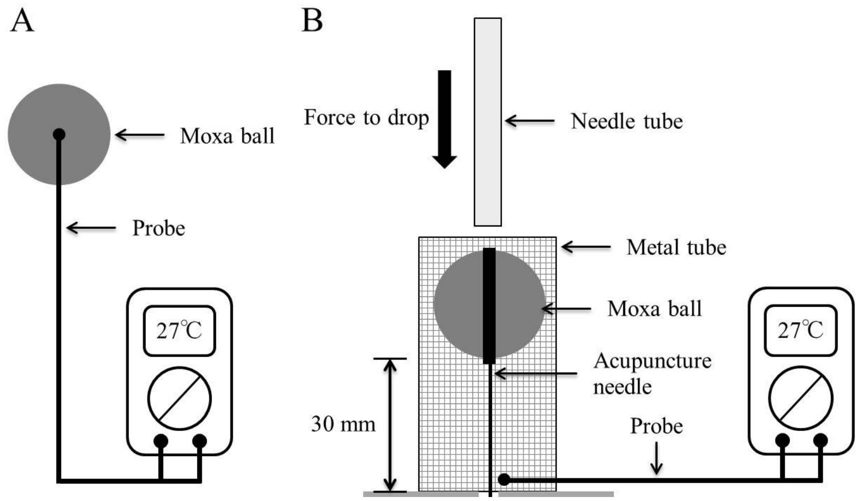
Other causes of burns due to needle moxa are excessive radiated heat, touching a hot needle shaft or a burning moxa ball, etc. Primary factors for the former two causes are the size (dimensions and weight) and hardness of the moxa ball. Quality of moxa is closely related to these factors. For burns due to excessive radiated heat, important factors are the distance between the burning moxa ball and skin surface, burn time, size of needle (length and diameter), deflection, and distance between needles when the moxa ball on two or more needles are burning at the same time. Furthermore, in any burn, the temperature change over time of a burning moxa ball and needle shaft is also an important factor.

In order to prevent burns due to dropping a burning moxa ball, it is effective to 1) affix the moxa ball sufficiently and shake the skin at the stimulation site to check that the moxa ball does not drop off[1], 2) stay by the patient after igniting the moxa ball[1], 3) prevent body motion of the patient[3], 4) do not touch the body of the patient[3], 5) put tar[4] or ointment on the needle shaft[5], 6) use a cap for needle moxa[4], and 7) whenever a moxa ball drops, immediately remove it, etc. In order to prevent burns due to burning moxa, it is effective to 1) preserve a distance of 2 cm to 2.5 cm or more between the bottom of the moxa ball and the skin surface[3], and 2) shade the heat, if it is strong, by using wet cotton[3] or wet cardboard[4], etc. In order to prevent burns that occur when the practitioner touches the needle shaft, it is effective to 1) hold the needle or both the needle and moxa ball with wet cotton when pulling out the needle[3,6] or 2) use a pair of tweezers when pulling out needles[1,4].

However, there are no studies that report on the validity of these preventive measures. Also there are few studies on basic data for needle moxa, especially on temperature characteristics. Most of the studies are on skin temperature[7-9]. It is expected that clarification of temperature characteristics, as in the case of moxibustion with moxa cones and warm tube moxibustion, will not only offer basic data to judge the validity of the above-mentioned preventive measures, but will also help beginners to understand the risks of needle moxa and raise awareness of safety, and eventually lead to the prevention of medical error, namely, burns[10-13].

Accordingly, in this study, we measured the core temperature (Tc) of burning moxa balls with different weights and the temperature at the landing point (Td) of moxa balls dropped at various times, and determined the critical time zones for preventing burns due to a drop of a moxa ball. Similarly, we used a thermograph temperature probe, which is inserted into a moxa ball and regarded as a needle shaft, to examine the critical time zones for burns due to grasping a moxa ball when pulling out the needle.

Fig.1 Measurement of the core and at the landing point temperature of moxa balls



To measure a core temperature of moxa ball, a thermograph temperature probe was inserted to a center of moxa ball (A). To measure the temperature at the landing point, the thermograph temperature probe was placed 2 mm away from the insertion point (B). The distance between the temperature probe and the bottom of the moxa ball was set at 3 cm. After igniting, we enveloped the moxa ball and needle with a metal tube. Then the moxa ball was forced to drop using the tube at the given time after igniting. Each moxa ball was ignited at its bottom by using an incense stick. The room temperature was maintained in the range of 25 to 30°C during the measurements.

II. Methods

1. Conditions for needle moxa

Stainless steel acupuncture needles (50 mm in length, 0.2 mm in diameter; M-Type; Seirin, Shizuoka, Japan) and medium-class moxa for needle moxa (*Wakakusa;* Shiga, Japan) were used. Although it is said that the size of moxa used is in general 18 mm in diameter and about 0.5 g in weight in most clinical settings, it is expected that practitioners adjust the size according to the conditions of the patient. Thus we conducted a preliminary survey of the 11 teachers at our university. They used moxa balls weighing 0.25-0.63 g (0.43 ± 0.12 g; mean ± SD) and 19.0-25.4 mm (23.3 ± 2.2 mm; mean ± SD) in diameter. From the result of our preliminary survey, we prepared three sizes of moxa balls, 0.15 g (13 ± 1 mm diameter), 0.30 g (16 ± 1 mm diameter), and 0.60 g (24 ± 1 mm diameter).

2. Thermometry

We used a digital multi-meter (MAS 838; Akizuki Denshi Tsusho, Saitama, Japan) and a temperature sensing probe (Type K thermocouple, chromel-alumel; Akizuki Denshi Tsusho, Saitama, Japan) to measure Tc of a burning moxa ball and Td of a dropped moxa ball. A thermograph temperature probe (hereinafter referred to as "temperature probe") was inserted to the center of the moxa ball to measure Tc of the moxa ball (Fig. 1-A).

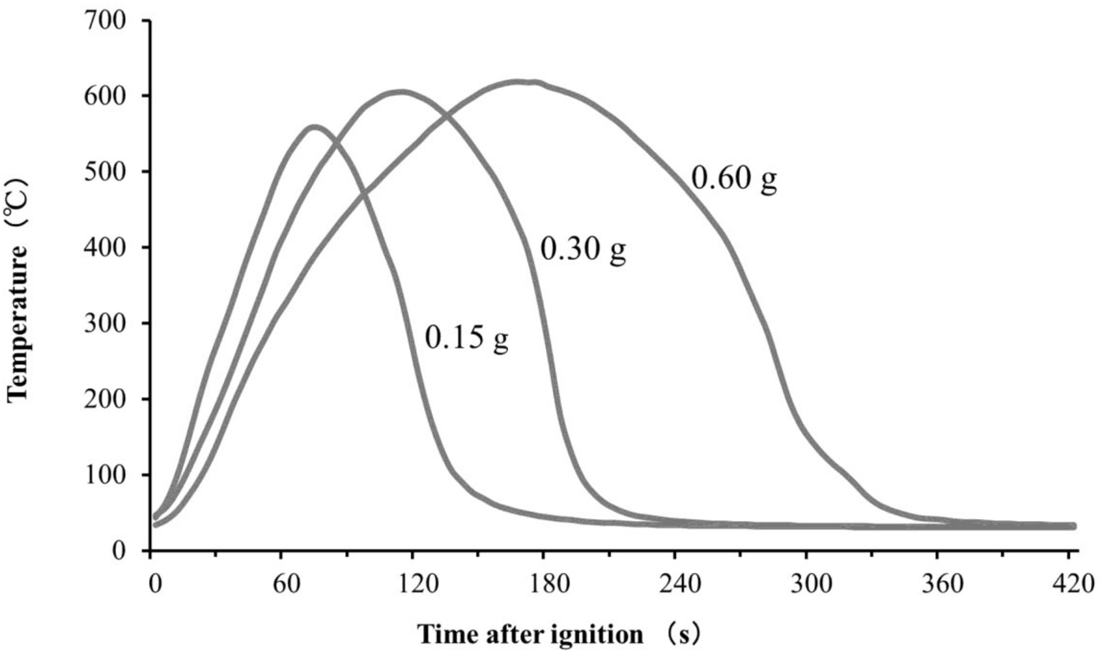
In order not to be influenced by the temperature of the acupuncture needle body (heated by the moxa ball burning), we placed the temperature probe 2 mm away from the insertion point when we dropped the burning moxa ball at the specific time to measure Td of the dropped moxa ball (Fig. 1-B). The distance between the temperature probe and the bottom of the moxa ball was set at 3 cm. After igniting, we enveloped the moxa ball and needle with a metal tube, and forced the moxa ball to drop at the given time using the tube. The moxa ball was forced to drop 30 s after igniting, when the burning part of the moxa connected to the temperature probe seemed to indicate the highest temperature. Also, by referring to the measured temperature at the center of the moxa (highest temperature), 0.15 g moxa balls were dropped at 60, 90, and 120 s after igniting, 0.30 g moxa balls at 120, 150, and 180 s after igniting, and 0.60 g moxa balls at 180, 210, 240 and 270 s after igniting.

Moreover Tc of each moxa ball and Td of each dropped moxa ball were measured 5 times. Each moxa ball was ignited at its bottom by using an incense stick. The room temperature was maintained in the range of 25 to 30°C during the measurements.

3. Statistical analysis

Statistical analysis software (Prism 5 for Windows Japanese Version 5.01, MDF) was used to analyze the data of Tc of the moxa balls versus time (one-way ANOVA). After that, if there was significant deviation, we used Tukey's multiple comparison test. The signifi-

Fig.2 The changes in the core temperature of moxa balls



The figure shows the changes in a core temperature of moxa balls (0.15 g, 0.30 g, and 0.60 g). The highest core temperature and a time to reach the highest temperature and to less than 45°C depended on its weight.

cance level was 5%. Data is expressed as mean ± SD.

III. Results

1. Tc of a moxa ball

Fig. 2 shows the changes in Tc of the moxa balls. As shown in Table 1, the times (elapsed time) when the burning moxa balls stopped smoking were 66 ± 4 s, 92 ± 4 s, and 144 ± 10 s for moxa balls weighing 0.15 g, 0.30 g, and 0.60 g, respectively. There was a tendency of increasing Tc when they stopped smoking for increasing weight of the moxa balls, but there was no significant statistical difference in Tc between moxa balls (P = 0.05; one-way ANOVA). On the other hand, the times when the burning moxa balls stopped smoking significantly depended on the weight of the moxa ball (0.15 g moxa ball vs. 0.30 g moxa ball, 0.15 g moxa ball vs. 0.60 g moxa ball, and 0.30 g moxa ball vs. 0.60 g moxa ball; P < 0.001 for each pair; Tukey's multiple comparison test). The times when Tc reached its highest for 0.15

Table 1. The core temperature of moxa balls

Size of moxa ball	Stopped smoking	Highest temperature	Less than 45℃
0.15 g	542 ± 32 ℃ 66 ± 4 s	569 ± 26 ℃ 72 ± 8 s	— 180 ± 8 s
0.30 g	575 ± 24 ℃ 92 ± 4 s ***	606 ± 26 ℃ 109 ± 4 s ***	— 225 ± 4 s ***
0.60 g	594 ± 33 ℃ 144 ± 10 s *** †††	624 ± 48 ℃ 167 ± 14 s *** †††	— 345 ± 13 s *** †††

The table shows a time after ignition to stopped smoking, leached highest temperature, and less than 45°C, and these core temperatures, respectively. There was no significant statistical difference in core temperature when burning moxa balls stopped smoking and leached highest temperature (P = 0.05, P = 0.08). The times of stopped smoking, leached highest temperature, and less than 45° C depended on the weight of the moxa balls (each P < 0.001). ***P < 0.001; vs. 0.15 g moxa ball, †††P<0.001; vs. 0.30 g moxa ball. Data is expressed as mean ± SD.

Table 2. The temperature at the landing point of moxa balls -30 s after igniting-

Size of moxa ball	After igniting	The temperature at the landing point after being dropped		
		At 1 s	At 5 s	At 10 s
0.15 g	30 s	60 ± 6 ℃	97 ± 7 ℃	137 ± 11 ℃
0.30 g	30 s	66 ± 7 ℃	96 ± 6 ℃	129 ± 2 ℃
0.60 g	30 s	64 ± 5 ℃	97 ± 6 ℃	124 ± 10 ℃

The table shows temperature at a landing point of moxa balls (0.15 g, 0.30 g, and 0.60 g) at 30 s after igniting. All of the temperature at the landing point was over 45°C at 1 s after being dropped. On the other hand, in the temperature at the landing point at 1 s, 5 s, and 10 s after being dropped, there were no significant differences between moxa ball weights (P = 0.28, P = 0.96, P = 0.10). Data is expressed as mean ± SD.

Table 3.The temperature at the landing point of moxa balls -less than 45 °C-

Size of moxa ball	After igniting	The temperature at the landing point after being dropped		
		At 1 s	At 5 s	At 10 s
0.15 g	60 s	61 ± 12 ℃ ‡	105 ± 14 ℃ ‡	155 ± 21 ℃ ‡
	90 s	48 ± 3 ℃ ‡	49 ± 6 ℃ ‡	64 ± 12 ℃ ‡
	120 s	41 ± 1 ℃	41 ± 1 ℃	41 ± 1 ℃
0.30 g	120 s	58 ± 4 ℃ ‡	80 ± 16 ℃ ‡	119 ± 18 ℃ ‡
	150 s	45 ± 3 ℃ ‡	57 ± 23 ℃ ‡	68 ± 31 ℃ ‡
	180 s	38 ± 1 ℃	38 ± 1 ℃	38 ± 1 ℃
0.60 g	180 s	80 ± 8 ℃ ‡	96 ± 16 ℃ ‡	135 ± 22 ℃ ‡
	210 s	59 ± 6 ℃ ‡	70 ± 10 ℃ ‡	94 ± 21 ℃ ‡
	240 s	42 ± 2 ℃	63 ± 10 ℃ ‡	77 ± 23 ℃ ‡
	270 s	42 ± 1 ℃	43 ± 1 ℃	43 ± 1 ℃

The table shows temperature at the landing point of moxa balls at the given time. By referring to measure the core temperature of the moxa ball (highest temperature), 0.15 g moxa balls were dropped at 60, 90, and 120 s after igniting, 0.30 g moxa balls at 120, 150, and 180 s after igniting, and 0.60 g moxa balls at 180, 210, 240 and 270 s after igniting. In 0.15 g, 0.30 g, and 0.60 g moxa balls, It takes 120, 180, and 270 s after igniting until the temperature at the landing point is less than 45°C, respectively. ‡mean≧ 45° C. Data is expressed as mean ± SD.

g, 0.30 g, and 0.60 g moxa balls were 72 ± 8 s, 109 ± 4 s, and 167 ± 14 s, and Tc of them were 569 ± 26°C, 606 ± 26°C, and 624 ± 48°C, respectively. There was a tendency for the highest Tc of a burning moxa ball to increase depending on its weight, but statistically it did not indicate a significant difference (P = 0.08; one-way ANOVA). On the other hand, the time to reach the highest temperature depended significantly on the weight of the moxa ball (0.15 g moxa ball vs. 0.30 g moxa ball, 0.15 g moxa ball vs. 0.60 g moxa ball, and 0.30 g moxa ball vs. 0.60 g moxa ball; P < 0.001 for each pair; Tukey's multiple comparison test). The times from when a moxa ball stopped smoking until Tc reached the highest temperature for 0.15 g, 0.30 g, and 0.60 g moxa balls was 6 ± 7 s, 17 ± 7 s, 23 ± 12 s, showing a temperature increase of 27 ± 18° C, 31 ± 8° C, and 31 ± 21° C, respectively (Not shown in the table). The time for Tc for 0.15 g, 0.30 g, and 0.60 g moxa balls to drop to less than 45° C was 180 ± 8 s, 225 ± 4 s, and 345 ± 13 s, respectively, and depended significantly on the weight of the moxa balls (0.15 g moxa ball vs. 0.30 g moxa ball, 0.15 g moxa ball vs. 0.60 g moxa ball, 0.30 g moxa ball vs.0.60 g moxa ball, P < 0.001; Tukey's multiple comparison test).

2. Td of a moxa ball

Table 2 shows Td of a moxa ball 30 s after igniting. For Td of moxa balls at 1 s, 5 s, and 10 s after being dropped, there were no significant differences between moxa ball weights (P = 0.28, P = 0.96, P = 0.10; one-way ANOVA).

As shown in Table 3, values of Td at 1 s, 5 s, and 10 s after being dropped for 0.15 g moxa balls that were dropped 60 s after igniting were 61 ± 12°C, 105 ± 14°C, and 155 ± 21°C, respectively. For the moxa balls that were dropped 90 s after igniting, values of Td were 48 ± 3℃, 49 ± 6℃, and 64 ± 12℃, respectively. 120 s or later after igniting, all the moxa balls were less than 45°C, and after being dropped there was no increase in temperature. 120 s after igniting, values of Td for 0.30 g moxa balls at 1 s, 5 s, and 10 s after being dropped were 58 ± 4°C, 80 ± 16°C, and 119 ± 18°C, respectively. For the moxa balls when being dropped at the time 150 s after igniting, values of Td were 45 ± 3°C, 57 ± 23°C, 68 ± 31°C. At 180 s after igniting or later, all the moxa balls were less than 45°C, and after being dropped there was no increase in temperature. Values of Td for 0.60 g moxa balls at the time when 1 s, 5 s, and 10 s after being dropped were, when being dropped at the time 180 s after igniting, 80 ± 8°C, 96 ± 16°C, and 135 ± 22°C, respectively. For the moxa balls when being dropped at the time 210 s after ignition, values of Td were 59 ± 6°C , 70 ± 10°C, and 94 ± 21°C , and at the time 240 s after ignition, values of Td were 44 ± 2°C , 63 ± 10°C, and 77 ± 23°C, respectively. Td of all the moxa balls at 270 s after igniting or later was less than 45°C.

IV. Discussion

In general, there are two methods to measure temperature; one is a contact method, that is, to make contact with a sample to be measured, and the other is a contactless method, that is, not to make contact with a sample to be measured. The temperature probe used in this study is classified as a contact method. A thermocouple uses a Seebeck effect or thermoelectric phenomena that induces a voltage in any closed circuit made by connecting two dissimilar metal wires exposed to a difference in temperature[14)]. K type thermocouple uses alloys of chromel (nickel and chronium) and alumel (nickel). Advantages of K type thermocouple are 1) good linearity of thermo-electromotive force, 2) suitability for oxidative atmosphere, 3) resistance to metal vapor, 4) unreduced thermo-electromotive force after a long period of use (in contrast to other thermocouples), and 5) wide range of temperature measurement (-200°C-+1,250°C), etc. On the other hand, it is weak in reductive atmosphere such as sulfurous acid gas or hydrogen sulfide[14, 15)]. This study uses a needle shaft that is 1.4 mm thick and a measuring probe with a 1.6 mm thick tip. Although there might be some difference in heat transfer (heat dissipation), since it is low priced in addition to the above-mentioned advantages, and we could not find any other suitable method, we used a K type thermocouple measuring probe for this examination and regarded it as the needle shaft.

For the conditions of needle moxa, Tanaka reported that he used moxa balls 0.5 g in weight, 1.8 cm in diameter, and the distance from the moxa ball to the skin was 2.5 cm[1)]. Also he reported that the acupuncture needles were used 30 to 50 mm in length and from 0.20 to 0.22 mm in diameter depending on stimulation sites. On the other hand, Akabane used acupuncture needles 0.18 to 0.24 mm in diameter and moxa balls the size of a little finger tip[16)]. At present, many of the textbooks with descriptions of needle moxa adopt Tanaka's conditions for the moxa ball and needle. Therefore, we decided to follow the methods of Tanaka et al. for the conditions for needle moxa. However, since Akabane adopted a moxa ball the size of a little finger tip, and there are large differences between practitioners, we decided to set the weight of moxa balls to 0.15 g, 0.30 g, and 0.60 g to cover them all.

In this study, the burning time of the moxa balls was significantly different between moxa balls, and was longer relative to the weight of the moxa ball, similar to the results by Tanaka et al[7,8)]. Tc of a moxa ball continuously increased after burning moxa balls stopped smoking. All the moxa balls increased in temperature from when smoke disappeared to their highest temperature by 30-50°C. Results showed the tendency that maximum temperature increased depending on the weight of the moxa ball, but there was no significant difference between moxa balls.

Under the same conditions, it took 180 ± 8 s, 227 ± 2 s, and 345 ± 13 s after igniting until Tc for 0.15 g, 0.30 g, and 0.60 g moxa balls, respectively, decreased to less than 45°C. From these results, it is suggested that there is a possibility of occurrence of a burn by touching a needle shaft when pulling out the needle, until 180 s, 240 s. and 360 s after igniting the moxa ball. In order to prevent a burn, it is recommended to take the following measures: 1) hold the needle together with the moxa ball by wet cotton when pulling out the needle[3,6], or 2) use a pair of tweezers. The results of this study show that it may be necessary to use these measures to pull out a needle at least until the times listed above. In clinical settings, however, it is desirable to take these precautionary measures in any case (at any time) to protect against contingencies. We believe that the above times should at least be recognized as the basis for taking these precautionary measures.

In the moxa ball dropping experiment, when forcibly dropping a moxa ball 30 s after igniting, Td of all the moxa balls increased to 60°C or higher 1s after being dropped. These results suggest that skin temperature reached up to invasion temperature (45°C or higher) at which protein clotting, a burn, or a severe burn occurs. At first it was expected that Td of a moxa ball would be the highest at the time 30 s after igniting, and the larger the moxa ball, the higher the temperature. However there was not any significant difference between moxa balls until 10 s after being dropped. The results suggest that in the early stage after igniting, despite the size of the moxa ball, the burning time is constant, so that it could be thought that there was no significant difference in Td. On the other hand, the larger the moxa ball, the lower was Td; although, there was no significant difference 10 s after being dropped. We assumed that the temperature was suppressed because the un-burnt part crushed the burning part and interrupted its oxygen supply.

Next, we measured Td around the times when Tc of each moxa ball was the highest (0.15 g moxa ball; 60 s after igniting, 0.30 g moxa ball; 120 s after igniting, 0.60 g moxa ball; 180 s after igniting). Each moxa ball indicated about the same temperature as or slightly higher than those at 30 s. This might be caused by differences in burning volume of the moxa balls; all the values were considerably lower than the highest temperatures. When a moxa ball drops, the ash around a burnt-out moxa ball touches the measuring probe. This is why Td of a dropped moxa ball was lower than Tc of a burning moxa ball. In order to prevent burns due to dropping a burning moxa ball during needle moxa, it is effective to 1) affix the moxa ball sufficiently and shake the skin at the stimulation site to check that the moxa ball will not drop off[1], 2) stay by the patient after igniting the moxa ball[1], 3) prevent body motion of the patient[3], 4) do not touch the body of the patient after igniting the moxa ball, 5) put tar[4] or ointment on the needle shaft[5], 6) use a cap for needle moxa[4], 7) whenever a moxa ball drops, immediately remove it, etc.

From the results mentioned above, it is desirable to remove a dropped moxa ball rapidly without crushing the moxa ball. Furthermore, the time it takes Td of 0.15 g, 0.30 g, and 0.60 g moxa balls to indicate less than 45° C was 120 s, 180 s, and 270 s, respectively, after igniting. It may be necessary for practitioners to pay special attention to dropping moxa balls until those times.

In this study, we examined temporal changes in Tc and Td for given weights of moxa balls. These temperatures may be influenced by the quality (types) and hardness (density) of moxa, and our results do not necessarily fit all current needle moxa techniques. Besides, this study only evaluated the temperature of the measuring probe tip, and did not evaluate the burn areas. Even if Td of a moxa ball is the same as that of another moxa ball, the larger the moxa ball, the larger the burn area, which results in higher burn severity for larger moxa balls. It may be necessary to perform a similar examination, while changing measuring method and the conditions of the moxa.

About burns due to dropping a burning moxa ball, although there are some precautions and preventive measures (as mentioned above), accidents cannot be prevented completely. In order to improve the safety of needle moxa, it may be necessary to review existing preventive measures or develop new ones. Now we believe that the most effective way as a preventive measure is to bond a moxa ball to a needle shaft by putting tar or ointment on the needle shaft. Although this method has been reported, the details remain to be elucidated. Also, there is no report which evaluates this method. We intend to examine the effectiveness of this method. Similarly, in order to prevent burns caused by heat radiated from a moxa ball, it is also necessary to examine the distance between the moxa ball and the skin (including deflection of the needle), and especially the distance between needles for needle moxa treatments that use two or more needles at the same time.

V. Conclusion

We measured Tc of burning moxa balls and Td of dropped moxa balls, and determined critical time periods for preventing burns due to dropping a burning moxa ball.

1. In considering Tc of a burning moxa ball and taking the temperature of the measuring probe as the temperature of the needle shaft, it is inferred that there is a threat of burn by touching the heated needle shaft until about 180 s, 240 s, and 360 s after igniting for moxa balls of 0.15 g, 0.30 g, and 0.60 g, respectively.
2. Since it takes 120 s, 180 s, and 270 s after igniting for Td of 0.15 g, 0.30 g, and 0.60 g moxa balls, respectively, to cool to less than 45°C, it may be necessary for practitioners to exercise caution to prevent burns due to dropping burning moxa balls at least until those times.

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