Chinese Medicine Acupuncture

MODULE: FCMR633 Dissertation

Module Leader: Dr Marie Polley

Title of Assignment:

Dissertation

Differences in needle tip temperature between

moxa punk and smokeless moxa in warm needling; A comparative study

Author: Steve McCulloch 10075353

Supervisor: James Cattermole

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Abstract

This report is the write up of an experimental research project. Warm needling entails applying moxa to an acupuncture needle handle to direct heat into the body. Practitioners are using smokeless moxa instead of moxa punk due to adverse reactions to smoke.

Aims This study aims to compare the ability of moxa punk (MP) and smokeless moxa (SM) to transfer heat to the end of an acupuncture needle in warm needling (WN). It also aims to determine if heat transfer is affected by needle diameter and MP quantity.

Methods Two moxa forms of equivalent weight were compared: an Ondan SM cone and Japanese MP rolled into a ball (n=12 for each moxa type). Filiform needles 40mm x 0.3mm and 40 x 0.25 were used. Baseline energy potential (Hg) of each moxa type was determined using a Bomb Calorimeter. A pilot was used to optimise the experiment set-up. Needles were retained vertically in ambient air. Temperatures were measured at needle end. To further inform results, two additional moxa forms were tested; a 22g moxa ball and a 0.32g pre-formed moxa punk roll.

Key Findings SM produced 10% more energy than MP. However MP produced a 41% greater and more rapid rate of change in temperature at the needle end than SM cones (2.5℃ versus 1.7℃, p=0.00 and 120sec versus 270sec (±15) respectively). Conversely, SM maintained maximum temperature four times longer than MP. Needle diameter had no effect. Weights of MP and temperature had a positive correlation.

Conclusions MP and SM produce different temperature characteristics at the needle end. MP is less dense than SM; the predominant factor causing the difference. The WN temperature characteristic produced from MP correlates with Chinese Medicine dispersing techniques while those from SM correlate to tonification. A lack of studies addressing differing temperatures on WN efficacy and the unknown temperature characteristics of acupuncture needles in-vivo prevents further conclusions being drawn.

Recommendations Development of a set of guidelines, reflecting standards and best practice for WN, to allow comparison and collation of results from future research. Additional research (recommended in the report) to further inform the findings from this study. Encourage manufacturers to provide multiple sizes of SM cones.

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Abbreviations

MP	Moxa Punk
SM	Smokeless moxa
WN	Warm Needling

1 Introduction

Moxa is a material made from the shredded and dried leaves of the mugwort plant (Artemisia vulgaris) which is compacted and lit to apply heat to a patient within the therapeutic practice of Chinese Medicine. The use of moxa in Chinese Medicine is thought to have originated between 400BCE and 260BCE (Wilcox, 2008).

According to O’Connor and Bensky (1981) moxa has been commonly used in Chinese Medicine to apply heat in order to move *qi* and Blood, treat Cold diseases and warm y*ang*. Traditionally moxa was formed into a cone, placed directly on the skin and burnt (Figure 1). However, Wang (1984) claims that because this method caused pain and scarring, after the start of the Ming dynasty moxa techniques were developed to apply heat indirectly.

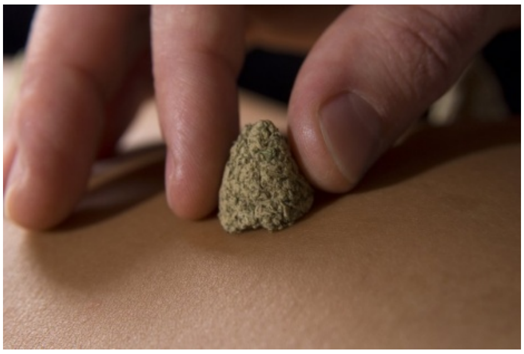

Figure 1: Moxa cone applied directly on the skin and burnt for the application of heat

British Acupuncture Council (2012a)

One such technique developed, and the focus of this paper, was called “lightning needle” (Wang, 1984, p.26) whereby moxa is applied to the handle of a needle and burned to direct heat into the body (Figure 2). In China this technique is known as *Wenjiu*, in Japan as the *Kyutoshin* technique and in modern English literature is commonly called Warm Needling (WN).

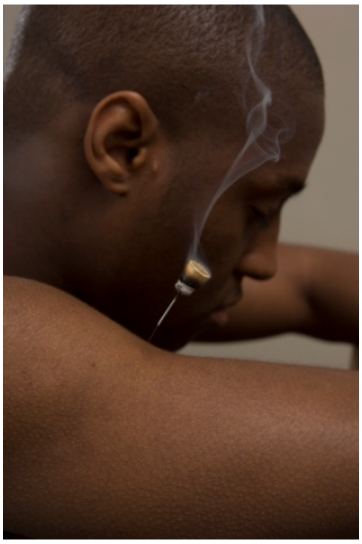

Figure 2: Indirect moxa application through an acupuncture needle

British Acupuncture Council (2012b)

Traditionally in WN, loose mugwort (commonly known as moxa punk (MP)) is rolled into a ball and attached to the handle of an inserted acupuncture needle (Birch & Ida, 1998). However, due to recorded adverse reactions to the smoke given off from burning MP (Park *et al.*, 2010), some practitioners now use a readily available pre-formed cone made out of a mix of charcoal and mugwort that inserts onto the needle handle and emits less smoke (Litscher *et al.*, 2009). Given that MP rolled into a ball is the traditional heat source used in WN and much of the current evidence on the efficacy of WN uses MP as the heat source (Liu, 2006; Kim *et al.*, 2009; Sun & Xu, 2010; Leeguo, 2011) the switch to smokeless moxa (SM) cones is being made with surprisingly little evidence to support a comparative therapeutic benefit.

A school of thought maintains that the therapeutic effect of burning MP is due to the dual aspects of heat and vapour & smoke which can penetrate to the meridians through the skin (Dharmananda, 2004). However, cardboard is often placed against the skin to protect the patient from excessive heat and bits of burning moxa that may fall off (Manaka *et al.*, 1995). The British Acupuncture Council (2010) ‘Guide to Safe Practice’ also states the skin must be shielded to protect the patient from falling ash. With the skin shielded from the burning moxa, any therapeutic effect is likely to be the result of heat transmitted through the needle into the body.

Birch and Ida (1998) concur that the therapeutic effect of WN comes from its ability to deliver a ‘deeper penetration of heat along the needle shaft into the body tissue’ (p.81) but give no further details on the depth of penetration required. The only indication offered is the recommendation that the needle should be inserted into the muscle where there are tight bundles. This implies that heat should travel below the subcutaneous layer to the muscle to have therapeutic effect. Kim *et al.* (2009) also concluded that the heat transferred below the skin in WN caused the therapeutic effect. The conclusion was reached by comparing the analgesic effect of WN, acupuncture and sham WN (moxa held in the same position but without needle inserted). Acupuncture and sham WN showed little analgesic effect when compared to the control group whereas WN showed significant effects. Considering that acupuncture and sham WN (that caused heating of the skin) had no effect, Kim *et al.* (2009) concluded it was the needle heat below the skin that was causing pain relief.

If the heat transmitted down the needle is central to the clinical effectiveness of WN then what provides the heat is of prime importantce. Therefore it is important to establish how SM and MP differ as heat sources. Two studies compared the heat characteristics of SM and MP (Shen *et al.*, 2006; Pach *et al.*, 2009). Both studies used moxa formed into sticks with the ends lit to provide indirect heat. Shen *et al* (2006) found that the MP stick gave off more heat than SM while Pach *et al.* (2009) found little difference between the two. Because of the disparity in results, no conclusions can be drawn.

Several studies published in English aimed to measure the heat transfer in WN (Kim *et al.*, 2009; Litscher *et al.*, 2009; Lim *et al.*, 2010). However all the studies measured the needle temperature at a point corresponding to skin level (were the needle inserted in flesh) and although MP or SM was used, they were not compared within one study. Moreover, varying needle thicknesses (0.25mm and 0.3mm), weights of moxa and inconsistent experimental protocols prevented a comparison between moxa types.

The needle is the main conductor of heat in WN and is therefore an important consideration within this study. Lim *et al.* (2010) found that various needle diameters affected heat transfer in WN and recommended further investigation into this area. However, the needles compared differed markedly: filiform compared to gold needles with 0.25mm and 0.53mm diameters respectively. The needles used in the WN studies mentioned previously were predominantly 0.25mm or 0.3mm which, although closer in diameter, might still show different heat transfer characteristics; further investigation is warranted.

In summary, transmission of heat below the skin, and hence temperature of the bottom portion of the needle, appears to be a significant factor in the therapeutic effect of WN. Transmission of heat down the needle is dependent on the heat source, which traditionally uses MP rolled into a ball, and possibly on needle diameter. Practitioners are using SM instead of MP to avoid adverse effects from the smoke. However available comparative studies between SM and MP are inconclusive and therefore the implications of changing to SM for WN are unknown.

This study is an investigation aimed at comparing the use of MP and SM in WN with particular focus on their respective abilities to transfer heat to the end of an acupuncture needle. A secondary aim is to determine if different needle diameters, commonly used in clinic, affect the heat transfer.

The objectives of this study are to:

- Set up a controlled and repeatable experiment to allow the temperature change of the needle to be measured dependent on either the heat source or needle thickness.

- Where possible follow protocols typically used in clinic in order to make the findings relevant to clinical practice.
- Use statistical analysis on findings to determine consistency and significance and report the results clearly and succinctly.
- Discuss and highlight key points from the experiment that inform or have implications on clinical practice.
- Draw conclusions and identify areas of follow on research from the outcomes of this study.

Ethical approval was not required for this study (Ethics and project sign-off appended in Appendix I).

The experiment was carried out in several stages:

- The first stage was to baseline the energy (calories/gram) of each sample of moxa used in the experiment. Energy is directly related to the potential heat each moxa type can give off when burnt and therefore the amount of heat available to transfer and raise the temperature of the needle. Establishing a baseline allows comparison between the potential of each moxa to transfer heat and the actual temperatures measured lower on the needle.
- The second stage consisted of running a pilot to find an experimental set-up that allowed accurate measurement of the temperature.
- The final stage consisted of running the experiment multiple times using the optimised set-up, with MP and SM as heat sources, to gather comparative temperature readings on the needle.

The following section describes the methods and materials used in each stage.

2 Method and Materials

The aim was to set up an experimental design to allow objective comparison of the ability of moxa punk (MP) and smokeless moxa (SM) to raise the temperature at the lower end of an acupuncture needle.

The objective of the experiment design was to control for as many variables as possible (confounding variables), therefore accurately measuring the dependent variable (temperature) due to the affect of the independent variables (type of moxa and needle thickness) (Creswell, 1994).

2.1 Experiment site

All experiments were carried out at the Westminster University Cavendish Campus laboratories between February 2012 and April 2012 over non-consecutive days. Laboratories are air-conditioned. Temperatures ranged between 18℃ and 24℃. To remove smoke, all WN experiment equipment was positioned within an extractor cabinet with a forced, regulated, measurable air flow rate varying between 50 to 60m/s.

2.2 Materials

The following equipment was used. Weights were measured using Precisa XT220A scales accurate to 4 decimal places. In WN experiments, temperatures were measured using an RT ceramic resistive temperature probe connected via a 1 metre lead to a Brighton Systems Ltd. Microlab-0 temperature metre (4 digit red LED display (± 0.1℃)). Calibration was checked with an infrared RS-1327K thermometer gun. All moxa samples and acupuncture needles were taken from a single batch to minimise variations.

Additional material details are given within each Stage discussed below. Justifications for material choice, if appropriate, are predominantly confined to Stage 2 – Pilot Study (optimising experiment design).

2.3 Stage 1 – Baseline calorific energy measurement

The calorific value was measured to establish a baseline of the potential heat each moxa type could provide. A standard Parr Instrument Company Oxygen Bomb calorimeter (Plain jacket Calorimeter 1341 + motor assembly A50MEE, Ignition unit 2901EX) was used (see Appendix II for standard operating procedure). Three samples each of Japanese MP and SM cones weighing 0.42g (± 0.01) were used. Testing was carried out consecutively. Each sample was placed in the jacket calorimeter which was sealed, pressurised to 30atm of oxygen and placed in 2 litres of distilled water. The water agitator was started and left for 5 minutes for water to reach equilibrium. The temperature of the water was then measured and recorded for the next 5 minutes at 1 minute intervals. The sample was ignited at the 6^{th} minute with water temperature readings taken every 30 seconds until no temperature increase was detected for 5 minutes. Temperature readings were read from a mercury thermometer (+/- 0.01℃).

2.4 Stage 2 – Pilot study: Optimising experiment design

The aim was to find an experimental setup that allowed accurate temperature measurement at the lower end of an acupuncture needle when different types of moxa were used as the heat source. A main objective was for the WN method to reflect clinical practice as much as possible. An analysis of WN guidelines from text books and previous studies gave no specific details (Appendix III). Japanese texts provided the greatest details therefore these were combined with information from past studies to form a basis and starting point for the pilot.

Other objectives were to create a device capable of retaining the needle and moxa within a safe environment and to enable consistent temperature measurement at the same point on the needle.

2.4.1 *Needle retaining device and temperature probe*

A container device was created from off-the-shelf material to retain the acupuncture needle vertically. The container was a small plastic bowl 800mm in diameter by 50mm deep with a silicone pad 10mm deep formed in the bottom from clear building sealant silicone (Figure 4). An RT ceramic resistive temperature probe (custom made by Brighton Systems Ltd.) was embedded horizontally within the silicone pad and connected to the Microlab-0 temperature metre (Brighton Systems Ltd.) via a 1 metre lead. The needle was inserted into the silicone pad until the tip contacted the temperature probe ensuring the temperature was consistently measured at the same point for each sample. As discussed in the Introduction, the end of the needle was chosen because: the ability to transmit heat below the skin is of interest in clinical practice; confirmation was required that heat is conducted the full length of the needle.

Once inserted, a cardboard shield (with a slit cut into it) was slid onto the top of the container (Figure 3) to:

- Add stability to the needle allowing it to take the weight of the moxa on the handle.
- Isolate the radiated moxa heat from the ceramic sensor thus ensuring only the effects of the heat transferred via the needle were measured.

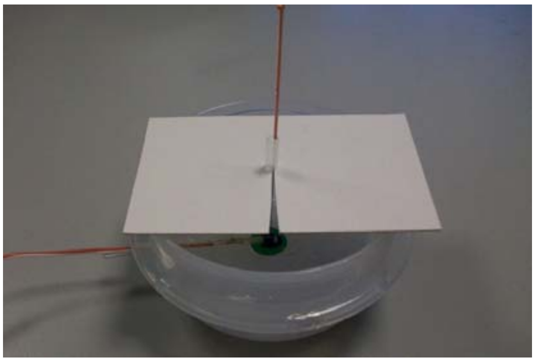

Figure 3: Cardboard shield on needle retaining device

Cardboard has a low thermal conductivity (0.21 $W.m^{-1}.K^{-1}$; The University of Sydney, 2001) comparable to that of asbestos making it an effective thermal insulator. Therefore it stabilised the needle without conducting heat.

The needle retaining device was inserted within a large glass container (400mm x 400mm x 600mm) during experimental runs to protect it from airflow as all equipment was located within a forced airflow extraction chamber to remove smoke.

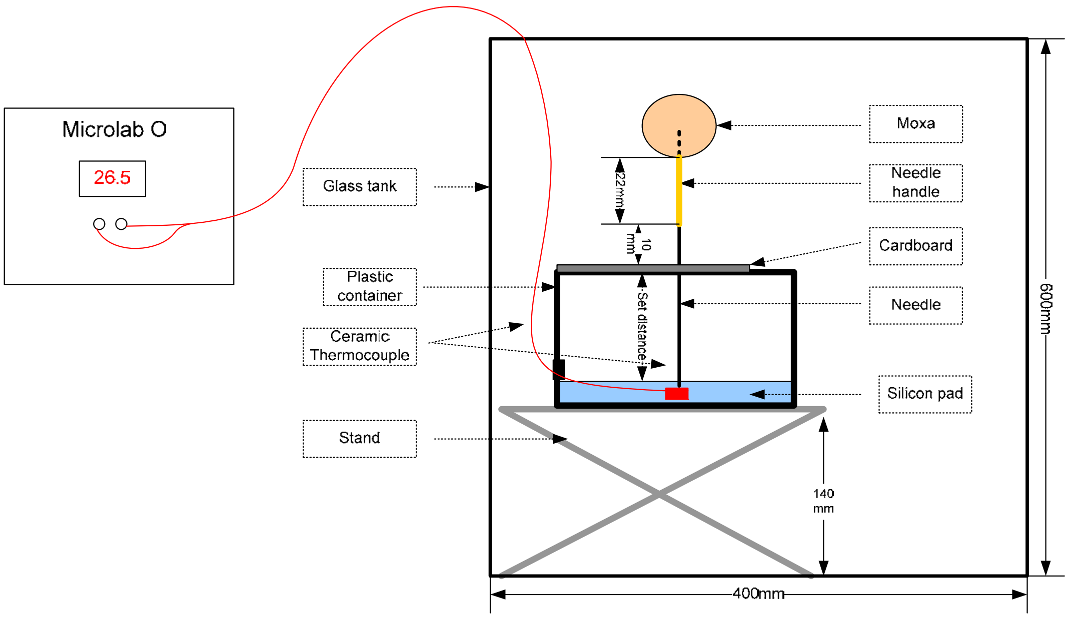

Figure 4: Equipment setup, WN and retaining device in experiment pilot study

The initial experiment used:

- Ondan Smokeless Needle-Warming pre-formed Moxa Cones, 10mm diameter at base, 11mm height and 8mm diameter at top, ~0.42g: supplied by Westminster University Polyclinic.
- Chinese moxa punk (formed as described below): supplied from Acumedic, UK.
- Stainless steel filiform needles, 40mm length x 0.3mm diameter: Supplied from Acumedic (see Appendix IV for manufacturing quality standards).

Ondan SM cones are used in the Westminster University Polyclinic and are the only smokeless cone used for WN commonly available in the UK. Chinese MP was recommended by Acumedic (a prominent London acupuncture equipment supplier) as a readily available, price competitive moxa for WN. The 40mm x 0.3mm needle correlates closely with previous WN experiments (Huang & Sheu, 2008; Litscher *et al.*, 2009; Lim *et al.*, 2010).

The SM cones are a fixed shape weighing approximately 0.42g with a preformed hole allowing insertion on a needle handle (Figure 5). Chinese MP comes in a loose form. A sample of 0.42g was taken and compacted into a ball for insertion on the needle handle. Equivalent weights were used in order to correlate with the baseline measured calorific values measured in Stage 1.

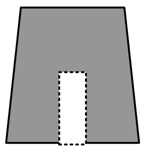

Figure 5: SM cone with pre-formed hole, cross section

During the experiment, the needle was inserted into the silicone until the tip touched the temperature probe. The cardboard was placed on the needle retaining container. The distance from the bottom of the needle handle to the cardboard was 10mm and cardboard to needle tip 30mm. The base of the SM cone was 22mm from the bottom of the needle handle when inserted which was used as a reference distance for placement of the Chinese MP ball. Moxa samples were lit from the bottom using a long match. Temperature readings were recoreded at the start and when maximum temperature was reached.

2.4.2 Trial runs

Three trial runs were carried out during which modifications were made to the equipment set-up, materials and protocol to ensure a final experimental design that allowed repeatability and accurate measurement of the temperature change at the end of the needle dependent on the moxa type. Each trial used three samples each of MP and SM. The following changes were made as a result of issues observed during the trials:

- Japanese MX-86 Wakakusa Ibuki MP (supplied from Oxford Medical, UK) was used in place of Chinese MP. The 0.42g of Chinese MP was difficult to compact into a ball, burned inconsistently and burning particles fell off setting the cardboard alight. Japanese MP (medium grade) is recommended for use in WN by Birch and Ida (1998) and is easily formed; 0.42g was compacted into a 20mm ball as per their instructions. A hole was made in the ball, using a sharp stick, for insertion on the needle handle.
- A match could not light SM or MP consistently. A gas lighter was used instead which allowed consistent light times. Ignition times of 6sec for SM cones and 2sec for MP were determined to be optimal.
- After the needle restraining device was placed inside the glass tank and the moxa lit, a partial lid was placed on the tank. Partial placement allowed smoke and heat to escape whilst sheltering the burning moxa

from the extraction chamber forced air flow. Until the lid was placed, turbulent air was affecting the moxa burn rate which in turn can affect the maximum temperature (Seung, 2009).

- The ceramic pad of the temperature probe was re-positioned above the silicone pad with the detecting face vertical (Figure 6). Prior to this, maximum temperature change recorded was 1℃ (refer to results in 3.2) which meant the Microlab-0 metre error of +/- 0.1℃ was significant. Re-positioning the pad raised the temperature change to between 1.7℃ - 2.5℃ thus reducing the error weighting. A consistent position was ensured by inserting the needle into the silicone, adjacent to the probe, until the bottom of the needle handle was 10mm distance from the cardboard. The lead to the probe created horizontal tension thus ensuring it pressed firmly against the needle.

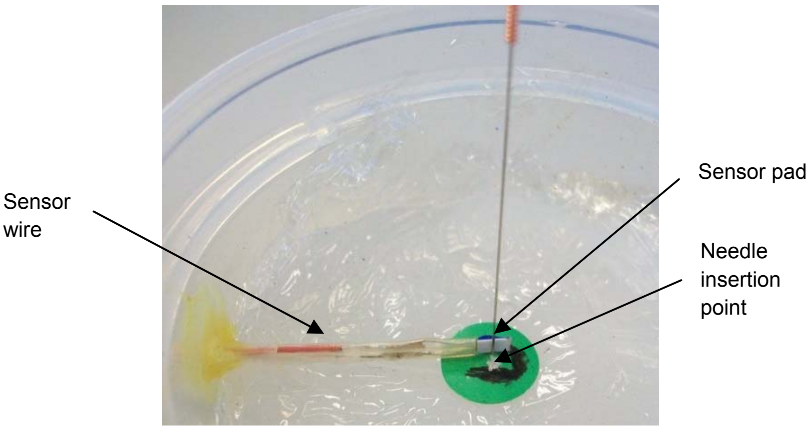

Figure 6: Temperature sensor position in relation to needle

2.5 Stage 3 - Warm Needle temperature experiment

Full details of the experiment set-up, methods and materials are as per the description given in 2.4.1 with the added modifications described in 2.4.2.

In brief, and in reference to Figure 8, Figure 9, and Figure 10 showing the experiment set-up:

- Stainless steel 40mm long filiform needles from Acumedic, UK were used. Two diameters (consistent with those used in previous WN experiments) were chosen; 0.3mm and 0.25mm.
- SM cones (Ondan needle-warming) and Japanese MP (Wakakusa Ibuki medium grade punk) were used for comparison.
- The SM cone is preformed with weights varying around 0.42g; small shavings were taken off the bottom to obtain the required weight. Loose MP was weighed at 0.42g (± 0.01) and then rolled to form a ball of 20mm (± 2) in diameter (Figure 7).

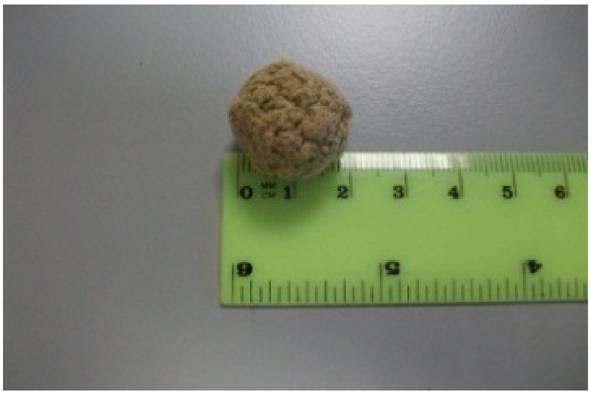

Figure 7: Rolled Japanese moxa punk

- The moxa samples were inserted on the needle handle, to a set distance 22mm from the moxa base to the bottom of the needle handle.
- Temperatures were measured at the end of the needle; the needle was inserted into the silicone until there was 10mm distance from the cardboard shield to the bottom of the needle handle to ensure the temperature probe consistently contacted the same point on the needle.

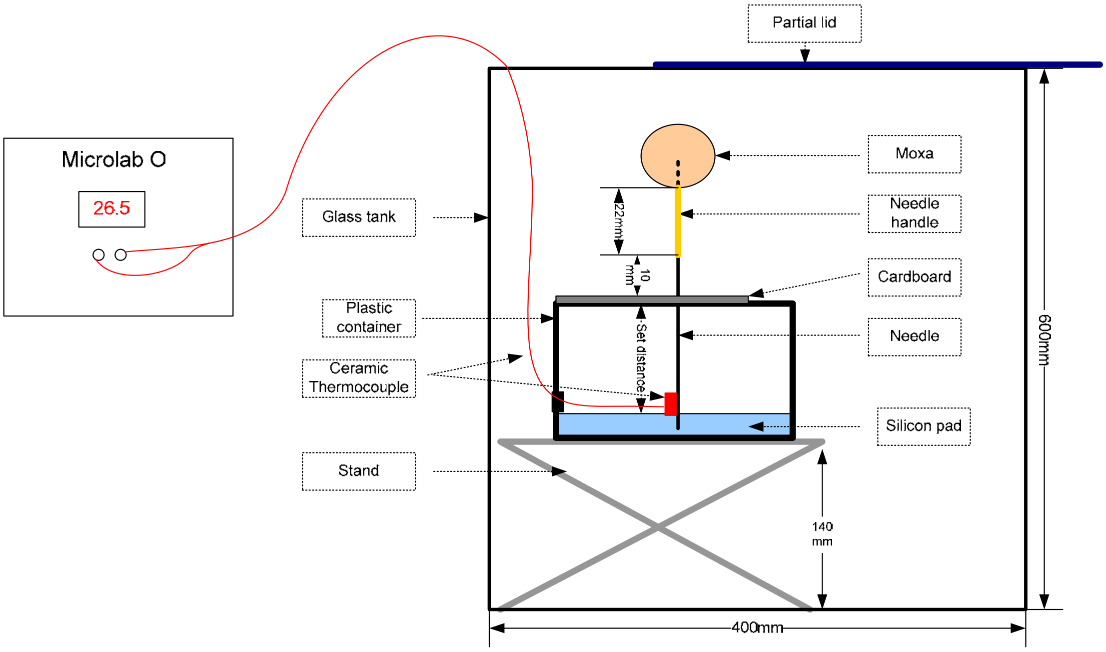

Figure 8: Diagrammatic elevation view of experimental set-up

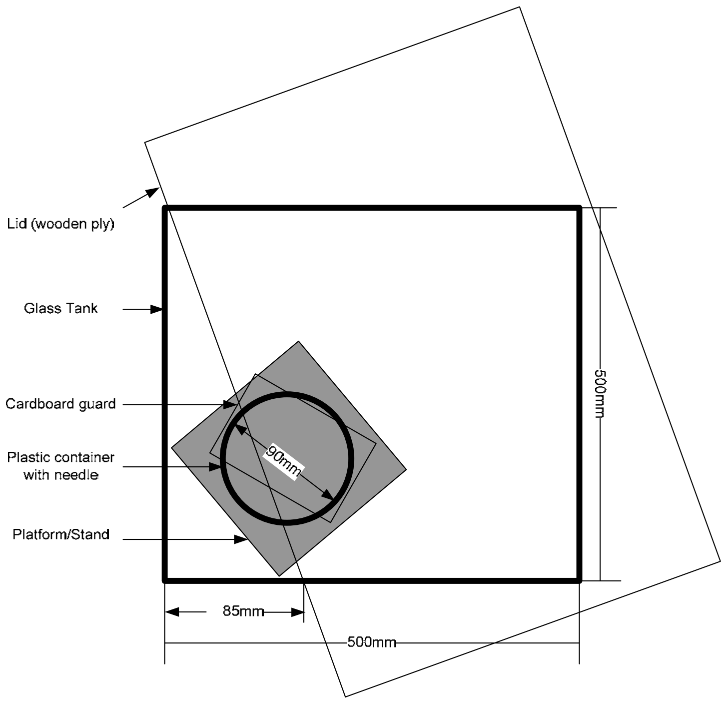

Figure 9: Diagrammatic plan view of experimental set-up

Figure 10: Actual experiment setup

2.6 Statistical analysis

The experiment was repeated 6 times for each moxa type and needle diameter combination (the independent variables). Results were then analysed using mean and standard deviation (SD). Confidence that the means of the two samples are large compared to the means uncertainty were calculated using the two-sided t-test method described by Peters (2001). Significance was set at $p<0.01$.

3 Results

The following results present the outcomes and analysis from running the calorific value measurements, the WN optimisation pilot and the final WN experiments. Results are presented as Value (± error) or Value ± SD. Significance levels are set at $p<0.01$.

3.1 Calorific values

The calorific value of SM cone and Japanese MP were measured to compare the energy potential (i.e. the heat that can be transferred) of each moxa type. Three samples of each type were measured. The SM cones vary around 0.42g, therefore samples weighing more than 0.42g were selected from the batch and shavings scraped off the bottom to achieve 0.42g (±0.01). Equivalent 0.42g (±0.01) portions of Japanese MP were taken from the batch bag and compacted lightly.

Each sample was placed in the Bomb Calorimeter, the water agitator started and left for 5 minutes for equilibrium to be reached. The temperature was then read and recorded for the next 5 minutes at 1 minute intervals. The sample was ignited at the 6th minute with readings taken every 30 seconds until no temperature increase was detected for 5 minutes.

The collected data used to calculate the calorific values are given in Appendix V (formulae for calculations are given in Appendix II). The calculated calorific values for each type of moxa are summarised in Table I.

The mean of the measured calorific value per gram of smokeless moxa was higher than moxa punk (4951Hg ± 35 versus 4488Hg ± 112 in 3 samples, $p<0.01$). SM cones produce approximately 10% more energy (and hence heat) on a gram per gram basis than Japanese MP.

Table I: Moxa types and calculated calorific values

	Calculated calorific value Hg ((tW-e3)/m)	
	Smokeless moxa	Moxa Punk
Sample size	n = 3	n = 3
	4937	4647
	4991	4410
	4926	4408
Average	4951	4488
Sample SD	35	112

3.2 Pilot experiment optimisation results

As discussed in the Methods section, the experiment was piloted to optimise the experimental set-up and protocol. Three trials using three samples of each moxa type were carried out consecutively before the optimum material selection and equipment set-up was achieved. The pilot used 40mm x 0.3mm diameter needles. All moxa sample weights were 0.42g (±0.01).

In summary, the results from trial 1 of the pilot experiment (Table II) showed little consistency in results with a maximum temperature change of 0.7℃ recorded at the needle end. The small change meant the Microlab-0 metre error of ± 0.1℃ could account for 14% error in the reading. One result for MP was nullified due to falling burning particles setting the cardboard shield alight. In trial 2, with a change to Japanese MP (refer to 4.2.2 for further information), the results were more consistent reflecting the use of: Japanese MP which burned more consistently; the gas lighter for ignition, and; improving experience of the technician.

Trial 3 results reflect the increased temperature change resulting from positioning the temperature probe vertically. Consistent results (with small SD) reflect the changes made in trial 2 and steadier burn rates resulting from placing a lid to reducing air-flow turbulence.

Table II: Results from pilot experiment for recording temperature change at the end of an acupuncture needle

Trial 1: no lid, embedded temp probe, 0.42gram						
	SM cone			**Chinese *MP***		
	Run 1	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
Max. temperature change at needle tip (℃)	0.7	0.5	0.4	0.5	Failed - cardboard burning	0.6
	Mean: 0.5 ± 0.2 (SD) ℃			Mean: 0.6 ± 0.1 (SD) ℃		
Trial 2: no lid, imbedded temp probe, 0.42gram – *change to Japanese Moxa punk*						
	SM cone			**Japanese MP**		
	Run 1	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
Max. temperature change at needle tip (℃)	1.0	0.8	0.8	0.7	0.6	0.6
	Mean: 0.9 ± 0.1 (SD) ℃			Mean: 0.6 ± 0.2 (SD) ℃		
Trial 3: change to *lid, temp probe vertical and above silicon*, 0.42gram						
	SM cone			**Japanese MP**		
	Run 1	**Run 2**	**Run 3**	**Run 1**	**Run 2**	**Run 3**
Max. temperature change at needle tip (℃)	1.9	1.7	1.8	2.3	2.5	2.5
	Mean: 1.8 ± 0.1 (SD) ℃			Mean: 2.5 ± 0.1 (SD) ℃		

3.3 Final moxa comparison experiment

A total of 24 SM cones (0.42g) and 24 rolled balls made from Japanese MP (0.42g) were used as heat sources in this experiment. Moxa samples were inserted on the handle of 40mm x 0.35mm or 40mm x 0.25mm filiform acupuncture needles, until the moxa base was 22mm from the bottom of the handle (66mm from the end). Measuring a sample of 10 needles showed the needle handle length was 34mm (± 0.5) (total needle length including handle was 74mm (± 1)).

A temperature probe measured the needle temperature at the end of a vertically retained needle (59mm (± 1) from the base of the moxa). The temperature probe was isolated from the burning moxa by a cardboard shield.

The experiment was run 6 times for each combination of moxa type and needle diameter over several days. Each experimental run followed the protocol defined in Figure 11. Data collected is supplied in Appendix VI.

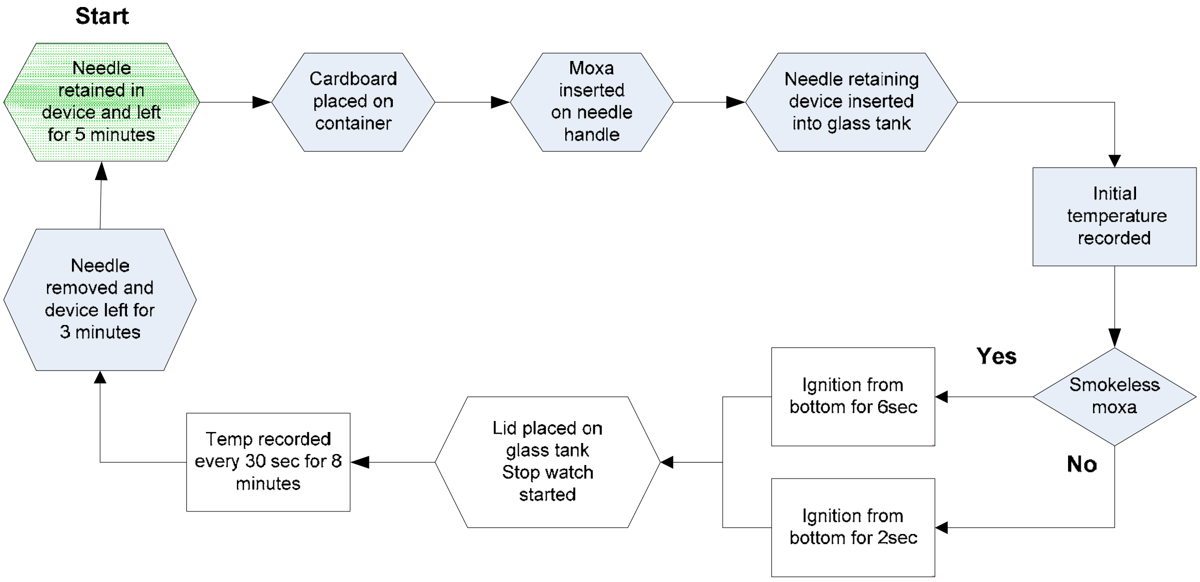

Figure 11: Protocol for running experiment to measure temperature change at needle tip

Once collated, the results showed the diameter of the needle had no effect on the mean temperature increase at the needle end (refer to Appendix VII for results and comparison), therefore results from needle diameters were combined giving a sample size of n=12 (Table III).

Table III: Maximum temperature change at needle end per moxa type (combined needle diameter results)

	Max Change in Temp at needle end (°C) 0.25mm diameter	
	Smokeless moxa n=12	Moxa Punk n=12
	1.6	2.5
	1.7	2.4
	1.7	2.4
	1.9	2.5
	1.7	2.3
	1.8	2.6
	1.8	2.5
	1.8	2.5
	1.9	2.4
	1.7	2.5
	1.6	2.3
	1.6	2.5
Sample AVG	1.7	2.5
Sample SD	0.1	0.1

Analysis of the combined results show that Japanese MP balls raised the needle end temperature 41% higher than SM Cones (2.5℃ $\pm$ 0.1 versus 1.7℃ $\pm$ 0.1 for a sample of 12, p=0.00).

Sample testing occurred over several days with the ambient temperature varying between 18℃ and 24℃. To determine if this had an effect on outcomes, the starting temperatures were plotted against the change in temperature recorded for each SM cone sample tested (Figure 12). There is no correlation between initial temperature and magnitude in change.

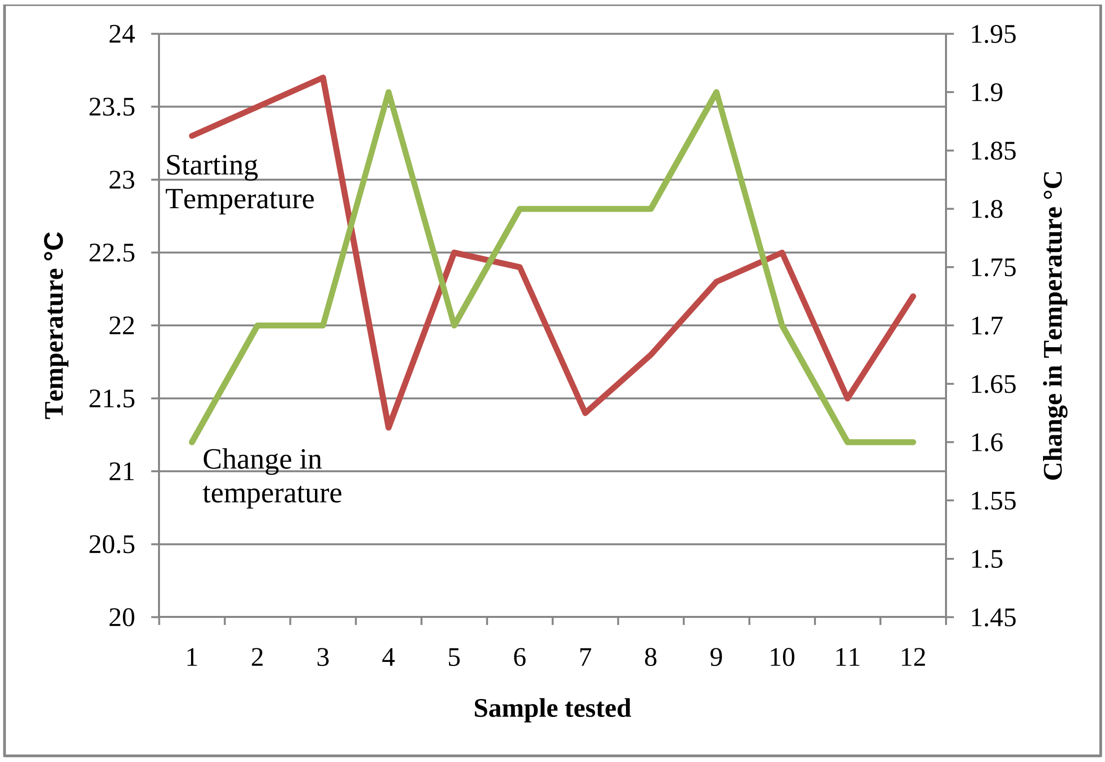

Figure 12: Change in temperature at the needle end versus starting temperature; results for SM n = 12

3.4 Temperature increase profile of different moxa

For each sample tested, the temperature at the end of the needle was measured every thirty seconds (from the time of lighting) for eight minutes. The plotted temperature increase profile at the end of the needle for each moxa type burnt (combined needle diameter results) is shown in Figure 13.

The rate of temperature increase using Japanese MP is faster than that of SM Cones. (maximum temperature reached in 120sec (±15) compared to 270sec (±15)). However, though the maximum temperature change recorded is less than Japanese MP (1.7℃ versus 2.5℃), SM cones maintain it at least three times longer than Japanese MP (150sec (±15) versus 30sec (±15)) before dropping off.

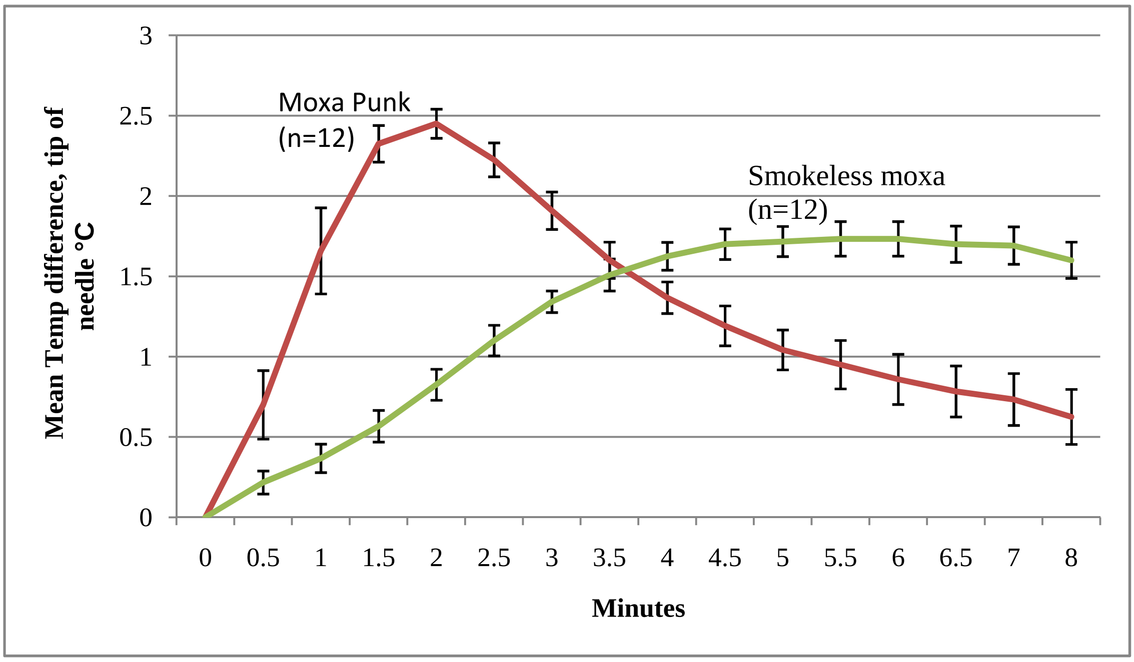

Figure 13: Comparison of measured mean temperature change (n=12) at needle tip of two moxa types. Error bars are SD.

3.5 Other forms of moxa

SM cones are fixed in size whereas MP can be compacted into varying sizes. Therefore, to further inform the findings from this study and out of an interest to observe how differing amounts of MP change the temperature, two other forms of MP commonly used in clinic were tested with 40mm x 0.25mm needles. Experimental set-up did not change:

- A 2.2g ball of moxa formed from Chinese MP, tightly packed into a ball 2.4mm in diameter: this is a form used in the Kai clinic, London, UK (as informed by Obaidey (2006)).
- A pre-formed 0.32g moxa roll for WN made from moxa punk, 10mm high x 11mm diameter: commonly available from acupuncture suppliers (supplied by Acumedic, UK).

Three samples of each type were tested.

The increase in temperature over time for all tested samples is summarised in Figure 14.

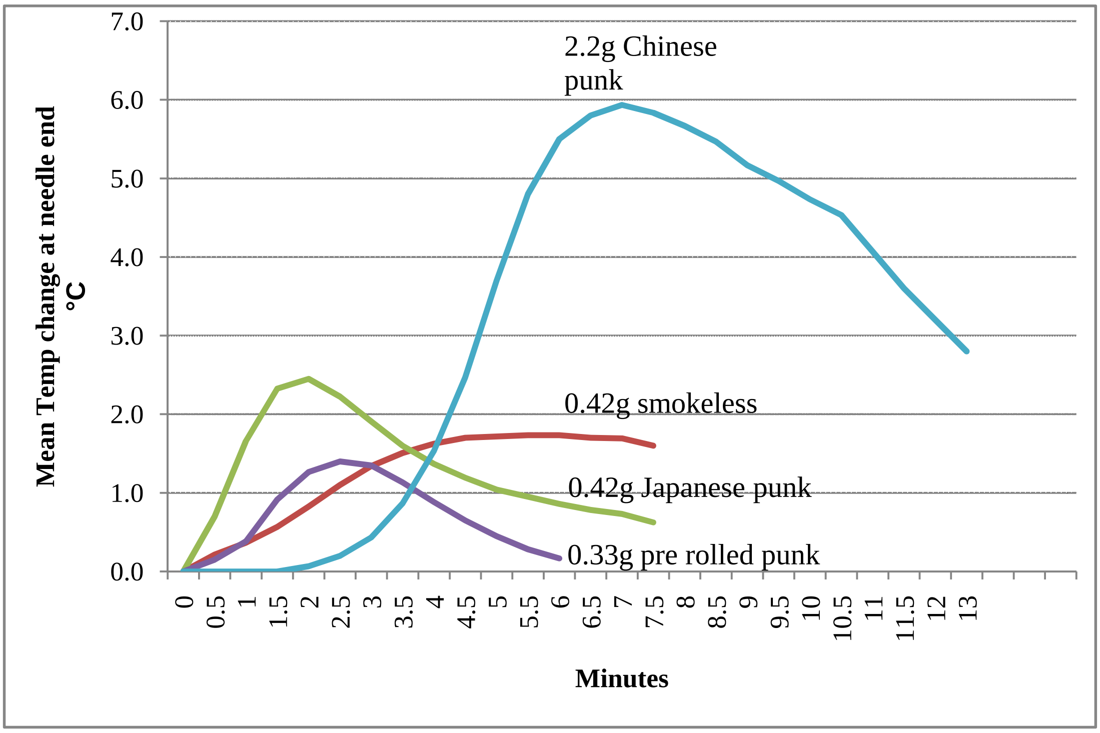

Figure 14: Comparison of measured mean temperature change at needle end of various moxa types

The maximum temperature change at the needle end increases with a greater MP weight. The 2.2g ball of MP is approximately 5 times the weight of the Japanese MP but only produces a 2.5 fold increase in temperature at the needle end and takes longer before a temperature change at the needle end is detected. Interestingly, independent of the size or weight, MP samples show a similar characteristic; a fast rate of temperature increase to the peak temperature followed almost immediately by a decline.

4 Discussion

The purpose of this study was to determine if a difference exists between MP and SM in WN. The study was carried out based on the assumption that it is the heat applied below the skin via the needle that makes WN therapeutically more effective than acupuncture or direct moxa for some conditions. Therefore the following discussion concentrates on the differences in temperature recorded on the needle from MP and SM cones, and how this may influence therapeutic outcomes.

4.1 Differences between smokeless moxa and moxa punk

Two significant differences between MP and SM cones were found related to the needle end temperature: the temperature change using MP is 41% greater than SM; SM cones maintain the raised temperature 4 times longer than MP. The findings and implications are discussed below.

4.1.1 Density and weight versus Temperature

The higher temperature change at the needle end produced from MP was contrary to expectations. Baseline calorific measurements of the moxa samples showed that SM produced 10% more energy than MP. Density appears to be the major factor causing the differential. Lee *et al.* (2001) found that low density moxa burnt more intensely than higher density MP and a study by Bang *et al.* (1995) discovered that the lower the density of moxa the shorter the combustion time (cited in Byoung *et al.*, 2010, p.2051). Although equivalent in weight, the 20mm MP balls used in this experiment were considerably larger than the 11mm x 8mm SM cones, thus less dense. They burnt more intensely, with a corresponding greater change in temperature at the needle end which was maintained for a shorter time than SM cones – both results consistent with the findings of Lee *et al.* (2001) and Bang et al (1995). In summary, moxa density is inversely related to temperature change at the needle end and positively related to the time the temperature is increased. Additionally, increasing the weight of the MP ball increases the temperature.

4.1.2 Moxa *position on the handle*

Before discussing how these findings may relate to practice, it is worth discussing moxa attachment to the handle as a possible influence on the needle end temperature increase. MP is formed and “wrapped” around the handle whereas SM cones, with a preformed hole, sit on the needle handle. Due to closer contact with the handle, MP is likely to transfer heat more efficiently than SM cones. Although not investigated within this study, it is worth mentioning that practitioner can also influence the needle end temperature by changing the MP ball position on the needle handle (Kim *et al.*, 2009) whereas the position of the SM cone is fixed.

4.1.3 Relevance to practice

In general, texts state that WN is used to apply heat via the acupuncture needle but any discussion regarding the relationship of temperature magnitude or length of application on therapeutic effects is lacking (Appendix III). Dharmananda (2004) argues that, as with acupuncture, there are strategies to disperse or tonify when using directly applied moxa cones. He recommends a steady and longer heat for tonification or a more rapid and intense heat for dispersing. Wilcox (2008) and Soulié de Morant (1994) agree with this interpretation. As shown in this study, the temperature characteristic at the needle end can be altered by changing the type of moxa and therefore potentially the therapeutic effect; the temperature characteristic produced by MP corresponding to a dispersion technique and that from SM cones with tonification. Thus practitioner could decide on a specific intervention when using WN through choice of moxa type. However this requires further investigation to confirm that the therapeutic actions due to differing heat application at skin level, would apply when that heat is introduced below the skin via the needle.

Relevance of the differing WN heat characteristics between MP and SM cones could also relate to the research carried out by Young and Craig (2010). They posit that large moxa cones (applied directly) provide a strong heat (corresponding to MP in WN) and stimulate the sympathetic nervous system which in turn activates aspects of the innate immune system. In contrast small moxa cones (applied multiple times) with a mild heat (corresponding to SM cones in WN) activate the parasympathetic system which boosts the adaptive immune systems. If differing heats applied through WN produces the same responses, this has interesting applications. Knowing the physiological affect, a practitioner could use MP or SM to enhance an acupuncture treatment protocol as appropriate.

Both moxa samples used in this study increased the temperature at the end of the needle. However, this does not imply that these results apply if the needle were inserted into a body. The thermal conductivity of the body to draw heat away from the needle, and ability to maintain a homeostatic temperature (Habash *et al.*, 2006), would possibly negate any increase in temperature. Therefore if the therapeutic effect of WN relies on introducing heat below the skin surface (as discussed in the Introduction) then the capacity of the moxa heat source to raise the temperature of the needle is crucial. This implies that MP, producing the higher temperature, may have more effect than SM cones. Additionally, in practice the MP weight can be increased to provide a higher temperature (as shown in this study) or moved further down the handle, an option not available with fixed form SM cones.

Before drawing conclusions, it is worth revisiting the concept that the therapeutic effect of WN comes from the needle providing heat below the skin (Kim *et al.*, 2009). The starting recorded temperature of the needle in this study was ambient air temperature (18 to 24℃). MP raised the temperature an average of 2.5℃ to a maximum temperature of 26.5℃ at the needle end (refer to collected data Appendix VI). Using comparable needles and an almost equivalent weight and size of MP, Lim *et al*. (2010) measured a temperature increase from 24.3℃ to 35℃ on the needle corresponding to skin level (if the needle were inserted 1.5cm as recommended by Birch and Ida (1998)). Considering temperatures below skin level are in excess of 36℃ then the findings from Lim *et al*. (2010) and this study suggest that the samples used cannot increase the temperature of the needle below the skin to introduce heat to deeper levels of the body. This raises an interesting point; if a needle acclimatises to ambient temperature before insertion (as found in this study), acupuncture entails inserting a relatively cold needle into the body. The counter argument is that the needle equalises to the body temperature once inserted; moxa then raises the temperature from that point which, given the increases measured in this study, implies the needle temperature below the skin could be raised. Either way, this area warrants further investigated as more benefit may be achieved with WN if the moxa is lit once the needle equalises to the body temperature.

Cohen *et al.* (1997) offer an alternative theory to explain why WN has an effect. They theorised that a temperature differential, created between the needle handle and end in WN, sets up a potential difference creating an electrical current in the needle within a range shown to have positive biological effects. Their experiment showed that the current through the needle increased with higher temperature differentials. If the amount of current is related to the therapeutic effect, and given that the needle end is colder or at the same temperature as the body, the moxa that produces the greatest temperature at the handle should be used, i.e. that which burns hottest which in this case is MP. It is interesting to note Obaidey (2011) similarly ascribes the therapeutic effect of WN to a differential, although couched in Chinese Medicine terms. His supposition is that burning moxa creates a "powerful splitting" (pg.157) between *Yin* and *Yang* which is transmitted through the needle and signals a change to the body.

4.2 Experimental review

An objective of this study was to utilise where possible the methods and protocols typically used in the practice of WN. However, a difficulty immediately identified was the lack of detailed descriptions on WN within English literature and a dearth of material on best practice (see Appendix III for an analysis). Published studies carried out on WN also do not adhere to any definable standard. Therefore a pilot was used to optimise the experimental set-up which successfully allowed consistent and reliable temperature readings to be made, dependent on the moxa type and needle thickness, for accurate comparative analysis. However the experiment set-up may not reflect how WN is used in many clinical practices limiting broader interpretation of results.

Scientifically, it also made sense to compare equivalent weights of the two moxa types based on the weight of the SM cone which has a fixed form. Although the SM cone is the most common form available from acupuncture suppliers, this may not apply to the form of MP decided on (0.42g, 20mm diameter). It would potentially have been more informative to practitioners if the comparison was done with commonly used forms of MP, used in practice for WN (obtained through a quick survey). As it was, a late decision was made to test two additional forms of MP used in clinic as it was felt it would provide further useful information for practitioners.

This study measured the temperature at the end of the needle thus limiting the interpretation and comparison of results with previous WN studies which measured the needle temperature at a level corresponding to the skin level (were the needle inserted into a body). Although measuring temperature at the needle end was justified, an additional measurement at the level corresponding to skin level would have supplied informative results on temperature gradients down the needle and allowed better comparison with previous experiments.

This was a comparative investigation measuring the effect on temperature when different Moxa types are used. Therefore, the experiments should have all been carried out at the same ambient temperature. Instead temperatures varied between 18℃ and 24℃. It did not appear to make a difference within this study (refer to 3.3); however for future studies requiring more sensitive measurement the difference may be significant.

5 Conclusions and recommendations

This study has proven there are significant differences between MP and SM when used for WN. The difference is reflected in the temperature characteristic measured at the end of the needle with MP burning more intense resulting in the needle temperature rising faster and 41% higher than SM but with a short duration. Conversely SM burns more moderately producing a lower temperature change but maintaining the temperature four times longer than SM. The use of 0.25mm or 0.3mm diameter needles did not affect the temperature change at the end of the needle.

MP is less dense than SM and this appears to be the predominant factor causing the difference in needle temperature characteristics within this study. However temperature change at the needle end also has a positive relationship with MP weight. Interestingly, MP weight does not appear to affect the rate of temperature increase or decrease suggesting temperature could be increased without affecting the character of the heat applied.

As argued in the discussion, the temperature characteristic at the end of the needle from MP correlates to dispersion techniques while that from SM cones correlate to tonification. This is the first study to clarify how different moxa types can potentially be used for tonification or dispersion in WN. These findings may be used to increase the efficacy of WN in treating indicated qi and Blood stagnation and Cold conditions; however, further research is required to confirm these outcomes in practice.

Although possible therapeutic relevance of the results were explored in the discussion, definitive interpretation of the results to clinical practice cannot be made as thermal characteristics and needle temperature would change when the needle is inserted into the body. Considering the maximum temperature measured at the needle end was 26.5℃ (which is below body temperature) there are unknown factors which must be explored before the mechanisms behind WN effectiveness and results from this study can further inform clinical practice. Further research to answer the following questions is suggested:

1) Considering the needle temperature starts at ambient air temperature, what temperature does an acupuncture needle adjust to when inserted into a body and how long does it take to reach equilibrium?
2) What temperature does the end of the needle attain when the corresponding point at skin level reaches 41℃ (the point at which cell injury occurs (Habash *et al.*, 2006)) and what weight of moxa can produce this temperature?
3) How do multiple applications of the sample moxa, on the same needle, affect temperature at the needle end?
4) How does varying the position of moxa on the needle handle affect the temperature on the needle?

In general there is a lack of consistency in the protocols and standards applied to research carried out in WN preventing the comparison of findings from multiple studies. A set of guidelines, reflecting standards and best practice for WN, would be a first step in ensuring that results from future research into WN could add to an evidence base which would in turn inform further research and efficacy.

Within current practice the practitioner has more control over the utilisation of MP than SM cones. Differing weights and sizes of MP balls can be formed, as the practitioner requires, to vary the amount and intensity of heat. However, SM has distinct advantages in emitting less smoke plus it delivers a longer and less intense heat. To give the practitioner informed choice, manufacturers should be encouraged to provide multiple sizes and density of SM cones with associated information on how much heat would be delivered.

In conclusion, given the lack of present evidence and guidelines for WN, especially in relation to temperature magnitude and duration, this study is a first step in providing insight into the temperature provided by the needle, below the skin. Knowing the differing temperature characteristics from MP and SM, in turn gives the practitioner some basis for making decisions on how differing moxa type and weights can be used for differing therapeutic effects and to begin correlating the outcomes in clinical practice.

Word Count: 7115

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Appendix I: Ethics form and project approval

SCHOOL OF LIFE SCIENCES

Ethical Conduct of Investigations, Demonstrations, Research and Experiments

For all research this completed form must be submitted to the School Office

<table>
<tr><td colspan="2">1.1 Project Title:
Differences in needle tip temperature between
pure and smokeless moxa in warm needling

Start date: 21st Nov 2011   Estimated end date: 7th May 2012</td></tr>
<tr><td colspan="2">1.2 Applicant Details</td></tr>
<tr><td>Name: Steve McCulloch</td><td>E-mail Address: s.mcculloch@my.westminster.ac.uk</td></tr>
<tr><td>Contact Address: 12 Odger Street, London, SW11 5AF</td><td>Telephone Number: 07949696268</td></tr>
<tr><td colspan="2">Please check the relevant box:

☒ Undergraduate ☐ Postgraduate ☐ MPhil/PhD Student ☐ Staff</td></tr>
<tr><td colspan="2">1.3 Ethical classification of the proposed research
Complete the tick sheet on the back of this page.
Is your project:

CLASS 1 x   CLASS 2 ☐   CLASS 3 ☐   CLASS 4 ☐</td></tr>
<tr><td colspan="2">If Class 1 and your research is required by an outside body to be scrutinized by the University's RESC to ensure that the research conforms with general ethical principles and standards, please also complete Form A of the Research Ethics Approval Form. Submit Form A to Huzma Kelly. If you are doing this please tick the box: ☐</td></tr>
</table>

If Class 2, does this project fit within a Generic Ethics Approval?

Yes ☐ No ☐

If yes, please write code:

If no, parts A and B of the Research Ethics Approval Form must be completed. Submit Forms A and B to Huzma Kelly.

If Class 3 and approval MUST be sought from an external body (for example, a NHS RESC or the HO), please complete Form A of the Research Ethics Approval Form. Submit Form A to Huzma Kelly. Copies of the approval letter from the external body should be lodged with both the School Office and Huzma Kelly. If you are doing this please tick the box: ☐

If Class 3 and approval from an external body is NOT required, Forms A and B of the Research Ethics Approval Form must be completed. Submit Forms A and B to Huzma Kelly. If you are doing this please tick the box: ☐

Does work include the *in vivo* use of animals?*

Yes ☐ No x

If yes, please enter Home Office project number and the licence number of the institution where the work will be done:

* NB no one is permitted to do *in vivo* research with animals on UoW premises

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If Class 4 and Generic Ethics Approval has not already been awarded, Forms A and B of the Research Ethics Approval Form must be completed. Submit Forms A and B to Huzma Kelly.

If you need to submit **any** forms to Huzma Kelly, Senior Research Officer, then you may not commence work until you receive the approval of the University's RESC. When you receive approval please lodge a copy of the approval letter with the School Office.

1.4 Declaration. The information on this form is true and to the best of my knowledge correct. If you are a student your supervisor must sign the declaration to demonstrate that they have read and approved your application.

Signature:

Name: J CATTERMOLE	**E-mail Address:** jcattermole@hotmail.com
Dept: LIFE SCIENCES	**Telephone Number:** 07985 45994

RISK OF HARM [this tick list is a quick guide to the classification of your work only. The exact classification should be determined using the University of Westminster Code of Practice for Investigations, Demonstrations, Experiments and Research (http://www.wmin.ac.uk/page-17110)].

		Yes	No	N/A
1	Is pain or more than mild discomfort likely to result from the study			X
2	Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?			X
3	Will the study involve prolonged or repetitive testing?			X
4	Will the study involve raising sensitive topics (e.g. sexual activity, drug use, revelation of medical history and/or illegal activities)			X
5	Does your work involve any material containing human cells (e.g. blood, urine, saliva, body tissues) from living or deceased persons? (Such work must take account of the Human Tissue Act).			X
6	Will DNA samples be taken from human participants? (Such work must take account of the Human Tissue Act).			X
7	Does your study raise any issues of personal safety for you or other researchers involved in the project? (Especially relevant if taking place outside working hours or off University premises)		X	
8	Does your study involve deliberately misleading the participants (e.g. deception, covert observation)			X
9	Does your work involve administration of a non-food substance in abnormally large amounts or one that is known to cause allergic reaction(s) in some people?			X

PARTICIPANTS

Does your work involve any of the following:

		Yes	No	N/A
10	Human participants in health settings (e.g. private patients in private clinics)		X	
11	Human participants in health settings (e.g. NHS patients in NHS clinics/hospitals)		X	
12	Human participants who are in the care of a social worker		X	
13	Expectant or new mothers		X	

14	Refugees		**X**	
15	Minors (under the age of 18 years old)		**X**	
16	Participants in custody (e.g. prisoners or arrestees)		**X**	
17	Participants with impaired mental capacity (e.g. severe mental illness, brain damaged, sectioned under Mental Health Act, lowered or reduced sense of consciousness)		**X**	
INFORMATION TO PARTICIPANTS				
		Yes	**No**	**N/A**
18	Will you provide participants with a Participant Information Sheet prior to obtaining consent which can be taken away by the participant?			**X**
19	Will you describe the procedures to participants in advance, so that they are informed about what to expect?			**X**
20	Will you obtain consent for participation? (normally written)			**X**
21	Will you tell participants that they may withdraw from the research at any time and for any reason?			**X**
22	With questionnaires, will you give participants the option of omitting questions they do not want to answer?			**X**
23	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?			**X**
24	Will you debrief participants at the end of their participation (e.g. give them a brief explanation of their study)?			**X**

Appendix II: Standard Operating procedures for the 1341 Bomb Calorimeter and heat of combustion calculations

Information as supplied by the Westminster Laboratory, New Cavendish Street Campus for use and subsequent calculation of Hg of samples burnt in the Bomb Calorimeter.

Steven McCulloch

Oxygen Bomb Calorimeter

Bomb calorimetry is used to determine the energy in food. It does so by measuring the enthalpy of combustion, $\Delta_{comb}H$.

Assuming only CHO was consumed then the reaction would be:

$$C_xH_yO_{z\ (solid)} + (2x + y/2 - z)/2\ O_{2\ (gas)} \rightarrow \quad xCO_{2\ (gas)} + yH_2O_{\ (liquid)}$$

When CHO only is combusted it undergoes the same chemical reaction as in the body so the amount of energy measured by the bomb calorimeter is directly proportional to how much energy is generated when the CHO is consumed and metabolised in the body.

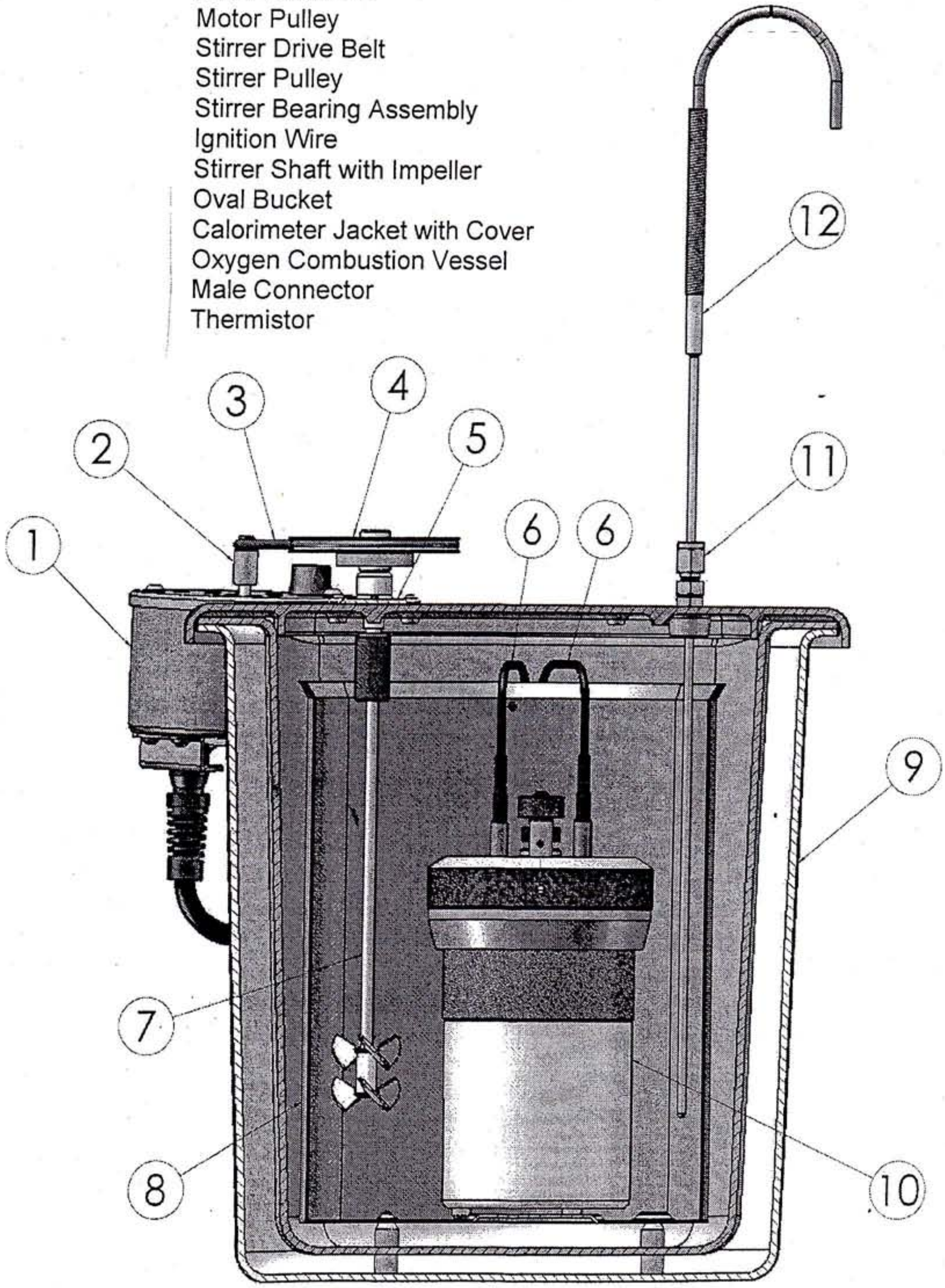
Most foods though are mixtures of CHO, fat and protein. The energy released when protein is combusted in the bomb calorimeter (5.65 kcal (23.64 kJ)/g) is not the same as that released in the body because the reactions involved are not the same. When combusted the nitrogen is oxidized to the dioxide but in the body if protein is used for energy then ammonia is produced and converted to urea; that is, the nitrogen is excreted. When proteins are used to generate energy in the body therefore they only produce 4.4 kcal (18.4 kJ)/g. This difference should be corrected for BUT today for simplicity's sake we are going to assume that our food sample has no protein in it.

Measuring the enthalpy of combustion essentially involves the measurement of a transfer of energy. Within an isolated environment (a stainless steel sample chamber – see diagram on reverse of this sheet) the food sample is combusted in the presence of oxygen. In most cases combustion will result in the generation of energy; that is, an exothermic reaction. The energy generated is measured indirectly by measuring the increase in the temperature of a water sleeve which is surrounding the sample chamber. For this measurement to be accurate a few aspects of the reaction need to be controlled. These are:

1. the sample chamber can not be distorted by the combustion. Distortion would mean that work has been done and work needs energy. The sample chamber is made of stainless steel and it is assumed that the transfer of energy through it walls is close to 100%

2. the sample chamber and the water sleeve surrounding it are well insulated from the ambient environment to ensure no heat flows out of the system

Key No.	Description
1	Motor Assembly with Pulley, 115V 60 Hz
	Motor Assembly with Pulley, 230V 50/60 Hz
2	Motor Pulley
3	Stirrer Drive Belt
4	Stirrer Pulley
5	Stirrer Bearing Assembly
6	Ignition Wire
7	Stirrer Shaft with Impeller
8	Oval Bucket
9	Calorimeter Jacket with Cover
10	Oxygen Combustion Vessel
11	Male Connector
12	Thermistor



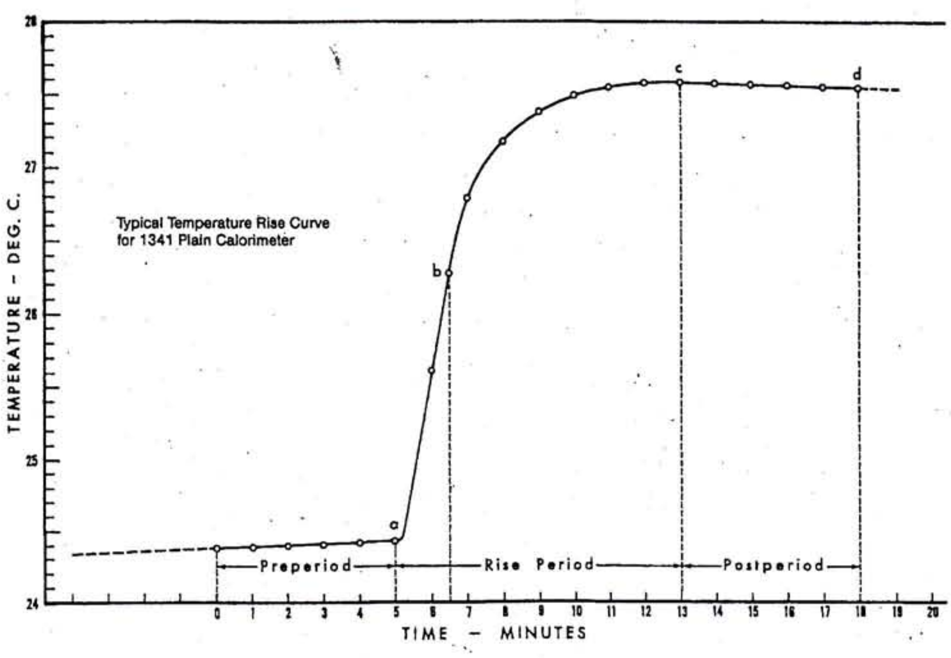
Calculating the heat of combustion:

The following data is required:

a = time of firing
b = time (to nearest 0.1 min) when the temp reaches 60% of total rise
c = time at beginning of period (after the temp rise) in which the rate of temp change has become constant
t_a = temperature at time of firing
t_c = temperature at time c
r_1 = rate (temp units per min) at which the temp was rising during the 5 min period before firing
r_2 = rate (temp units per min at which the temp was rising during the 5 min period after time c
W = energy equivalent of the calorimeter in calories per °C
m = mass of the food sample in grams

Three thermochemical corrections should also be included but we are not going to correct for the calories of heat resulting from the formation of nitric acid nor for the calories of heat resulting from the formation of sulphuric acid. We will however correct for the calories of heat resulting from the combustion of the fuse wire. The combustion of the food is done by passing an electric charge along the wire, the wire gets hot and ignites the food: combustion of the food results. The amount of wire destroyed in the combustion process needs to be accounted for when doing the final calculations (e_3).

The temperatures recorded over the preperiod, rise period and postperiod should be plotted as illustrated below.



t = net corrected temperature rise

$= t_c - t_a - [r_1 (b - a)] - [r_2 (c - b)]$

Gross heat of combustion, H_g calories per gram

$$H_g = \frac{tW - e_3}{m}$$

W= 2426

e_3 = 2.3 X cm. of wire used.
(calories/cm)

Today the energy in a common breakfast cereal will be calculated. About 1 g of pulverized cereal will be placed in the sample chamber – it is important to record the exact weight. Then, as instructed, record the temperature over the preperiod, rise period and postperiod (see diagram above). Determine how much wire was consumed in the combustion. Use the information above to calculate H_g. Compare the value you obtain with the value the manufacturer of the cereal provides.

TEMPERATURE RECORD SHEET

	Time (min:sec)	*Temperature (°C)*
Pre-firing	0:00	
	1:00	
	2:00	
	3:00	
	4:00	
Fire Bomb!	**5:00**	
	5:45	
	6:00	
	6:15	
	6:30	
	6:45	
	7:00	
	8:00	
	9:00	
	10:00	
Post-firing	11:00	
	12:00	
	13:00	
	14:00	
	15:00	
	16:00	
	17;00	
	18:00	
	19:00	
	20:00	

BOMB CALORIMETER

Preparing the Oxygen Bomb

- Prepare sample

The bomb should never be charged with a sample which will release more than 8000 calories when burned in oxygen. This generally limits the mass of the sample to approximately 1g. Place the weighed sample in the fuel capsule and place the fuel capsule in the electrode loop.

- Attach fuse wire

Secure a 10cm length of fuse wire between the two electrodes by inserting the wire through the eyelets at the end of each stem and pushing the caps downward to pinch the wires into place. Bend the wire downwards toward the surface of the sample: for powered and liquid samples the loop should be set just slightly above the surface; for pellet samples the loop should press against the pellet.

- Close the bomb

Whilst being careful not to disturb the sample, check the sealing ring on the bomb head (to make sure it is in good condition) and moisten slightly. Make sure that the gas release valve is open and slide the bomb head into the cylinder, pushing down as far as it will go. Set the screw cap on the cylinder and turn it down firmly by hand.

- Fill with Oxygen

Slide the slip connector onto the inlet valve on the bomb head and push down as far as it will go. Close the gas release/outlet valve on the bomb head and open the oxygen tank valve by no more than ¼ turn. Open the filling connection control valve slowly and watch the gage as the bomb pressure rises to the desired filling pressure of 30atm (never fill to more than 40atrm), then close the control valve. Release the residual pressure in the filing hose by pushing downward on the lever attached to the relief valve – the gage should now return to 0atm. Finally, close the outlet valve on the oxygen tank.

Preparing the Calorimeter

Fill the calorimeter bucket with 2000(± 0.5g) of distilled water, which should be approximately 1.5^{0}C below room temperature (although this can be varied to suit the operator's preference), and set the bucket in the calorimeter, making sure it is the correct way round – the three feet should sit into the grooves on the bucket.

While carefully handling the bomb, so that the sample is not disturbed, attach the lifting handle and partially lower bomb into the water. Push the two ignition leads into the sockets on the bomb head (making sure they are orientated away from the stirrer shaft) and lower the bomb completely into the water. Remove the lifting handle and shake any drops of water back into the bucket.

Check for gas bubbles!

Set the cover on the calorimeter with the thermometer facing toward the front. Turn the stirrer by hand to be sure it is running freely and slip the drive belt onto the pulley.

Starting the Test

Start the motor by turning the knob clockwise, until you hear a click, and let the stirrer run for 5 minutes to reach equilibrium. At then end of this period start a timer and read the temperature. Read and record the temperatures at one minute intervals for 5 minutes.

At the start of the 6th minute stand back from the calorimeter and fire the bomb by pressing the ignition button and holding it down until the indicator light goes out. (Normally the light will glow for only about ½ second but release the button within 5 seconds regardless of the light).

Do not have the head, hands or any parts of the body over the calorimeter when firing the bomb, and continue to stand clear for 30 seconds after firing!

Recording the Data

Take temperature measurements at 45, 60, 75, 90 and 105 seconds after firing, and continue to record the temperature at one minute intervals until the difference between successive readings (i.e. the rate of temperature change) has been consistent for five minutes.

Terminating the Test

After the last temperature reading, stop the motor (by turning the knob clockwise, until you hear a click), remove the belt and lift the cover from the calorimeter. Wipe the thermometer bulb and stirrer and set the cover on the stand. Attach the lifting handle and remove the bomb from the bucket. Detach the ignition leads and wipe over to dry.

Depressurising the Bomb

Before attempting to open the bomb, release the gas pressure by opening the knurled knob on the bomb head. This release should proceed slowly over a period of not less than one minute.

After all the pressure has been released unscrew the cap and carefully lift the head out of the cylinder and place it on the stand. Examine the interior of the bomb for soot or other evidence of incomplete combustion, if present, the test will have to be discarded.

Clearing Up

Remove all unburned pieces of fuse wire from the bomb electrodes, straighten them and record their combined length in centimeters. Subtract this length from the initial 10cm used – this is the net amount of wire burned, you will need this for your calculations.

Wash all interior surfaces of the bomb with distilled water and dry with tissue. Make sure all parts of the bomb and calorimeter are clean and dry before leaving the lab.

Calculating the Heat of Combustion

If you need any further instructions on how to use this equipment or technical information about it, please contact a Human and Health Sciences Technician in room C4.10 or on extension 3889.

Appendix III: Comparison of warm needle methods and guidelines

A review of the methods and guidelines for warm needling was carried out using text books found in the Westminster library and electronic articles/studies found online (those that had no control group were discarded). The findings are summarised in the following table.

Text or study	Moxa type	Needle spec	Instructions	Shield	Indications
Texts					
Auteroche, 1992, p.105	Moxa punk	26guage needle	Insert needle to obtain qi. Prepare moxa ball, compress well. Should be size of broad bean. Insert over handle. 1 or 2cm slice of moxa stick can be used. Leave at least 20mm between skin and base of moxa. Light using incense stick.	Slide paper between skin and base of moxa	Apply heat, follows pathways of channel more closely
Baecker, M. and Hammes, M., p.137	Moxa punk	None	Compact moxa into a ball, insert moxa on an inserted needle and light.	None	Heat tonifies deficiency, drain excess
Beijing College of Traditional Medicine *et al.*, 1980, p.316	Moxa punk	Filiform needle	Wrap moxa tightly around the handle of an inserted needle. Ignite to cause mild heat.	None	Heat applied for patients with painful joints due to cold and damp
Birch and Ida, 1998, pg.81-101 & Manaka *et al.*, 1995, p183.	Moxa punk. Medium grade	1.3cun or 1.6cun. 3 to 5 (0.2 to 0.25mm) gauge. Filiform needle	Moxa rolled to 1.8 to 2cm diameter ball. Lower border of moxa ball 2.5cm from skin. Should burn approx. 2.5min. Light from bottom. Make sure a portion of moxa sits over the top of the handle. Depth of insertion generally 1.5cm. Burn two moxa balls.	If required	Pressure pain and muscular knots palpated. Cold conditions – Interpreted as local oedema or retention of fluid in tissue creating coldness. Therapeutic value from heat passing into needle and radiated heat from moxa.

Text or study	Moxa type	Needle spec	Instructions	Shield	Indications
Ellis *et al.*, 1991, p.25	Moxa punk	None	Wrap moxa around the handle of an inserted needle and light. Allow to burn completely	Paper or aluminium shield around needle	None
O'Connor and Bensky, 1998, p.430	Moxa punk	Silver needle preferred but filiform ok	Insert needle to obtain qi. Burn 1-3 slices to cause desired warmth below skin. Light moxa from below. Secure moxa to tail of needle	Place towel around needle to catch ash	Heat good for wind Dampness and Cold diseases
Xinnong, 1990, p.366	Moxa punk	None	After arrival of qi, wrap moxa around handle and ignite.	None	Warm meridians and promote free flow of qi and blood. Treat painful joints caused by Cold-Damp, numbness and paralysis.
<u>Studies</u>					
Lim *et al.*, 2008.	Moxa punk	35mm x 0.53mm gold needle. 40mm x 0.25 filiform.	0.5g ball, 20mm diameter. Position on top of handle.	None	Improve chronic diseases generating from irregular qi flow caused by a lack of heat.
Litscher *et al.*, 2009	Smoke-less moxa	50mm x 0.3mm filiform	A holder was used for moxa, 5mm diameter and height packed with Mugwort coals.	None	None
Kim *et al.*, 2008	Moxa punk – perform role	34mm x 0.2mm filiform	Moxa 0.13g, 8mm high x 7mm diameter. Inserted such that top end of moxa sat against top of needle. 12mm from moxa base to bottom of handle (although not consistent with diagram). Moxa lit from top.	None	Chronic pain resulting from rheumatoid arthritis, joint pain and cold or numb limbs.
Sun & Xu, 2010	Moxa punk	40mm x 0.35mm filiform	When needle obtained qi, moxa attached and lit, retained for 20min.	None	conduct the heat through the needle into the body to warm and unblock meridians and collaterals, activate blood and remove obstruction

Text or study	Moxa type	Needle spec	Instructions	Shield	Indications
Wu *et al.*, 2009	Moxa punk	40mm x 0.3mm filiform	When needle obtained qi, a piece of smokeless moxa roll 10mm in diameter x 15mm length inserted on needle handle and ignited from bottom. Each roll burn for 10min – 3 rolls were burnt each time.	None	Promote blood circulation, decrease the release of algogenic substance. Warms the meridians, circulate qi, activate blood and relieve pain.
Liu & JV, 2006	Not clear	50mm x 0.3mm filiform	Needle inserted to some depth. 2cm moxa stick placed on the needle. Applied 3 times.	None	Dredge the meridians and collaterals, disperse Dampness. Stop pain with acupuncture. Dispel wind and cold, warm kidney yang.
Leeguo, 2011	Not clear	40-70mm x 0.3mm filiform	Needle inserted until qi obtained, 2cm length moxa stick placed on needle. Applied 2 times.	None	warm and dredge meridians and collaterals, promote the activation of qi and blood, as well as to dispel cold and kill pain

Appendix IV: Manufacturing quality standards for Acumedic acupuncture needles

CE

EC DECLARATION OF CONFORMITY

MANUFACTURER: ACUMEDIC LTD
101-105 CAMDEN HIGH STREET
LONDON
NW1 7JN

DIRECTIVES COVERED BY THIS DECLARATION: **Medical Devices Directive 93/42/EEC (amended by MDD 2007/47/EC)**

PRODUCTS COVERED BY THIS DECLARATION: AcuMedic Disposable Acupuncture Needles

STOCKCODES: JA07X20, JA15X20, JA15X25, JA30X20, JA30X25, JA30X28, JA30X30, JA40X30, JA50X30, JA50X35, JA75X35, CC07X20, CC15X20, CC15X25, CC30X20, CC30X25, CC30X28, CC30X30, CC40X25, CC40X28, CC40X30, CC50X35, CC75X35, PZ07X20, PZ15X20, PZ30X20, PZ30X25, PZ30X28, PZ40X25, PZ40X28, PZ50X35, XF10X16, XF10X18, XF30X16, XF30X20, IM15X20, IM15X25, IM30X20, IM30X25, IM40X28, IM50X30, IM60X30, EF15X16, EF30X16, EF40x25, INTR-GL

BATCHES: ALL BATCHES SUPPLIED AFTER THE DATE OF THIS DECLARATION OF CONFORMITY

CLASS: CLASS IIa, rule 6 of annex IX of directive 93/42/EEC taking into account amendments of MDD2007/47/EC

APPLIED HARMONISED STANDARDS, NATIONAL STANDARDS OR OTHER NORMATIVE DOCUMENTS:

EN550:1994, EN552:1994+A1+A2, ISO11137:1995+A1, EN556-1:2001, ISO14971:2000+A1:2003, EN980:2003, EN1041:1998, EN868-1:1997, ISO11607:2003 ISO14644-1:1999, ISO14644-2:2000, ISO11737-1:1995, ISO11737-2:1998, ISO11737-3:2004, ISO10993-1:2003, ISO10993-5:1999, ISO10993-10:2002, ISO7153-1:2001

WE DECLARE UNDER OUR SOLE RESPONSIBILITY AS OBL MANUFACTURERS THAT THE PRODUCTS COVERED BY THIS DECLARATION MEET THE REQUIREMENTS OF THE DIRECTIVES COVERED BY THIS DECLARATION.

NOTIFIED BODY: SGS

NAME AND POSITION OF SIGNATORY: Jon Mei (Director)

SIGNATURE:

DATE: 23 September 2011

AM093 R5 20110923

Appendix V: Collected data from the Bomb Calorimeter experiment

Moxa - smokeless cone Run-1																						
Weight (g)	0.41																					
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20
Temp	22.3	22.3	22.3	22.3	22.3	22.3	22.38	22.5	22.6	22.68	22.82	22.94	23.04	23.08	23.1	23.12	23.12	23.13	23.13	23.14	23.14	23.14
Wire used (cm)	6																					
Calorie value																						
Temp at firing (ta)	22.3																					
Temp final (tc)	23.14																					
Degree rise at 60%	0.504																					
t	0.84																					
W	2426																					
e3	13.8																					
Hg = (tW-e3)/m	**4936.683**																					
Total time temp change	7																					
for 95%	23.056																					

Moxa Smokeless Run-2																						
Weight (g)	0.42																					
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20
Temp	21.92	21.92	21.92	21.92	21.92	21.92	21.94	22.06	22.23	22.38	22.5	22.58	22.63	22.68	22.71	22.73	22.75	22.76	22.78	22.79	22.79	22.8
Wire used (cm)	6.3																					
Calorie value																						
Temp at firing (ta)	21.92																					
Temp final (tc)	22.79																					
Degree rise at 60%	0.522																					
t	0.87																					
W	2426																					
e3	14.49																					
Hg = (tW-e3)/m	**4990.786**																					
Total time temp change	7																					
for 95%	22.703																					

Moxa Smokeless Run-3																						
Weight (g)	0.42																					
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20
Temp	22.66	22.66	22.66	22.66	22.67	22.67	22.68	22.82	23	23.13	23.24	23.32	23.38	23.42	23.45	23.47	23.49	23.5	23.52	23.52	23.52	23.52
Wire used (cm)	7.5																					
Calorie value																						
Temp at firing (ta)	22.66																					
Temp final (tc)	23.52																					
Degree rise at 60%	0.516																					
t	0.86																					
W	2426																					
e3	17.25																					
Hg = (tW-e3)/m	**4926.452**																					
Total time temp change	7																					
for 95%	23.434																					

Moxa - MX-82 Punk Run-1																								
Weight (g)	0.42																							
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20	21	22
Temp	19.32	19.34	19.34	19.36	19.36	19.37	19.48	19.66	19.8	19.9	19.98	20.02	20.06	20.08	20.1	20.12	20.13	20.14	20.15	20.16	20.17	20.18	20.18	20.18
Wire used (cm)	5.7																							
Calorie value																								
Temp at firing (ta)	19.37																							
Temp final (tc)	20.18																							
Degree rise at 60%	0.486																							
t	0.81																							
W	2426																							
e3	13.11																							
Hg = (tW-e3)/m	**4647.5**																							
Total time temp change	9																							
for 95%	20.099																							

Moxa - MX-82 Punk Run-2																						
Weight (g)	0.42																					
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20
Temp	20.52	20.53	20.54	20.54	20.55	20.55	20.62	20.8	20.96	21.07	21.16	21.2	21.23	21.25	21.27	21.28	21.29	21.3	21.31	21.31	21.32	21.31
Wire used (cm)	6.9																					
Calorie value																						
Temp at firing (ta)	20.55																					
Temp final (tc)	21.32																					
Degree rise at 60%	0.462																					
t	0.77																					
W	2426																					
e3	15.87																					
Hg = (tW-e3)/m	**4409.881**																					
Total time temp change	7																					
for 95%	21.243																					

Moxa - MX-82 Punk Run-3																						
Weight (g)	0.42																					
Time	5	6	7	8	9	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	17	18	19	20
Temp	21.31	21.32	21.32	21.32	21.32	21.33	21.4	21.6	21.74	21.84	21.92	22	22	22.02	22.04	22.05	22.06	22.1	22.08	22.09	22.09	22.09
Wire used (cm)	7.2																					
Calorie value																						
Temp at firing (ta)	21.32																					
Temp final (tc)	22.09																					
Degree rise at 60%	0.462																					
t	0.77																					
W	2426																					
e3	16.56																					
Hg = (tW-e3)/m	**4408.238**																					
Total time temp change	7																					
for 95%	22.013																					

Appendix VI: Collected data from warm needle experiments

Warm Needle experiment

Needle 40mm x 0.30mm

Smokeless Moxa Cone

Weight	**0.425**	**0.413**	**0.42**	**0.414**	**0.419**	**0.413**	**0.425**	**0.413**	**0.42**	**0.414**	**0.419**	**0.413**		
Time min	**Temp 1**	**Temp 2**	**Temp 3**	**Temp 4**	**Temp 5**	**Temp 6**	**Temp 1a**	**Temp 2a**	**Temp 3a**	**Temp 4a**	**Temp 5a**	**Temp 6a**	**AVG smokeless**	**STDDev**
0	21.4	21.8	22.3	22.5	21.5	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
0.5	21.6	22	22.6	22.8	21.6	22.4	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.08
1	21.8	22.2	22.8	23	21.8	22.5	0.4	0.4	0.5	0.5	0.3	0.3	0.4	0.09
1.5	21.9	22.4	23	23.2	22.0	22.7	0.5	0.6	0.7	0.7	0.5	0.5	0.6	0.10
2	22.2	22.7	23.2	23.5	22.3	22.9	0.8	0.9	0.9	1.0	0.8	0.7	0.9	0.10
2.5	22.5	23	23.4	23.7	22.6	23.2	1.1	1.2	1.1	1.2	1.1	1.0	1.1	0.08
3	22.7	23.2	23.7	23.9	22.8	23.5	1.3	1.4	1.4	1.4	1.3	1.3	1.4	0.05
3.5	22.9	23.4	23.9	24.1	22.9	23.6	1.5	1.6	1.6	1.6	1.4	1.4	1.5	0.10
4	23.1	23.5	24	24.2	23.0	23.7	1.7	1.7	1.7	1.7	1.5	1.5	1.6	0.10
4.5	23.2	23.6	24.1	24.2	23.1	23.8	1.8	1.8	1.8	1.7	1.6	1.6	1.7	0.10
5	23.2	23.6	24.1	24.2	23.1	23.8	1.8	1.8	1.8	1.7	1.6	1.6	1.7	0.10
5.5	23.2	23.6	24.2	24.2	23.1	23.8	1.8	1.8	1.9	1.7	1.6	1.6	1.7	0.12
6	23.2	23.6	24.2	24.2	23.1	23.8	1.8	1.8	1.9	1.7	1.6	1.6	1.7	0.12
6.5	23.2	23.6	24.1	24.1	23.1	23.7	1.8	1.8	1.8	1.6	1.6	1.5	1.7	0.13
7	23.2	23.6	24.1	24.1	23.1	23.7	1.8	1.8	1.8	1.6	1.6	1.5	1.7	0.13
8	23.1	23.5	24	24	23.0	23.6	1.7	1.7	1.7	1.5	1.5	1.4	1.6	0.13
Max temp diff	1.8	1.8	1.9	1.7	1.6	1.6	1.8	1.8	1.9	1.7	1.6	1.6		
													Average	**1.7**
													SDEV	**0.12**

Needle 40mm x 0.3mm

Japanese Moxa Punk MX-86

Weight		0.425	0.423	0.421	0.422	0.422	0.426	0.425	0.423	0.421	0.422	0.422	0.426		
	Time min	**Temp 1**	**Temp 2**	**Temp 3**	**Temp 4**	**Temp 5**	**Temp 6**	**Temp 1a**	**Temp 2a**	**Temp 3a**	**Temp 4a**	**Temp 5a**	**Temp 6a**	**AVG Punk**	**STDev**
	0	23.3	23.4	23.3	23.1	22.7	23	0	0	0	0	0	0	0.0	0.00
	0.5	24.3	24.2	23.9	24.2	23.2	23.5	24.3	24.2	23.9	24.2	23.2	23.5	23.9	0.44
	1	25.4	25.1	24.7	25.3	24.1	24.5	25.4	25.1	24.7	25.3	24.1	24.5	24.9	0.50
	1.5	25.8	25.8	25.5	25.5	24.9	25.3	25.8	25.8	25.5	25.5	24.9	25.3	25.5	0.34
	2	25.8	25.9	25.7	25.6	25	25.5	25.8	25.9	25.7	25.6	25	25.5	25.6	0.32
	2.5	25.5	25.7	25.6	25.2	24.8	25.3	25.5	25.7	25.6	25.2	24.8	25.3	25.4	0.33
	3	25.2	25.4	25.3	24.8	24.5	24.9	25.2	25.4	25.3	24.8	24.5	24.9	25.0	0.34
	3.5	24.9	25.1	25	24.5	24.2	24.6	24.9	25.1	25	24.5	24.2	24.6	24.7	0.34
	4	24.7	24.8	24.7	24.3	24	24.4	24.7	24.8	24.7	24.3	24	24.4	24.5	0.31
	4.5	24.5	24.6	24.6	24.1	23.8	24.2	24.5	24.6	24.6	24.1	23.8	24.2	24.3	0.32
	5	24.4	24.5	24.4	23.9	23.6	24	24.4	24.5	24.4	23.9	23.6	24	24.1	0.36
	5.5	24.3	24.4	24.3	23.8	23.5	23.9	24.3	24.4	24.3	23.8	23.5	23.9	24.0	0.36
	6	24.2	24.3	24.3	23.7	23.4	23.8	24.2	24.3	24.3	23.7	23.4	23.8	24.0	0.37
	6.5	24.2	24.2	24.2	23.6	23.3	23.7	24.2	24.2	24.2	23.6	23.3	23.7	23.9	0.39
	7	24.1	24.2	24.1	23.5	23.3	23.7	24.1	24.2	24.1	23.5	23.3	23.7	23.8	0.37
	8	24	24.1	24	23.4	23.2	23.6	24	24.1	24	23.4	23.2	23.6	23.7	0.37
Max temp diff		2.5	2.5	2.4	2.5	2.3	2.5	25.8	25.9	25.7	25.6	25	25.5		

Needle	40mm x 0.25mm														
Smokeless Moxa cone															
Weight (g)		**0.418**	**0.424**	**0.421**	**0.422**	**0.419**	**0.416**	**0.418**	**0.424**	**0.421**	**0.422**	**0.419**	**0.416**		
	Time min	**Temp 1**	**Temp 2**	**Temp 3**	**Temp 4**	**Temp 5**	**Temp 6**	**Temp 1**	**Temp 2**	**Temp 3**	**Temp 4**	**Temp 5**	**Temp 6**	**AVG smokeless**	**STD**
	0	23.3	23.5	23.7	21.3	22.5	22.4	0	0	0	0	0	0	0.0	0.00
	0.5	23.4	23.8	24	21.5	22.7	22.6	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1	0.04
	1	23.5	23.9	24.1	21.6	22.8	22.8	0	0	0	0.0	0	0	0.0	0.00
	1.5	23.7	24.2	24.3	21.8	23	23	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.04
	2	24	24.4	24.5	22.1	23.2	23.3	0.5	0.5	0.4	0.5	0.4	0.5	0.5	0.05
	2.5	24.2	24.7	24.8	22.4	23.5	23.6	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.05
	3	24.5	24.9	25	22.7	23.8	23.8	1	1	0.9	1.1	1	1	1.0	0.06
	3.5	24.6	25.1	25.2	22.9	24	23.9	1.1	1.2	1.1	1.3	1.2	1.1	1.2	0.08
	4	24.8	25.2	25.3	23.0	24.1	24	1.3	1.3	1.2	1.4	1.3	1.2	1.3	0.08
	4.5	24.8	25.2	25.4	23.1	24.2	24.1	1.3	1.3	1.3	1.5	1.4	1.3	1.4	0.08
	5	24.9	25.2	25.4	23.2	24.2	24.1	1.4	1.3	1.3	1.6	1.4	1.3	1.4	0.12
	5.5	24.9	25.2	25.4	23.2	24.2	24.2	1.4	1.3	1.3	1.6	1.4	1.4	1.4	0.11
	6	24.9	25.2	25.4	23.2	24.2	24.2	1.4	1.3	1.3	1.6	1.4	1.4	1.4	0.11
	6.5	24.9	25.2	25.4	23.2	24.2	24.1	1.4	1.3	1.3	1.6	1.4	1.3	1.4	0.12
	7	24.9	25.2	25.4	23.2	24.1	24.1	1.4	1.3	1.3	1.6	1.3	1.3	1.4	0.12
	8	24.8	25.1	25.3	23.1	24.1	24	1.3	1.2	1.2	1.5	1.3	1.2	1.3	0.12
Max temp diff		**1.6**	**1.7**	**1.7**	**1.9**	1.7	1.8	1.4	1.3	1.3	1.6	1.4	1.4		
														Average	**1.4**
														SDEV	**0.1**

Needle 40mm x 0.25mm

Japanese Moxa Punk MX-86

Weight (g)	0.423	0.422	0.425	0.422	0.422	0.426	0.423	0.422	0.425	0.422	0.422	0.426		
Time min	**Temp 1**	**Temp 2**	**Temp 3**	**Temp 4**	**Temp 5**	**Temp 6**	**Temp 1a**	**Temp 2a**	**Temp 3a**	**Temp 4a**	**Temp 5a**	**Temp 6a**	**AVG punk**	**STD**
0	23.8	24.1	24	23.6	23.2	22.9	0	0	0	0	0	0	0.0	0.00
0.5	24.7	24.8	24.6	24.3	23.8	23.3	24.7	24.8	24.6	24.3	23.8	23.3	24.3	0.59
1	25.7	25.7	25.5	25.1	24.8	24.4	25.7	25.7	25.5	25.1	24.8	24.4	25.2	0.53
1.5	26.2	26.3	26.3	25.9	25.4	25.4	26.2	26.3	26.3	25.9	25.4	25.4	25.9	0.43
2	26.3	26.5	26.4	26.1	25.5	25.5	26.3	26.5	26.4	26.1	25.5	25.5	26.1	0.45
2.5	26.1	26.3	26.3	25.9	25.2	25.2	26.1	26.3	26.3	25.9	25.2	25.2	25.8	0.51
3	25.8	26.1	26	25.6	24.9	24.8	25.8	26.1	26	25.6	24.9	24.8	25.5	0.56
3.5	25.5	25.8	25.7	25.2	24.6	24.5	25.5	25.8	25.7	25.2	24.6	24.5	25.2	0.56
4	25.3	25.5	25.5	24.9	24.4	24.3	25.3	25.5	25.5	24.9	24.4	24.3	25.0	0.54
4.5	25.2	25.4	25.3	24.7	24.2	24.1	25.2	25.4	25.3	24.7	24.2	24.1	24.8	0.57
5	25	25.2	25.2	24.6	24.1	24	25	25.2	25.2	24.6	24.1	24	24.7	0.54
5.5	25	25.2	25.1	24.4	24	23.9	25	25.2	25.1	24.4	24	23.9	24.6	0.58
6	24.9	25.1	25	24.3	23.9	23.8	24.9	25.1	25	24.3	23.9	23.8	24.5	0.58
6.5	24.8	25	24.9	24.2	23.9	23.8	24.8	25	24.9	24.2	23.9	23.8	24.4	0.53
7	24.8	24.9	24.9	24.2	23.8	23.7	24.8	24.9	24.9	24.2	23.8	23.7	24.4	0.56
8	24.7	24.8	24.8	24.0	23.7	23.6	24.7	24.8	24.8	24.0	23.7	23.6	24.3	0.56
Max temp diff	**2.5**	**2.4**	**2.4**	**2.5**	**2.3**	**2.6**	**26.3**	**26.5**	**26.4**	**26.1**	**25.5**	**25.5**		
													Average	**26.1**
													SDEV	**0.4**

Needle 40mm x 0.25mm

Pre-rolled Moxa punk

Weight		0.324	0.329	0.324					
	Time min	Temp 1	Temp 2	Temp 3	**Temp 1a**	**Temp 2a**	**Temp 3a**	**Avg**	**SDEV**
	0	25.3	25	25	**0**	**0**	**0**	0.0	0.0
	0.5	25.5	25.1	25.1	0.2	0.1	0.1	0.1	0.1
	1	25.9	25.3	25.5	0.6	0.3	0.5	0.5	0.2
	1.5	26.3	25.7	25.9	1	0.7	0.9	0.9	0.2
	2	26.6	26.1	26.2	1.3	1.1	1.2	1.2	0.1
	2.5	26.7	26.3	26.4	1.4	1.3	1.4	1.4	0.1
	3	26.6	26.4	26.3	1.3	1.4	1.3	1.3	0.1
	3.5	26.4	26.2	26.1	1.1	1.2	1.1	1.1	0.1
	4	26.1	26	25.8	0.8	1	0.8	0.9	0.1
	4.5	25.9	25.7	25.6	0.6	0.7	0.6	0.6	0.1
	5	25.7	25.5	25.4	0.4	0.5	0.4	0.4	0.1
	5.5	25.5	25.3	25.3	0.2	0.3	0.3	0.3	0.1
	6	25.4	25.2	25.1	0.1	0.2	0.1	0.1	0.1
Max temp diff		**1.4**	**1.4**	**1.4**	1.4	1.4	1.4	1.4	
							AVG		1.4
							STD		0

Needle 40mm x 0.25mm

2.2g chinese moxa

Weight		2.2	2.2	0.324					
	Time min	Temp 1	Temp 2	Temp 3	Temp 1a	Temp 2a	Temp 3a	AVG	**SDEV**
	0	24.5	22.8	24	0.0	0	0	0.0	0.0
	1	24.5	22.8	24	0.0	0.0	0.0	0.0	0.0
	2	24.5	22.8	24	0.0	0.0	0.0	0.0	0.0
	3	24.5	22.8	24	0.0	0.0	0.0	0.0	0.0
	3.5	24.6	22.9	24	0.1	0.1	0.0	0.1	0.1
	4	24.8	23	24.1	0.3	0.2	0.1	0.2	0.1
	4.5	25.2	23.1	24.3	0.7	0.3	0.3	0.4	0.2
	5	26	23.3	24.6	1.5	0.5	0.6	0.9	0.6
	5.5	27	23.8	25.1	2.5	1.0	1.1	1.5	0.8
	6	28.2	24.4	26.1	3.7	1.6	2.1	2.5	1.1
	6.5	29.5	25.5	27.4	5.0	2.7	3.4	3.7	1.2
	7	30.3	26.8	28.6	5.8	4.0	4.6	4.8	0.9
	7.5	30.7	27.9	29.2	6.2	5.1	5.2	5.5	0.6
	8	30.9	28.4	29.4	6.4	5.6	5.4	5.8	0.5
	8.5	30.8	28.8	29.5	6.3	6.0	5.5	5.9	0.4
	9	30.6	28.9	29.3	6.1	6.1	5.3	5.8	0.5
	9.5	30.4	28.8	29.1	5.9	6.0	5.1	5.7	0.5
	10	30.1	28.6	29	5.6	5.8	5.0	5.5	0.4
	10.5	29.8	28.3	28.7	5.3	5.5	4.7	5.2	0.4
	11	29.6	28.1	28.5	5.1	5.3	4.5	5.0	0.4
	11.5	29.3	27.9	28.3	4.8	5.1	4.3	4.7	0.4
	12	29.1	27.7	28.1	4.6	4.9	4.1	4.5	0.4
	13	28.6	27.3	27.6	4.1	4.5	3.6	4.1	0.5
	14	28.1	26.8	27.2	3.6	4.0	3.2	3.6	0.4
	15	27.7	26.4	26.8	3.2	3.6	2.8	3.2	0.4
	16	27.3	26	26.4	2.8	3.2	2.4	2.8	0.4
Max temp diff		**6.4**	**6.1**	**5.5**	**6.4**	**6.1**	**5.5**	**6.0**	0.5
							AVG		6.0
							STD		0.5

Appendix VII: Temperature change results from differing needle diameters

Results from temperature change at needle end per moxa type and needle diameter.

	Max Change in Temp at needle end (°C) 0.25mm diameter		Max Change in Temp at needle end (°C) 0.3mm diameter	
	Smokeless *moxa*	*Moxa* Punk	Smokeless *moxa*	*Moxa* Punk
sample size	n = 6	n = 6	n = 6	n = 6
	1.6	2.5	1.8	2.5
	1.7	2.4	1.8	2.5
	1.7	2.4	1.9	2.4
	1.9	2.5	1.7	2.5
	1.7	2.3	1.6	2.3
	1.8	2.6	1.6	2.5
Sample AVG	1.7	2.5	1.7	2.5
Sample SD	0.1	0.1	0.1	0.1

The mean temperature increase for SM Cone was 1.7 +/- 0.1 (SD) ℃ compared to 2.5 +/- 0.1 ℃ for Japanese MP. The diameter of the needle had no affect on the mean temperature increase. As such all results were combined, for the dependent variable (the *moxa* type) giving a sample size of n=12