Original article

Preliminary study on effects of a hand-made natural sand hot pack on skin temperature changes compared with the standard hot pack

Piyanee Sriya[1], Panadda Hathachote[2], Arom Khunpasri[3], Chittapon Jantararussamee[4], and Wipapan Khimmaktong[5]

[1]Department of Anatomy; [2]Department of Physiology; [3]Department of Rehabilitation Medicine, Phramongkutklao College of Medicine; [4]Department of Anatomy, Faculty of Medicine, Srinakharinwirot University; [5]Department of Anatomy, Faculty of Science, Prince of Songkhla University

Abstract:

Objective: *To evaluate the efficacy of an in-house glass sand hot pack compared with the standard hot pack for therapeutic use by measuring the skin temperature.* ***Material and methods:*** *The study design was a single-blinded randomized control trial and conducted at Department of Physical Medicine and Rehabilitation, Phramongkutklao Hospital. The total of 60 healthy male subjects, aged 20-22 years old, were enrolled in the study. The subjects applied a standard hot pack on the right thigh and a glass sand hot pack on the left thigh. Skin temperature was recorded every 4 minutes for total duration of 28 minutes on both sides.* ***Results:*** *The average skin temperature using either the glass sand hot pack or standard hot pack was not significantly different ($p > 0.05$) at 0, 20, 24, and 28 minutes. However, the results showed a significant difference of temperature on skin reaching 40°C using the glass sand hot pack at 4, 8, 12, and 16 minutes which was the range of therapeutic temperature (40-45°C), compared with that using the standard hot pack.* ***Conclusion:*** *The future use of the glass sand hot pack as a natural therapeutic material at home or in the rehabilitation clinics is promising since its application could achieve the therapeutic temperature of 40°C for 20 minutes.*

Keywords: ● *Superficial heat* ● *Hot pack* ● *Sand hot pack*

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Corresponding Author: Piyanee Sriya, Department of Anatomy, Phramongkutklao College of Medicine, Rajvithi Rd., Ratchathewi Dirstrict, Bangkok 10400 Phone: 02 354 7760 E-mail: piyanisriya@gmail.com

นิพนธ์ต้นฉบับ

การศึกษาเบื้องต้นผลการเปลี่ยนแปลงอุณหภูมิผิวหนัง ระหว่างการใช้แผ่นประคบร้อนทรายแก้วที่ผลิตเองเปรียบเทียบกับแผ่นประคบร้อนมาตรฐาน

ปิยาณี ศรียา[1] ปนัดดา หัตถโชติ[2] อารมย์ ขุนภาษี[3] ชิตพล จันทรรัศมี[4] และ วิภาพรรณ ขิมมากทอง[5]

[1]ภาควิชากายวิภาคศาสตร์ [2]ภาควิชาสรีรวิทยา [3]ภาควิชาเวชศาสตร์ฟื้นฟู วิทยาลัยแพทยศาสตร์พระมงกุฎเกล้า [4]ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ [5]ภาควิชากายวิภาคศาสตร์ คณะวิทยาศาสตร์ มหาวิทยาลัยสงขลานครินทร์

บทคัดย่อ

วัตถุประสงค์ *เพื่อศึกษาเปรียบเทียบอุณหภูมิผิวหนังระหว่างผลของการใช้แผ่นประคบร้อนทรายแก้ว (glass sand hot pack) ที่ผลิตเองโดยบรรจุทรายละเอียดธรรมชาติที่ใส่ถุงผ้าด้ายดิบและแผ่นประคบร้อนมาตรฐาน (standard hot pack)* ***วัสดุและวิธีการ*** *ใช้รูปแบบการศึกษาแบบสุ่มในอาสาสมัครเพศชาย อายุ 20-22 ปี จำนวน 60 คน โดยทำการศึกษาที่แผนกกายภาพบำบัด กองเวชศาสตร์ฟื้นฟู โรงพยาบาลพระมงกุฎเกล้า เดือนกุมภาพันธ์ถึงเมษายน พ.ศ. 2553 แต่ละคนได้รับการวางแผ่นประคบร้อนทั้งสองชนิด โดยวางและแผ่นประคบร้อนมาตรฐานบริเวณขาขวาและวางแผ่นประคบร้อนทรายแก้วบริเวณขาซ้าย ใช้เวลานาน ชนิดละ 28 นาทีโดยบันทึกผลทุกๆ 4 นาที* ***ผลการศึกษา*** *ผลการศึกษาพบว่าอุณหภูมิเฉลี่ยขณะใช้แผ่นประคบร้อนมาตรฐาน ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p > 0.05$) และผลการทดลองพบว่า เมื่อวางแผ่นประคบร้อนทรายแก้วแล้ว อาสาสมัครมีอุณหภูมิผิวที่เพิ่มขึ้น นาทีที่ 4, 8, 12 และ16 ซึ่งเป็นช่วงอุณหภูมิที่ใช้ในการบำบัดรักษาทางกายภาพบำบัด (40-45˚C) ซึ่งให้ผลเช่นเดียวกับการใช้แผ่นประคบร้อนแบบมาตรฐานที่วางจำหน่าย* ***สรุป*** *ทั้งนี้ในอนาคตสามารถนำแผ่นประคบร้อนที่ใช้จากวัสดุธรรมชาติจากทรายแก้วนำไปประยุกต์ใช้ในการบำบัดรักษา ในช่วงอุณหภูมิและเวลาของการรักษาได้ซึ่งสามารถคงอุณหภูมิในการรักษาในช่วง 40˚C ในช่วงเวลาที่ใช้ในการรักษา 20 นาที*

คำสำคัญ: ● *ความร้อนตื้น* ● *แผ่นประคบร้อน* ● *แผ่นประคบร้อนทรายแก้ว*

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ได้รับต้นฉบับเมื่อ 3 พฤษภาคม 2563 แก้ไขบทความ 2 ธันวาคม 2563 ได้ตีพิมพ์เมื่อ 13 ธันวาคม 2563

ผู้นิพนธ์หลัก ปิยาณี ศรียา ภาควิชากายวิภาคศาสตร์ วิทยาลัยแพทยศาสตร์พระมงกุฎเกล้า ถนนราชวิถี เขตราชเทวี กรุงเทพฯ 10400

Introduction

A hot pack or a moist heat pack is a type of superficial heat therapeutic application, which is widely used in rehabilitation centers and spas[1]. The application of moist heat packs is functioned by a conductive physical law associated with the mechanism of heat energy moving from a high temperature object to an area of lower temperature. When the moist heat pack is placed on skin, moisture carries more calories transferring heat through the cutaneous blood vessels of the skin and muscle. The hot packs have affected cutaneous blood vessels leading to a massive temperature change within the first centimeter of tissue depth. Increased superficial tissue temperature leads to a release of chemical mediators such as histamine and prostaglandins resulting in vasodilation. In addition, the vasodilation is stimulated by cutaneous thermo receptors that synapse on the cutaneous blood vessels, causing the release of bradykinin to relax the smooth muscle walls. As a result of temperature elevation, such vasodilation increases tissue oxygenation and transport of metabolites from exercising tissue. As physiological and biomechanical of superficial heat can be used in thermotherapy for rehabilitation purposes, the hot pack is primarily used to control pain by rising soft tissue extensibility and increase blood circulation to injured tissue as well as accelerate healing[2,3]. As a result, treatment with hot packs benefits patients with chronic and acute pain, muscle strain, spasms, or arthritis. According to superficial thermotherapy effect, hot packs are usually selected for home program application by most patients. Commercially available hot packs are usually made of silica gel, which is silicon dioxide, SiO_2, extracted from the beach sand covered with canvas. SiO_2 can absorb heat energy leading to temperature rise. Each small silica gel granule contains a network of inter-connecting microscopic pores, which attract and hold moisture by a phenomenon known as adsorption. Canvas is a fibrous material that is capable of withstanding normal handling, breathing, and being permeable to water. This means that water molecules can pass through the material and be adsorbed by silica gel. For thermotherapy, commercially standard hot packs are kept in hot water at 70°C to 158°C which is thermostatically controlled before use. To use a hot pack, it is then taken from a boiling pot and wrapped with hot sheet fabric and placed on a treatment area for 20 minutes. It has been shown that properties of natural glass sand are similar to those of silica gel[3-5] which can maintain temperature stability and be applied for therapeutic purpose. Thus, simple development of in-house hot packs made from natural glass sand could be used in the same way as commercially silica gel packs. Therefore, the objective of this study is to compare an in-house glass sand hot pack with commercially standard hot pack for conduction on skin. This could be further developed for rehabilitation use in the future.

Materials and Methods

Study design

This study was a prospective single-blind randomized control trial. The study was approved by the Institutional Review Board of the Royal Thai Army, Medical Department. The approval number was 614/2552.

Subjects

Sixty healthy males aged between 20 and 22 years old volunteered to participate in this study after signing informed consent documents. During February to March 2010, subjects without a history of diabetes, hypersensitivity, impairment sensation, or skin inflammatory disease were included in the study at Department of Physical Medicine and Rehabilitation, Phramongkutklao Hospital. Before the study, all volunteers had to complete general health screening.

Preparation of in-house natural glass sand hot packs

Glass sand hot packs were made by filling a canvas bag, size 10x12 inches with 1,500 g of natural glass sand. Glass sand was collected from Khanom district, Nakhon Si Thammarat province which had fine glass-quality, white in color with a fineness grain size of 0.05-0.1 mm.

Experimental treatment

During the experiment, volunteers were lying in a prone position. Skin temperature probes were taped on the surface of both back thighs of volunteers and then centered with the wrapped hot packs. Four reusable hot packs, 10x12 inches, were used in the experiments in rotating order. Two hot packs were standard hot packs (Chatanooga Corp; Chattanooga, TN, USA) and the other two were in-house hot packs made from natural glass sand. These hot packs were kept at 71-80°C in a thermostat-controlled water bath before treatment. The hot packs were wrapped with six layers of dry towels and then carefully applied to the back of thighs. Subjects received a standard hot pack on the right thigh and a glass sand hot pack on the left. During the experiment, skin temperatures were recorded every 4 minutes for a total duration of 28 minutes on each side, and then the hot packs were removed. Visual inspection of the color of the skin was also carried out.

Statistical analysis

The data were expressed as mean ± standard deviation (SD) and statistically analyzed using a pair T-test. The value of $p > 0.05$ was considered to indicate statistical significance.

Results

The results of the temperature levels by application of the glass sand and standard hot packs on the back thighs of each volunteer recorded every 4 minutes are shown in Table 1. The average skin temperature using standard hot packs increased gradually between 0 to 16 minutes (32.71-40.29°C) and then declined at the last 12 minutes to 39.55°C. In addition, the mean skin temperature after applying with the glass sand hot packs increased abruptly between 0 to 12 minutes (32.71-40.74°C), and then declined at the last 16 minutes to 39.4°C. From Figure 1, the average skin temperature after applying glass sand hot packs reached a peak at 12 minutes at 40.74°C. In contrast, when using standard hot packs, the highest skin temperature was at 40.29°C. Using the glass sand hot packs, the average skin temperature decreased rapidly from 40.33-39.4°C within the last 8 min.

Table 1 Effect of the standard hot pack and sand hot pack application on skin temperature in 60 males

Time (minutes)	Temperature (°C)			*p*-value
	Glass sand hot pack mean±SD	Standard hot pack mean±SD	Mean Difference mean±SD	
0	32.72±1.06	32.71±1.04	0.02±0.19	0.336
4	37.16±1.89	35.77±1.55	1.39±0.32	< 0.001
8	39.92±1.85	38.61±1.76	1.31±0.33	< 0.001
12	40.74±1.59	39.9±1.55	0.84±0.29	< 0.001
16	40.72±1.29	40.29±1.27	0.43±0.23	0.012
20	40.33±1.04	40.25±1	0.08±0.19	0.587
24	39.87±0.86	39.94±0.81	-0.06±0.15	0.576
28	39.4±0.87	39.55±0.77	-0.15±0.15	0.136

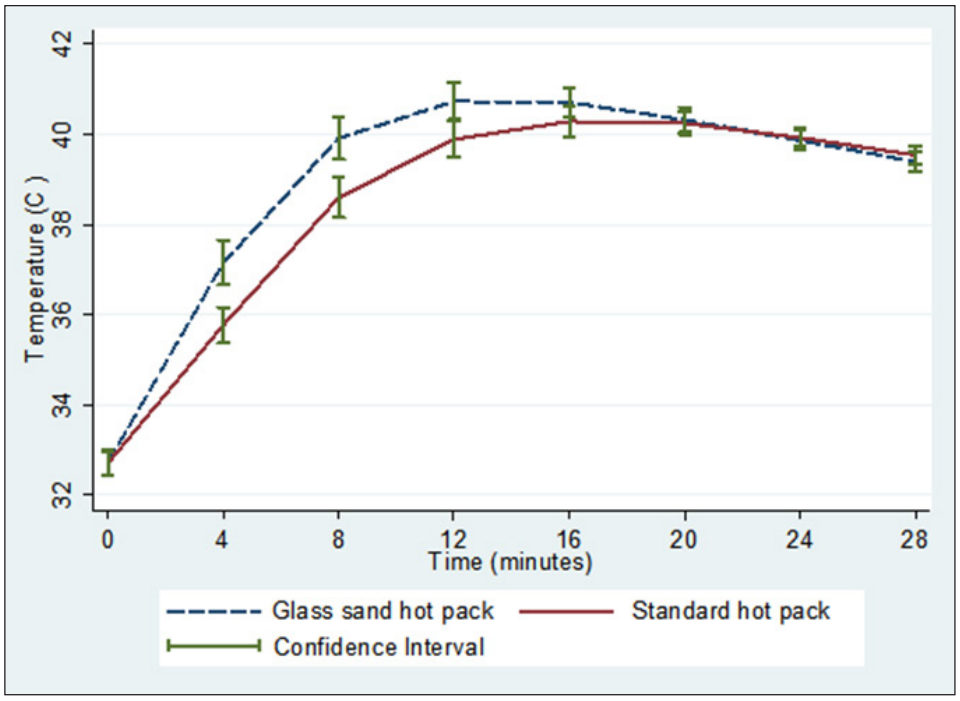

Figure 1. Effect of the standard hot pack and the glass sand hot pack application on skin temperature in 60 males (mean±SD)

As a result, the average skin temperature using either the glass sand or standard hot pack at 0, 20, 24, and 28 minutes was not significantly different ($p > 0.05$). However, the results revealed a significant difference of temperature on skin reaching the range of the therapeutic temperature of 40°C after applying the glass sand pack at 4, 8, 12, and 16 minutes compared with lower temperature obtained from applying the standard one. Burned areas on the skin was not visually observed using either the natural sand hot pack or the standard one.

Discussion

The use of therapeutic heat for treatment is common in many conditions such as back pain, arthritis, and soft tissue inflammation. The goal effects of superficial heat have been documented as increasing the local temperature of tissues and softening the surrounding tissue, which may improve the range of joint motion.[6] The thermal modalities such as moist heat pack, paraffin wax, and fluid therapy cause an increase in skin and subcutaneous tissue temperature within 1 to 3 cm depth.[7]

People can make their own reusable hot packs using insulating material filled with natural glass sand which is able to hold heat. Moisture carries more calories conducting heat through the cutaneous blood vessels of the skin and muscle. In addition, when local heat was placed on skin, the skin temperature was increased via two physiological mechanisms. The first approach is skin vasodilatation response via nociceptors initiation related to an axon-axon influx. The second way of prolonged blood flow is caused by calcium influx and nitric oxide. According to vasodilation, moist heat packs can be applied for skin temperature alteration to improve muscle spasm and soft tissue adhesion[8].

The thermotherapy application at temperatures of around 50°C may not be able to significantly increase skin, subcutaneous tissue, and muscle temperature[9]. However, under these conditions the epidermal to dermal layer can reach temperatures above 40°C[9], like those investigated in this study, which increase blood flow in the hypodermic layer[10].

However, nowadays, no data has been collected to evaluate the efficiency of these glass sand hot packs for therapeutic use. Our study showed that both standard silica gel and natural glass sand hot packs could absorb and retain a considerable amount of heat for therapeutic purposes. The time at target temperature was measured indicating both kinds of hot packs worked effectively and could achieve therapeutic temperature of 40-45°C within 12-20 minutes[11-15].

However, glass sand hot packs could significantly achieve therapeutic temperature quicker than the standard one. In the experiment, surface temperature increased dramatically as a result of rapid penetrating water in the towel. Glass sand hot packs could retain the heat less than that of the standard silica gel hot pack during the last 4 minutes. However, the retained temperatures were not significantly different and were not applicable for therapeutic temperature.

Our study used the finest natural glass sand collected from Nakhon Si Thammarat province, of which the size, uniformity, texture, composition, and chemical purity of glass sand has not yet been investigated. Thus, further study regarding the quality of natural glass sand should be conducted since it is one of the quality controls for the in-house preparation of hot packs. Additionally, glass sand hot packs have advantages over silica gel standard hot packs according to their economical price and self-packing option.

In conclusion, future use of the glass sand hot pack as a natural therapeutic material at home or in the rehabilitation clinics is promising since its application could achieve the therapeutic temperature of 40°C for 20 minutes.

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