

SURVEYING THE CORRELATION OF TEMPERATURE MEASURING BY NEW INFRARED METHOD AND RANGE OF MOTION OF JOINTS AFTER JOINT MOVEMENT EXERCISES

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ABSTRACT

Objective: The primary objective of this study was to investigate the connection between temperature variations and the range of motion (ROM) in the neck and shoulder regions following specific joint movements based on Traditional Medicine practices. To accomplish this, a novel infrared measurement method was employed to enhance the accuracy of assessments.

Method: The research was conducted at Ho Chi Minh City Hospital for Rehabilitation – Occupational Diseases over a period from April to July 2024. A total of 30 healthy participants, aged 18 and older, were recruited for the study, all of whom met established inclusion and exclusion criteria. To measure ROM and the temperature of acupoints in the neck and shoulder areas, an expert with over five years of relevant experience utilized a goniometer for assessing ROM and the advanced infrared method known as ATHERM for temperature measurement. The study specifically aimed to evaluate the changes in these parameters before and after the participants performed a series of joint movement exercises three times.

Results: The findings indicated a robust correlation between the observed temperature changes at the acupoints and improvements in ROM, which suggested that these exercises contributed to enhanced blood circulation and muscle function within the neck and shoulder regions.

Conclusion: This research underscores the significant relationship between temperature fluctuations at acupoints and improvements in

ROM, particularly for the bilateral shoulder joints and cervical spine, following exercises rooted in Traditional Medicine.

Keywords: *Traditional Medicine neck joint movement exercises, Traditional Medicine shoulder joint movement exercises, new infrared method, neck and shoulder ROM, goniometer, skin temperature*

I. INTRODUCTION

Neck and shoulder pain is a widespread issue that impacts quality of life and work [1]. Causes include poor posture, prolonged mechanical stress, trauma, and musculoskeletal diseases [2]. With increased use of electronic devices, the risk of this pain is rising [3]. It often results from muscle tension, spine disorders, or nerve issues [4], highlighting the need for further research to improve treatment and reduce its negative impact on public health and productivity. [5].

In traditional medicine, joint movement exercises in massage help treat musculoskeletal issues by relieving pain, improving function, circulation, and mobility [16]. However, evidence on their effectiveness for treating neck and shoulder pain and enhancing circulation is limited.

Infrared methods for measuring skin temperature are emerging as a tool for diagnosing musculoskeletal diseases by assessing circulation and inflammation [6]. However, challenges with accuracy and reflecting physiological disorders remain [7], requiring further research to improve clinical use, early diagnosis, and treatment [8].

This study examines the effects of neck and shoulder exercises in healthy individuals by measuring changes in skin temperature, range of motion (ROM), and the correlation between thermal response and joint flexibility.

II. SUBJECTS AND METHODS

2.1. Subjects, locations and study period

Participants were recruited within the age groups of 18 years old or older, regardless of gender or occupation. Suitable participants must (1) be

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actively engaged in regular study, work, and daily activities; (2) possess full cognitive and behavioral capacity; and (3) provide voluntary consent before participation. Individuals who have (1) reported or complained of neck or shoulder pain in the previous month; (2) history of neck and shoulder disorders, including injuries and fractures, and a history of neurological and/or rheumatic disorders; (3) other significant medical histories are excluded from this study.

2.2. Research methods

A cross-sectional study of 30 individuals was conducted from April to July 2024 at Ho Chi Minh City Hospital for Rehabilitation – Occupational Diseases. The background variables include age and gender (Male/Female). The study variables are shoulder range of motion (Flexion, extension, abduction, adduction, internal rotation, external rotation), neck range of motion (Flexion, extension, right side bending, left side bending, right rotation, left rotation), skin temperature of acupuncture points in the shoulder region (unit: °C) (GB-21, LI-15, TB-14, SI-9, LU-2, LI-14), the neck region (unit: °C) (GB-20, GV-16, GV-14) and specific acupuncture points in the neck region (unit: °C) (LI-7, SI-3). Room temperature is 26°C.

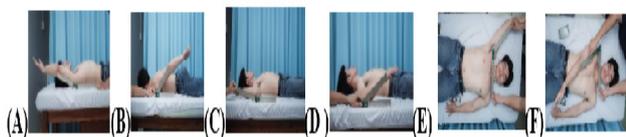


Figure 1. Shoulder ROM. (A) Flexion, (B) Extension, (C) External rotation, (D) Internal rotation, (E) Abduction, (F) Adduction

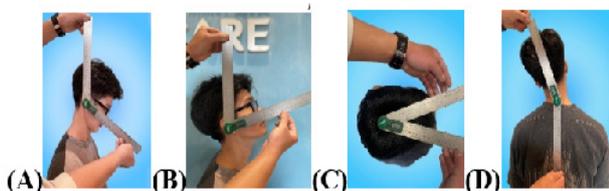


Figure 2. Neck ROM. (A) Flexion, (B) Extension; (C) Rotation, (D) Side bending.

- Measurement and data collection tools

A goniometer was used for measuring of joint range of motion has calibration certificate No. KT3-00481ADD4 dated April 11, 2024

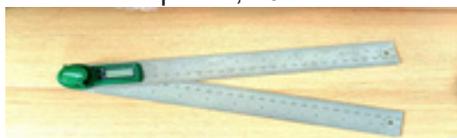


Figure 3. Goniometer

ATHERM infrared method No. 0057TN24/TĐC – TN has been standardized at the Ho Chi Minh City Quality Measurement Standards Technical Center on February 1, 2024 and accepted by BME10 Program Committee for publishing in IFBME Proceedings (Springer), indexed by Scopus.



Figure 4. AThERM infrared method

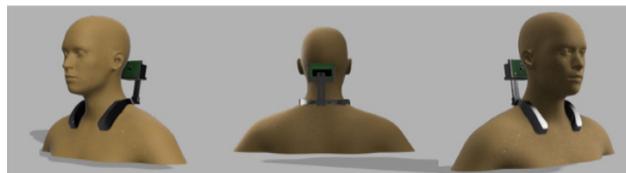


Figure 5. Design of the AThERM machine - Procedure

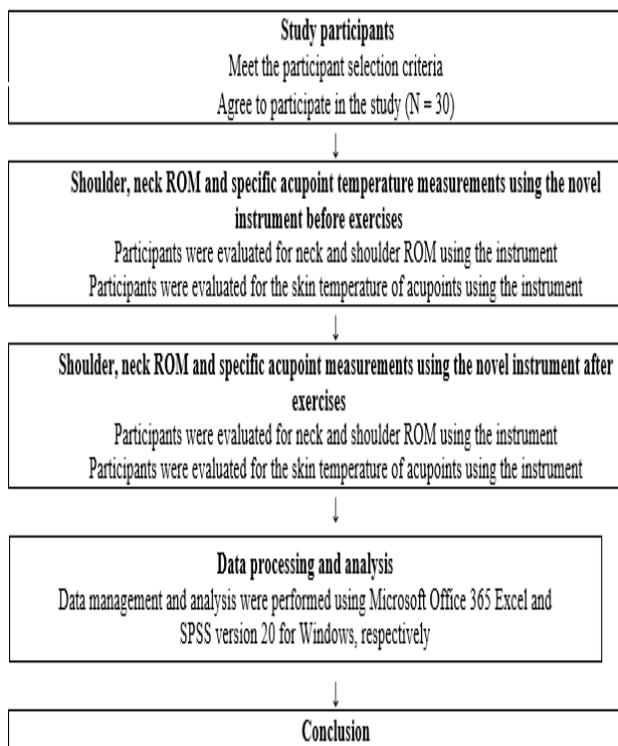


Figure 6. Procedure - Joint movement exercises [16] :



Figure 7. Shoulder joint movement exercise. (A) Small rotation; (B) Wide rotation forward. (C) Shoulder stretch; (D) Wide rotation back

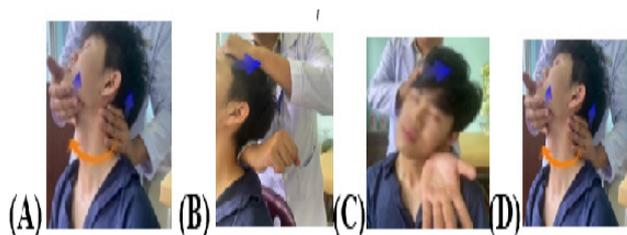


Figure 8. Neck joint movement exercise. (A) 360° rotation; (B) Extension; (C) Side bending.

2.3. Research ethics

This research project has received ethical approval from the Institutional Review Board (IRB)

III. RESULT

The study surveyed 30 healthy volunteers who met the inclusion and exclusion criteria at Ho Chi Minh City Hospital for Rehabilitation - Occupational Diseases from Feb 2024 to May 2024:

Table 1. Assessment of shoulder range of motion and before and after shoulder joint movement exercise

ROM	Before exercise	After exercise
Mean ± Standard Deviation		
Flexion	164.74° ± 7.05	174.44° ± 5.74
	Δ= 9.7° ± 2.04	
	p < 0.001	
Extension	35.22° ± 3.98	39.93° ± 3.67
	Δ=4.7° ± 0.97	
	p < 0.001	
Abduction	166.5° ± 5.73	174.33° ± 6.04
	Δ= 7.83° ± 1.78	
	p < 0.001	
Adduction	36.48° ± 3.36	42.09° ± 3.66
	Δ= 5.61° ± 1.61	
	p < 0.001	
Internal rotation	76.35° ± 3.51	80.7° ± 4.14
	Δ= 4.35° ± 1.87	
	p < 0.001	
External rotation	75.17° ± 3.40	79.74° ± 3.4
	Δ= 4.57° ± 0.85	
	p < 0.001	

According to Table 1, The shoulder ROM increased with a statistically significant change (p < 0.05), with an increase from 4.35° to 9.70°.

Table 2. Assessment of shoulder range of motion and before and after shoulder joint movement exercise

ROM	Before exercise	After exercise
Mean ± Standard Deviation		
Flexion	41.31° ± 6.72	46.71° ± 6.78
	Δ= 5.40° ± 1.08	
	p = 0.002	

No. 287 of the University of Medicine and Pharmacy (UMP) on February 1, 2024, and was assigned the code 06/IRB - RVH - OHP on the same date at the Rehabilitation Hospital - Occupational Health Disease, Ho Chi Minh City. The study aims to solely evaluate and improve patient health, not for any other purpose. All participants voluntarily engaged in the study after receiving written consent and a thorough explanation of the study protocol. As any participants show signs of non-cooperation or request to stop participating in the study, the study will discontinue their involvement.

ROM	Before exercise	After exercise
Extension	63.25° ± 7.93	68.43° ± 8.00
	Δ=5.18° ± 0.98	
	p = 0.014	
Left side bending	63.48 ° ± 2.55	73.75° ± 3.29
	Δ= 10.27° ± 3.05	
	p < 0.001	
Right side bending	69.47° ± 1.94	78.78° ± 2.56
	Δ=9.31° ± 1.96	
	p < 0.001	
Left rotation	43.14° ± 4.99	50.81° ± 5.15
	Δ= 7.67° ± 0.94	
	p < 0.001	
Right rotation	42.75° ± 4.80	50.35° ± 4.78
	Δ= 7.60° ± 0.9	
	p < 0.001	

Table 2 shows the neck ROM increased with a statistically significant change (p < 0.05), with an increase from 5.18° to 10.27°.

Table 3. Assessment of acupoints temperature on the shoulder before and after shoulder joint movement exercise

Temperature	Before exercise	After exercise
Mean ± Standard Deviation		
GB-21	34.44° C ± 1.27	36.61° C ± 1.47
	Δ= 2.17° C ± 0.37	
	p < 0.001	
LI-15	34.38° C ± 1.61	35.58° C ± 2.23
	Δ= 1.20° C ± 0.73	
	p = 0.02	
TB-14	34.55° C ± 1.74	37.64° C ± 2.09
	Δ= 3.10° C ± 0.46	
	p < 0.001	
SI-9	34.62 ° C ± 2.05	37.62° C ± 1.81
	Δ= 3.00° C ± 0.40	
	p < 0.001	
LU-2	34.48° C ± 1.83	37.67° C ± 2.36
	Δ= 3.18° C ± 0.68	
	p < 0.001	
LI-14	35.7° C ± 2.4	39.04° C ± 0.59
	Δ= 3.35° C ± 2.49	
	p < 0.001	

Table 3 indicates the temperature of acupuncture points in the shoulder area increased statistically significantly (p < 0.05), with an increase from 1.2°C to 3.35°C after joint exercise.

Table 4. Assessment of acupoints temperature on the neck before and after neck joint movement exercise

Temperature	Before exercise	After exercise
Mean ± Standard Deviation		
GB-20	35.64° C ± 2.06	36.55° C ± 2.02
	$\Delta = 1.13^\circ \text{C} \pm 0.87$	
	$p = 0.035$	
GV-16	35.97° C ± 3.06	37.64° C ± 3.32
	$\Delta = 1.67^\circ \text{C} \pm 1.02$	
	$p = 0.048$	
GV-14	35.8° C ± 2.53	37.57° C ± 2.55
	$\Delta = 1.77 \pm 0.53$	
	$p < 0.001$	

As Table 4, the neck temperature increased statistically significantly ($p < 0.05$), with an increase from 1.13°C to 1.77°C after exercising the neck and shoulder joints.

Table 5. Assessment of specific acupoints temperature for the neck before and after neck joint movement exercise

Temperature	Before exercise	After exercise
Mean ± Standard Deviation		
LI-7	35.88° C ± 2.79	37.45° C ± 2.91
	$\Delta = 1.57^\circ \text{C} \pm 0.74$	
	$p = 0.038$	
SI-3	35.71° C ± 2.29	37.58° C ± 2.28
	$\Delta = 1.87^\circ \text{C} \pm 0.46$	
	$p < 0.001$	

Table 5 shows the temperatures of LI-7 and SI-3 acupuncture points both increased statistically significantly ($p < 0.05$), with an increase from 1.57°C to 1.87°C

Table 6. Correlation between changes of shoulder acupuncture point temperature and shoulder ROM

r/pearson	Flexion	Extension	Abduction	Adduction	Internal rotation	External rotation
GB-21	0.97	0.96	0.94	0.91	0.95	0.94
LI - 15	0.95	0.93	0.97	0.96	0.97	0.97
TB - 14	0.96	0.94	0.93	0.91	0.94	0.93
SI - 9	0.96	0.92	0.99	0.98	0.99	0.98
LU - 2	0.91	0.95	0.88	0.89	0.89	0.92
LI - 14	0.97	0.96	0.96	0.94	0.97	0.95

Table 6 presents the correlation coefficients (r) between the changes in temperature at various shoulder acupuncture points and the range of motion (ROM) in different shoulder movements. The correlation coefficients range from 0.88 to 0.99 across the various measures, indicating a strong relationship between temperature changes and shoulder ROM.

Table 7. Correlation between changes of neck acupuncture point temperature and shoulder ROM

r/pearson	Flexion	Extension	Right side bending	Left side bending	Right rotation	Left rotation
GB - 20	0.85	0.87	0.88	0.90	0.94	0.91
GV - 16	0.89	0.91	0.91	0.93	0.96	0.94
GV - 14	0.89	0.90	0.91	0.93	0.96	0.94
LI - 7	0.88	0.90	0.90	0.91	0.95	0.93
SI - 3	0.90	0.91	0.92	0.95	0.98	0.96

Table 7 presents the correlation coefficients (r) between changes in temperature at various neck acupuncture points and the range of motion (ROM) in shoulder movements, including flexion, extension, side bending, and rotation. The results reveal a generally positive correlation between temperature changes at these acupuncture points and shoulder ROM across all measured movements.

IV. DISCUSSION

This study aimed to investigate the correlation between temperature and ROM of the neck and shoulder when practicing neck and shoulder joint movement exercise according to Traditional medicine using a new infrared method on healthy people, providing remarkable results in a better understanding of the effects of exercise on body temperature and ROM.

According to traditional medicine, the body’s meridian system facilitates the circulation and movement of Qi (energy) and blood. The sinew meridians connect various joints and are primarily responsible for movement. The “knot” and “prosperity” points of the sinew meridians are located at the acupoints surrounding the joints. Therefore, we selected acupoints around the shoulder, including GB-21, LI-15, TB-14, SI-9, LU-2 and LI-14 to survey the temperature of the shoulder region. For the neck and nape area, we examined acupoints GB-20, GV-16 and GV-14 [16]. The acupoint LI-7 is significant for the neck and shoulders, while SI-3 is a crucial distal point related to pain, stiffness, and contracture along the meridian path and various cervical spine disorders [15].

In healthy individuals, restrictions in the range of motion (ROM) in the joints are often attributed to muscle tension caused by improper postures during daily activities or related pathologies. In such cases, skin temperature at the joints tends to be higher than that in other areas, indicating an inflammatory response that may be associated with the tension and discomfort in the muscles surrounding the joints [10,11].

Joint movement exercise is one of the massage techniques and a non-pharmacological method in traditional medicine. Joint movement exercise supports the muscle pump mechanism, aiding venous blood return to the heart. The contraction and relaxation of muscles during passive movement create a pumping action, facilitating venous blood return and increasing circulation [12]. The release of chemicals such as nitric oxide, prostaglandins, and adenosine leads to vasodilation, enhancing blood flow to the tissues [13]. The dilation of superficial skin blood vessels helps increase thermal dissipation from the body into the surrounding environment. This contributes to the perception of warmth on the skin surface, measured by the increase in temperature in our study [14].

The results indicate a significant correlation between body skin temperature and the ROM in the neck and shoulders. After joint movement exercises, the ROM for both the neck and shoulder joints increased. For shoulder ROM, the flexion movement showed the most significant increase with a mean rise of 9.70° (±2.04), while the internal rotation movement had the lowest increase with a mean of 4.35° (±1.87). In terms of neck ROM, left rotation exhibited the highest increase with a mean rise of 10.27° (±3.05), while the extension movement had the lowest with a mean of 5.18° (±0.98). LI-14 is the intersection point of the two meridians Hand Yang Ming Large Intestine and Foot Yang Ming Stomach, which is a meridian with much Qi and much blood. The temperature of LI-14 is highest before (35.70°C ± 2.40) and after exercise (39.04°C ± 0.59) which is evidence that

this is a meridian with much Qi and much blood in traditional medicine.

The infrared method we used has proven to be an accurate tool for measuring surface temperature on the body. Results from this method show high consistency and reliability in identifying temperature changes after joint movement exercises [17]. The infrared method also provides continuous, non-invasive observation capabilities, allowing for the tracking of temperature changes over time during exercise.

V. CONCLUSION

This study reveals a strong correlation between increased skin temperature at neck and shoulder acupoints and improved range of motion (ROM) after joint exercises based on traditional medicine. The rise in temperature is linked to better circulation and muscle function. Infrared measurement proved accurate in assessing temperature changes, highlighting its potential for clinical use. Further research with larger, diverse samples is needed to confirm these findings and apply them to broader populations. This could lead to personalized exercise programs and better management of neck and shoulder pain, enhancing patient care and recovery.

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