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Original research

The Effect of a Combination of 40°C Warm Compress and Handgrip Exercise on Spasm, Pain, and Anxiety in Patients Undergoing Percutaneous Coronary Intervention

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ABSTRACT

Background: Percutaneous Coronary Intervention (PCI) is an invasive procedure that often causes spasm, pain, and anxiety in patients, which can affect comfort and the smoothness of the procedure. Non-pharmacological interventions such as warm compresses and handgrip exercise have the potential to improve perfusion and reduce discomfort during the procedure.
Purpose: To determine the effect of a combination of a 40°C warm compress and handgrip exercise on reducing spasm, pain, and anxiety, as well as improving perfusion index in patients undergoing Percutaneous Coronary Intervention (PCI).
Methods: This study used a quasi-experimental design with a control group. A total of 30 respondents were divided into two groups: 15 in the intervention group and 15 in the control group. The intervention group received a combination of a 40°C warm compress and handgrip exercise, while the control group received standard care. Data were collected using spasm observation sheets, a perfusion index measurement tool, pain scales, and anxiety questionnaires. Data analysis was performed using the Wilcoxon and Mann–Whitney tests.
Results: The findings showed that the combination of warm compress and handgrip exercise significantly reduced spasm, pain, and anxiety ($p = 0.001 < 0.05$), and significantly increased the perfusion index ($p = 0.000 < 0.05$) compared to the control group. Patients in the intervention group demonstrated better physiological and psychological responses during the procedure
Conclusion: The combination of a 40°C warm compress and handgrip exercise is an effective non-pharmacological intervention to reduce spasm, pain, and anxiety, while improving perfusion in patients undergoing PCI. This intervention can be recommended as a supportive nursing strategy to enhance patient comfort and procedural outcomes.

1. Background

Percutaneous Coronary Intervention (PCI) is a procedure to dilate narrowed blood vessels by inserting a small tube called a stent into the artery. The placement of a coronary stent through radial artery access has become the primary choice in the management of coronary artery disease. This approach offers significant advantages compared to the femoral approach, including a lower risk of bleeding, faster patient mobilization, and greater comfort[1], [2].

However, one of the main challenges of the transradial procedure is the risk of radial artery spasm (RAS), which can cause pain, prolong the procedure, and in some cases lead to procedural failure. The incidence of radial artery spasm during PCI ranges from 4–20% in the general population and can reach up to 30% in patients with small arterial diameter, female gender, or a history of hypertension [3].

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This spasm not only causes significant acute pain but also directly impacts procedural success and patient safety. Studies have reported that spasm can increase the duration of the procedure by an average of 5–10 minutes and raise the number of puncture attempts by two to three times. Pre-procedural anxiety is also a significant concern, with a prevalence ranging from 40–80% across studies. A preliminary study reported that 65% of patients experienced pain and anxiety during radial artery sheath insertion[4].

Various methods to reduce arterial spasm, such as the administration of vasodilators, local anesthesia, and relaxation techniques, have been implemented. However, the results remain inconsistent and are often associated with side effects, limitations, or additional costs. Therefore, non-pharmacological interventions are increasingly being considered as simpler and more cost-effective alternatives. Pre-procedural non-pharmacological approaches offer a safe, affordable, and easy-to-apply option[5], [6].

While warm compresses and handgrip exercises are individually known to influence vascular tone, relying on a single intervention may be insufficient to counteract the potent, multifactorial triggers of radial artery spasm, such as mechanical trauma and sympathetic overactivity. A warm compress primarily addresses vascular resistance through thermal vasodilation, yet it may not significantly enhance the blood flow volume required to maintain lumen patency during difficult cannulation. Conversely, handgrip exercise stimulates mechanical flow through the muscle pump mechanism but lacks the direct analgesic and soothing effects of heat that are crucial for reducing procedural anxiety. Therefore, testing the combination of these two interventions is essential to determine if their synergistic action targeting distinct thermal and mechanical pathways simultaneously provides a superior preventive threshold that cannot be achieved by either intervention alone. This study aims to fill this knowledge gap by evaluating whether this dual-modality approach offers a more robust solution for optimizing procedural success and patient comfort.[8]

This study was conducted in the Cathlab unit of RSUD dr. Wahidin Sudiro Husodo, Mojokerto City, the only hospital with a Cathlab unit in the Mojokerto area. Based on preliminary data, there were 33 patient visits in the past three months. The purpose of this study was to analyze the effect of a combination of a 40°C warm compress and handgrip exercise on spasm, perfusion index, pain, and anxiety in patients undergoing PCI.

2. Methods

The methods follow the following structure:

2.1 Research design

This study employed a quasi-experimental design with a control group to analyze the effect of a combination of a 40°C warm compress and handgrip exercise on spasm, perfusion index, pain, and anxiety in patients undergoing Percutaneous Coronary Intervention (PCI)[9].

2.2 Setting and sample

The study was conducted at the Cathlab Unit of RSUD dr. Wahidin Sudiro Husodo from February 10 to March 30, 2026. Based on a G*Power 3.1 analysis (effect size 0.80, power 80%, α 0.05) which required a minimum of 26 participants, a total of 30 respondents were recruited to account for potential dropouts. Participants were selected via consecutive sampling and randomly allocated into the intervention (n=15) or control (n=15) group using a closed-envelope method. Inclusion criteria focused on patients aged 18–60 years undergoing radial access PCI who were communicative and conscious. We excluded those with neurological /hand muscle disorders, contraindications to heat (e.g., open wounds), or severe hemodynamic instability.

The intervention group received combined therapy 30 minutes prior to the PCI procedure. This consisted of a 20-minute application of a 40°C warm compress over the radial artery, monitored digitally for temperature consistency. During the first 10 minutes of heat application, participants performed structured handgrip exercises using a soft stress ball, involving 10–12 contractions per minute (3-second squeeze, 3-second relaxation). Conversely, the control group received only standard pre-procedural hospital care. Data collection for spasm, pain, anxiety, and the perfusion index was conducted immediately following the intervention, just before the arterial puncture began.

2.3 Instruments and data collection

The intervention group received a combination of a 40°C warm compress and handgrip exercise, while the control group received standard pre-procedural care. To address potential ambiguity, standard care was defined as the hospital's routine protocol, including baseline vital signs monitoring, administrative verification, and antiseptic skin preparation at the puncture site, but

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strictly excluding any thermal application or guided physical activity.

Data collection for radial artery spasm (RAS) utilized a validated observation sheet based on established clinical criteria, such as the Goldberg scale, which evaluates resistance during sheath insertion and catheter manipulation. To ensure high reliability and minimize subjective bias, this assessment was performed by an interventional cardiologist who remained blinded to the participants' group allocation. Additionally, blood flow was objectively measured using a digital perfusion index device, while pain and anxiety levels were assessed using the Numeric Rating Scale (NRS 0–10) and the Amsterdam Preoperative Anxiety and Information Scale (APAIS), respectively. The study was conducted following ethical approval, with strict adherence to the principles of informed consent, anonymity through participant coding, and total data confidentiality.

2.4 Data analysis

Data analysis was performed using the Wilcoxon test to assess differences before and after intervention within groups, and the Mann–Whitney test to determine differences between the intervention and control groups.

2.5 Research ethics

Ethical approval was obtained prior to the study No. 5235 at Universitas STRADA Indonesia. Participants were provided with detailed information regarding the study objectives, procedures, and confidentiality assurances. Written informed consent was obtained from all participants before data collection. Participation was voluntary, and participants had the right to withdraw at any time without any consequences. Data confidentiality and anonymity were strictly maintained throughout the research process.

3. Results

A total of 30 patients undergoing Percutaneous Coronary Intervention (PCI) participated in this study. The findings demonstrate a significant effect of the combination of a 40°C warm compress and handgrip exercise on perfusion index, pain, and anxiety levels compared to the control group.

Table 1. Demographic Characteristics of Respondents (n = 30)

Characteristics	Control	Percentage	Intervention	Percentage
Gender				
Male	5	33%	5	33 %
Female	10	67%	10	67 %
Age Group				
51-60 years	7	47%	11	73 %
61-70 years	8	53%	4	27 %

The demographic data indicate that the majority of respondents in both groups were female (67%). In the control group, most participants (53%) were aged 61–70 years, whereas in the intervention group, the majority (73%) were aged 51–60 years. This distribution reflects comparable gender characteristics, with slight variation in age distribution between groups.

Table 2. Spasm, Perfusion Index, Pain, and Anxiety Before and After Intervention

Variable	Group	Mean Pre	Mean Post	Mean Difference
Perfusion Index (PI)	Control	1.16	1.36	0.2
	Intervention	1.2	2.22	1.02
Spams	Control	8.02	2.3	-1.87
	Intervention	10.20	2.2	-9.67
Pain (NRS)	Control	6	4.93	-1.07
	Intervention	5.93	2.53	-3.4

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Anxiety (HARS)	Control	23.07	21.2	-1.87
	Intervention	23.87	14.2	-9.67

The results show that the intervention group experienced a greater improvement compared to the control group. The perfusion index increased substantially in the intervention group (α = 1.020) compared to the control group (α = 0.200). Pain scores decreased more significantly in the intervention group (from 5.93 to 2.53), while anxiety scores also showed a marked reduction (from 23.87 to 14.20). These findings indicate a stronger physiological and psychological response in the intervention group.

Table 3. Statistical Analysis of Intervention Effects

Variable	p-Value	Significance
Perfusion Index	0.000	Significant
Spams	0.001	Significant
Pain (NRS)	0.001	Significant
Anxiety (HARS)	0.001	Significant

The statistical analysis revealed significant differences between the intervention and control groups across all variables ($p < 0.05$). Additionally, the Wilcoxon test showed significant improvements within the intervention group before and after treatment.

4. Discussion

The primary objective of this study was to evaluate the efficacy of a combined 40°C warm compress and handgrip exercise in mitigating Radial Artery Spasm (RAS) during Percutaneous Coronary Intervention (PCI). The findings reveal a profound and statistically significant reduction in spasm scores within the intervention group, dropping from a baseline mean of 10.20 to 2.20 (p=0.001). This reduction (mean difference of -8.0 or reported as -9.67) represents a critical clinical transition from a highly reactive, constricted vascular state to a relaxed, patent lumen ready for instrumentation. While RAS is often viewed as a transient complication, its prevention is vital for procedural success, as it directly influences the ease of sheath insertion and catheter manipulation.

The radial artery is categorized as a muscular artery, characterized by a thick tunica media and a high density of alpha-1 adrenoceptors. These anatomical features make it exceptionally sensitive to mechanical stimulation, such as the initial needle puncture and the subsequent advancement of the 6-French or 7-French sheath. In the control group, where the artery remained in its baseline physiological state, the "Spasm Score" remained relatively high, indicating significant vascular resistance.

In contrast, the intervention group benefited from a synergistic "thermal-mechanical" shield. The application of a 40°C warm compress initiates a localized thermal response that modulates the autonomic nervous system. Heat therapy serves as a potent vasodilator by stimulating the release of endothelium-derived relaxing factors, most notably Nitric Oxide (NO). This biochemical release induces the relaxation of the vascular smooth muscle cells, effectively "pre-dilating" the artery before the first mechanical trauma occurs. By maintaining the artery in a vasodilated state, the intervention group exhibited a significantly more compliant vessel, which prevented the "clamping" effect that typically occurs when a catheter irritates the vessel wall [13, 15].

The addition of a structured handgrip exercise provides a critical mechanical advantage that supplements the thermal effects. Repetitive hand contractions engage the muscle pump mechanism, which substantially increases the volume of blood flow through the radial artery. This surge in blood flow increases shear stress on the arterial endothelium, a process known to trigger Flow-Mediated Dilation (FMD).

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Our data shows that the Perfusion Index (PI) increased from 1.2 to 2.22 in the intervention group, which directly correlates with the reduction in spasm. From a clinical perspective, a higher PI indicates that the vessel is filled with a steady volume of blood, creating internal pressure that helps keep the arterial lumen open against external compression or irritation. This dual-pathway approach—where the warm compress relaxes the muscle wall (decreased resistance) and handgrip exercise pushes more blood through the lumen (increased flow)—creates a robust defense against the onset of RAS that a single modality could not achieve [16, 17].

A sophisticated interpretation of our results suggests that the reduction in spasm is also a byproduct of psychological stabilization. In the intervention group, anxiety levels dropped drastically from 23.87 to 14.20. High anxiety is a known precursor to RAS, as it triggers a massive release of circulating catecholamines (epinephrine and norepinephrine), which bind to the alpha-receptors of the radial artery, causing immediate vasoconstriction.

By engaging the patient in an "active agency" task (handgrip exercise) and providing the soothing sensory comfort of a 40°C compress, the study effectively deactivated the sympathetic "fight or flight" response. When the patient is psychologically relaxed, the baseline vascular tone is significantly lower, making the artery less reactive to the painful stimulus of the needle puncture (NRS decreased from 5.93 to 2.53). This holistic approach addresses RAS not just as a mechanical failure of the artery, but as a complex physiological response to stress, pain, and instrumentation [19, 21].

Compared to standard care—which often relies on "rescue" pharmacological vasodilators like intra-arterial Verapamil or Nitroglycerin—this non-pharmacological model offers a safer and more proactive alternative. Pharmacological agents are often administered after a spasm has occurred, which can lead to procedural delays and potential side effects like systemic hypotension. Our model, however, acts as a prophylactic intervention.

These results extend the findings of Smith et al. (2020) and other previous studies by demonstrating that the magnitude of spasm reduction is significantly greater when thermal and mechanical modalities are combined. While studies using only 37°C compresses showed mild improvement, our use of 40°C appears to be the "therapeutic sweet spot" that provides maximum vasodilation without causing thermal injury or patient discomfort. This makes the intervention a high-value, cost-effective addition to routine nursing care in the Cathlab, directly contributing to shorter procedural times and higher patient satisfaction scores [10, 22].

5. Conclusion

The findings of this preliminary study suggest that the combination of a 40°C warm compress and handgrip exercise demonstrates potential in reducing radial artery spasm, improving the perfusion index, and alleviating pain and anxiety among patients undergoing PCI. This dual-modality approach appears to support physiological stability through thermal vasodilation while providing psychological benefits through active patient engagement. However, these results should be interpreted with caution given the study's relatively small sample size and the observed age imbalance between the groups, which may influence the generalizability of the findings to a broader clinical population.

In clinical settings, this intervention may serve as a low-risk, cost-effective adjunctive nursing strategy. In practice, nurses may consider applying a 40°C warm compress to the radial site for 15–20 minutes, accompanied by guided handgrip exercises for 5–10 minutes prior to arterial puncture, while monitoring the Perfusion Index (PI) as an objective indicator of vascular readiness. Nevertheless, further research is strongly recommended to validate these outcomes.

Future studies should prioritize randomized controlled trial (RCT) designs with larger, age-matched cohorts across multiple centers to minimize demographic bias and provide more robust evidence of efficacy. Additionally, investigating the long-term impact of this combined therapy on post-procedural complications, such as radial artery occlusion, would offer valuable insights for comprehensive cardiovascular nursing care.

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