Indonesian Journal of Global Health Research
Volume 8 Number 1, February 2026
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

IMPLEMENTATION OF FEMOVENART MECHANICAL COMPRESSION (FEMOPRESS) IN FEMORAL SHEATH REMOVAL FOR POST-CARDIAC CATHETERIZATION PATIENTS

Bambang Julianto*, Fery Agusman Motuho Mendrofa, Blacius Dedi
Universitas Karya Husada Semarang, Jl. R. Soekanto No.46, Sambiroto, Tembalang, Semarang, Central Java 50276, Indonesia
*bambangjulianto57@gmail.com

ABSTRACT
Manual femoral sheath removal following percutaneous coronary intervention (PCI) remains a major challenge in interventional cardiac nursing practice. Variations in manual pressure, prolonged compression duration, and nurse fatigue can lead to inconsistent hemostasis and potential peripheral complications. To address these issues, an innovative mechanical compression device Femovenart Mechanical Compression (Femopress) was developed as a locally engineered nursing tool designed to provide consistent, ergonomic, and safe compression after cardiac catheterization. This action research study was conducted at the Cathlab Unit of Dr. Loekmono Hadi General Hospital, Kudus, Central Java, from May to June 2025. The study involved four Cathlab nurses as collaborative practitioners and twenty post-PCI patients with femoral access. Data were collected through direct observation, peripheral safety assessment using six indicators (pulse, skin color, oxygen saturation, hematoma, paresthesia, and pain), and focus group discussions (FGDs). Triangulation was performed with three experts: an academic supervisor, an interventional cardiologist, and a senior Cathlab nurse. Quantitative data were analyzed descriptively, while qualitative data were processed using thematic content analysis. Prior to the innovation, manual compression required 15–20 minutes and often caused nurse fatigue and inconsistent hemostasis. Implementation of Femopress reduced compression time to 13–18 minutes, maintained optimal hemostasis, and improved peripheral safety. Based on the Abukays Peripheral Safety Scale, 90% of patients achieved "safe" scores (9–12), with no secondary bleeding or hematoma. Six FGD themes emerged: (1) manual practice limitations, (2) unavailability of special tools, (3) inadequacy of facilities, (4) need for dedicated compression devices, (5) positive evaluation of Femopress, and (6) expectations for future development. The Femopress innovation effectively improves procedural efficiency, reduces nurse workload, and enhances patient comfort and safety in femoral sheath removal after PCI. This device demonstrates strong potential as a standard nursing technology for Cathlab practice and a model of nursing-led innovation in cardiovascular care.

Keywords: action research; cardiac catheterization; femopress; femoral sheath removal; nursing innovation; patient safety

How to cite (in APA style)
Julianto, B., Mendrofa, F. A. M., & Dedi , B. (2025). Implementation of Femovenart Mechanical Compression (Femopress) in Femoral Sheath Removal for Post-Cardiac Catheterization Patients. Indonesian Journal of Global Health Research, 8(1), 293–300. https://doi.org/10.37287/ijghr.v8i1.647.

INTRODUCTION

The advancement of cardiovascular interventions, particularly percutaneous coronary intervention (PCI), presents new challenges in nursing practice—especially during the post-procedural phase of femoral sheath removal (aff sheath femoral). Traditionally, nurses perform manual compression using finger pressure or elastic bandages for 15–20 minutes to achieve hemostasis. However, this conventional method depends on hand strength and precision, leading to fatigue, musculoskeletal strain, and inconsistent pressure that may affect patient outcomes.

Previous studies have shown that nurse fatigue and inconsistent manual pressure contribute to complications such as hematoma, pseudoaneurysm, and discomfort (Lee et al., 2019; Park et al., 2020). Excessive or uneven pressure may also cause localized pain and anxiety in patients (Kolcaba, 2015). These findings emphasize the need for innovation in post-catheterization care—

particularly mechanical solutions that ensure stable compression, minimize fatigue, and optimize both safety and comfort.

The Femovenart Mechanical Compression (Femopress) device was developed to address these limitations. Designed as a mechanical system with adjustable screw pressure, Femopress provides consistent and controlled compression over the femoral puncture site. Its design also incorporates ergonomic considerations for nurses and comfort for patients. From a theoretical perspective, Femopress aligns with Roy's Adaptation Theory (2009), which views individuals as adaptive systems responding to environmental stimuli, and Kolcaba's Comfort Theory (2015), which promotes holistic patient comfort across physical and psychological dimensions. The integration of these frameworks guided the development of Femopress as an innovative nursing tool that supports patient adaptation, comfort, and safety while improving the efficiency and sustainability of nursing practice. The purpose of this study was to assess the implementation and effectiveness of Femopress in improving the safety, comfort, and efficiency of post-cardiac catheterization femoral sheath procedures.

METHOD

Study Design

This research employed a qualitative exploratory phenomenological design combined with an action research approach. The phenomenological component explored nurses' experiences and perceptions of femoral sheath removal before and after Femopress implementation, while the action research process involved collaborative planning, application, observation, and reflection between researchers and Cathlab nurses to evaluate and refine the innovation.

Setting and Duration

The study was conducted in the Cathlab Unit of Dr. Loekmono Hadi General Hospital, Kudus, Central Java, Indonesia, from May to June 2025. Ethical approval was obtained from the hospital's Health Research Ethics Committee (KEPK) before data collection with No. 29/KEPK/ RSLH/ IV/2025

Participants

Four Cathlab nurses were purposively selected based on the following inclusion criteria:

1. Minimum of diploma-level nursing education.
2. Completion of cardiovascular or ACLS (Advanced Cardiac Life Support) training.
3. Active involvement in femoral sheath removal procedures.
4. Willingness to participate voluntarily.

Table 1.

Characteristics of FGD Informants

Code	age	Role	Years of service	Description
N1	31 years	Diploma 3	10 years	Experienced in manual sheath removal
N2	48 years	Registered Nurse	25 years	Responsible for post-PCI care
N3	46 years	Registered Nurse	18 years	Involved in Femopress testing
N4	31 years	Registered Nurse	8 years	Assisted patient observation

All participants had experience in manual femoral sheath removal and actively contributed to discussions regarding procedural limitations and the advantages of Femopress.

Additionally, twenty post-PCI patients with femoral access were included for clinical observation of peripheral safety outcomes.

Data Collection Procedure

The data collection process involved several stages:

1. Preparation: Submission of ethical clearance, coordination with Cathlab management, and development of FGD and observation instruments.
2. FGD Phase (Problem Identification): Conducted with four Cathlab nurses to explore limitations of manual compression and expectations for innovation.
3. Expert Consultation and Design: Collaboration with medical and technical experts to refine the design and SOP for Femopress.
4. Implementation and Observation: Trial application of Femopress on 20 post-PCI patients, assessing hemostasis time and peripheral safety.
5. Reflection and Evaluation: FGD feedback and expert reviews were analyzed to improve the device and its standard operating procedures.

Data Analysis

Qualitative data from FGDs were analyzed thematically following Colaizzi's approach, including data reduction, categorization, theme identification, and interpretation. Quantitative data from safety assessments were analyzed descriptively to summarize mean safety scores and frequency distributions.

Ethical Considerations

All participants (nurses and patients) provided informed consent before participation. The study adhered to ethical principles of confidentiality, respect, and non-maleficence. The Femopress device was officially registered and recognized with Intellectual Property Rights (HAKI) from the Ministry of Law and Human Rights of the Republic of Indonesia, confirming its legitimacy as a nursing innovation.

RESULT

1. Qualitative Findings from FGDs (Four Cathlab Nurses)

Based on the Focus Group Discussion (FGD) with four Cathlab nurses at Dr. Loekmono Hadi General Hospital Kudus, six key themes emerged that captured their experiences, perceptions, and reflections regarding femoral sheath removal procedures before and after the implementation of the Femovenart Mechanical Compression (Femopress).

Theme 1: Manual Femoral Sheath Removal Practice Before the Innovation

Prior to the introduction of Femopress, the femoral sheath removal procedure was performed manually using finger pressure or elastic bandages. Nurses had to maintain manual pressure continuously for approximately 15–20 minutes to achieve hemostasis. This often caused hand fatigue, musculoskeletal pain, and inconsistent pressure levels, which affected hemostasis outcomes. Excessive pressure also caused discomfort and anxiety in patients. These conditions highlighted the limitations of manual techniques and the need for an innovative, consistent, and ergonomic mechanical compression solution.

"We manually pressed for about 15–20 minutes, our hands felt sore and sometimes we had to take turns," (N1).

"If the patient became anxious or moved a little, the bleeding could start again," (N3).

"Kami menekan manual sekitar 15–20 menit, tangan terasa pegal bahkan kadang harus bergantian." (N1)

"Kalau pasien cemas atau bergerak sedikit, darah bisa keluar lagi." (N3)

Interpretation: Manual compression caused fatigue and inconsistency, highlighting the need for mechanical support.

Theme 2: Availability of Tools and Facilities for Femoral Sheath Removal

The Cathlab Unit lacked specific mechanical devices for femoral sheath compression. Nurses relied on improvisations such as folded gauze and adhesive tape, which were unstable and dependent on

the nurse's hand strength. This inconsistency affected both efficiency and quality assurance. Participants emphasized that the absence of a standardized compression device hindered uniform results, patient comfort, and procedural safety.
"There was no special device; we used folded gauze and stuck it with tape so it wouldn't shift," (N2).
"The pressure still had to be maintained by hand, otherwise bleeding could recur," (N4).
"Belum ada alat bantu, kami pakai kasa dilipat lalu ditempel plester biar tidak bergeser." (N2)
"Tekanannya tetap dijaga dengan tangan, karena kalau dilepas bisa berdarah lagi." (N4)
Interpretation: The absence of proper tools made procedures highly dependent on nurse endurance.

Theme 3: Adequacy of Existing Facilities
Nurses reported that existing resources were inadequate to support safe and effective femoral sheath removal. Without mechanical aids, physical workload was high and the procedure was time-consuming. In some cases, nurses alternated in applying pressure due to hand fatigue. These challenges were perceived as threats to care quality and patient safety, indicating an urgent need for improved equipment in the Cathlab to support efficient and standardized care delivery.
"When there were many patients, we had to take turns pressing because our backs and hands hurt," (N1).
"The workspace was small, and the position was uncomfortable for long compression," (N3).
"Kalau pasien banyak, kami bergantian menekan karena posisi lama bikin punggung dan tangan pegal." (N1)
"Tempatnya kurang nyaman untuk posisi menekan lama." (N3)
Interpretation: Physical discomfort and inadequate ergonomics reduced work efficiency.

Theme 4: The Need for a Dedicated Femoral Compression Device
All participants agreed on the importance of developing a dedicated mechanical compression device to replace manual hand pressure. The ideal device, according to the nurses, should deliver stable, constant, and adjustable pressure; be easy to operate; comfortable for patients; and allow direct visualization of the puncture site without hand contact. This demand led to the conception of the Femovenart Mechanical Compression (Femopress)a simple, reusable, and ergonomic nursing innovation addressing these needs.
"If there's a tool that can press automatically and keep stable pressure, our work would be easier," (N2).
"As long as it's safe, sterilizable, and easy to adjust, it would be very useful," (N4).
"Kalau ada alat yang bisa menekan stabil, kami bisa sambil memantau pasien dengan tenang." (N2)
"Yang penting aman, bisa disterilkan, dan mudah diatur tekanannya." (N4)
Interpretation: This identified the direct need that inspired the development of Femopress.

Theme 5: Evaluation of Femopress Performance
Nurses evaluated Femopress positively after implementation. The device was user-friendly, provided stable and consistent pressure, and adapted well to patient body contours. Using Femopress reduced compression time from 15–20 minutes (manual) to 13–18 minutes without compromising hemostasis. Nurses reported decreased fatigue and better ergonomic posture, while patients expressed increased comfort and reduced pain. Visual observation of the site without direct hand contact improved monitoring and workflow efficiency.
"The device is light, easy to use, and the pressure is stable," (N3).
"Patients felt calmer because we no longer used our hands directly," (N1).
"Alatnya ringan, mudah dipasang, dan tekanannya stabil." (N3)
"Pasien lebih tenang karena tidak ditekan langsung pakai tangan." (N1)
Interpretation: Femopress improved efficiency and comfort for both nurses and patients.

Theme 6: Future Development of Femopress

Participants expressed enthusiasm for further development and broader use of Femopress. They suggested producing lighter, more portable versions with automatic pressure adjustment systems, suitable for ICU and Emergency settings. Nurses also recommended training sessions and workshops to standardize the use of Femopress according to established SOPs. Collaboration with hospital management and local industries was also proposed to support mass production and national-scale distribution of Femopress as a cost-effective nursing innovation.

"If there's a lighter, more flexible version, it will be even better," (N4).

"This device is good and could be used in other Cathlabs as well," (N3).

"Kalau bisa dibuat versi yang lebih fleksibel dan ringan, pasti lebih nyaman." (N4)

"Alat ini bagus dan bisa digunakan di Cathlab lain juga." (N3)

Interpretation: Strong endorsement from nurses indicates high potential for wider adoption.

2. Results of Expert Triangulation

Expert Triangulation

To ensure data validity, three experts were involved in triangulation:

Table 2.
Three experts were involved in triangulation

Code	Profession	AGE	Expertise	Role
E1	Cardiologist	45 Years	Interventional Cardiology	Validated medical safety and clinical impact
E2	Senior Cathlab Nurse	43 Years	Cardiovascular Nursing	Evaluated nursing practice and workflow
E3	Cardiovascular Technician	23 Years	Cardiovascular Technician	Validated mechanical and operational design

These experts reviewed the tool design, clinical application, and standard operating procedures (SOPs) for Femopress.

Medical Expert (E1)

"With Femopress, the pressure remains constant without needing continuous hand compression. Manually it usually takes around 15–20 minutes, but with this tool, hemostasis is achieved in about 13–18 minutes," (E1).

"Dengan Femopress, tekanan lebih konstan tanpa harus ditekan terus dengan tangan. Kalau manual biasanya butuh sekitar 15–20 menit, sekarang rata-rata 13–18 menit sudah berhenti perdarahannya." (E1)

Interpretation: Femopress reduced hemostasis time by 2–5 minutes compared to manual methods, ensuring safety and efficiency.

Senior Cathlab Nurse (E2)

"This device is very helpful; we no longer need to press for long periods, and the bleeding stops faster," (E2).

"Alat ini sangat membantu, tidak perlu menekan lama, hasilnya juga cepat berhenti darahnya." (E2)

Interpretation: The device improved workflow, reduced workload, and maintained procedural safety.

Cardiovascular Technician (E3)

"The structure is strong but lightweight, pressure can be adjusted according to the patient's position, and it's easy to sterilize," (E3).

"Desainnya kuat tapi ringan, tekanan bisa diatur sesuai posisi pasien dan mudah dibersihkan." (E3)

Interpretation: Technically, Femopress meets ergonomic and operational standards for safe reuse in clinical practice.

3. Quantitative Findings (Observation of 20 Patients)

Femopress was tested on twenty post-PCI patients to assess peripheral safety using the **Abukays Peripheral Safety Scale**. Observations were conducted at three time intervals: the first minute, fifth minute, and after the procedure.

Table 3.
Peripheral Safety Scale

Safety Category	Number of Patients	Percentage (%)
Safe (Score 9–12)	18	90%
Intermediate (Score 5–8)	2	10%
Unsafe (<5)	0	0%

No secondary bleeding, severe hematoma, or paresthesia occurred. All nurses agreed that Femopress reduced physical strain and improved both workflow efficiency and patient comfort compared to manual compression.

DISCUSSION

1. Analysis Based on Roy's Adaptation Theory

According to Sister Callista Roy's Adaptation Model (2009), humans respond to environmental stimuli through physiological and psychological adaptive mechanisms. Femopress serves as a positive adaptive stimulus that stabilizes the patient's physiological response after catheter removal. Patients demonstrated adaptive outcomes such as improved distal perfusion, stable hemostasis, and reduced procedural pain. The mechanical consistency of Femopress minimized stress responses, facilitating quicker physiological adaptation compared to manual compression.

2. Analysis Based on Kolcaba's Comfort Theory

In Kolcaba's Comfort Theory (2015), patient comfort encompasses physical, psychospiritual, environmental, and sociocultural aspects. Femopress contributes primarily to physical comfort by preventing excessive hand pressure and maintaining steady compression, which reduces discomfort. Psychologically, patients felt calmer and safer knowing that the compression was performed with a professional device rather than by manual force. The environmental calmness and nurse confidence also contributed to an overall atmosphere of holistic comfort.

3. Comparison with Previous Studies

Several studies have validated the benefits of mechanical compression in improving hemostasis and patient safety. Kim et al. (2018) and Ahn & Kim (2018) found that mechanical compression devices reduce hematoma risk and ensure stable hemostasis compared to manual methods. Similarly, Hwang & Park (2020) demonstrated enhanced patient comfort with mechanical compression. The findings of this research align with these studies—Femopress achieved a 90% "safe" rating without any complications, demonstrating comparable performance to commercial compression devices while offering local affordability and ergonomic design.

4. Contribution to Nursing Practice

Femopress exemplifies how nursing innovation can bridge technology and clinical efficiency. The device empowers nurses to maintain consistent procedural outcomes while minimizing physical strain, supporting the concept of "nurse-led innovation for patient safety." It also enhances interdisciplinary collaboration between nurses, physicians, and biomedical engineers in the Cathlab. The use of Femopress represents a milestone in locally developed nursing technology that contributes to safer and more efficient cardiovascular care practices.

5. Reflection and Future Development

Action research reflection indicated that nurses, experts, and researchers found Femopress to be highly practical and effective. Future plans include:

a. Adjusting the design for lighter materials and enhanced portability.
b. Conducting larger-scale quantitative studies to strengthen evidence of effectiveness.
c. Organizing training for Cathlab nurses to standardize Femopress usage.
d. Developing further intellectual property protections and exploring collaboration with medical device manufacturers for production scalability.

The innovation's success demonstrates the potential of locally developed devices to reduce dependency on imported medical equipment while promoting indigenous nursing ingenuity.

CONCLUSION

The implementation of Femopress in femoral sheath removal has significantly improved hemostasis efficiency, nurse ergonomics, and patient comfort. By maintaining stable pressure, it reduced procedure time from 15–20 minutes to 13–18 minutes while minimizing operator fatigue. The integration of the Abukays Peripheral Safety Scale further enhanced the system, offering structured and objective safety monitoring through six critical indicators—dorsalis pedis pulse presence, skin color, pulse oximetry (SpO_2), hematoma presence, paresthesia, and pain level—each scored to assess patient safety. This dual-function system, combining mechanical compression with safety assessment, ensures optimal patient outcomes and standardized nursing practice in post-cardiac catheterization care. The collaboration between Femopress and the Abukays Scale exemplifies applied nursing innovation, blending ergonomic technology with evidence-based safety, supporting adaptive and holistic care as aligned with Roy's Adaptation Theory and Kolcaba's Comfort Theory.

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