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Investigating Patient' Perspectives on Open Heart Surgery Based on Gender: A Metaphorical Study

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Abstract

Objectives: Gender plays a crucial role in shaping experiences and needs in healthcare. Investigating metaphors used by men and women provides valuable insights into gender-based differences, particularly in the context of complex surgeries like open-heart surgery (OHS). However, the use of metaphors to understand patient perspectives in such surgeries remains underexplored. This study aimed to explore the emotions and insights of patients before OHS through metaphorical expressions.

Materials and Methods: The study was conducted using the metaphor analysis technique based on the phenomenological method. Metaphor analysis, as a qualitative research approach, provides an in-depth understanding of lived experiences. The COREQ statement, a 32-item checklist for reporting qualitative studies, was followed to ensure transparency and rigor. The sample consisted of 62 patients.

Results: More than half of the patients (n=33) were male. Most patients (n=38) were primary school graduates, 28 of them were retired, and almost all of them (n=57) were married. Coronary artery bypass grafting was planned for 45 of the patients. The patients' ages ranged from 37 to 85 years. Patients produced 38 different metaphors for OHS, frequently including repair, salvation, recreation, goodness, fear, anxiety, and guidance. The metaphors were categorized into four themes: the mechanical perspective, the spiritual perspective, the cognitive-emotional perspective, and the accepting perspective. Male patients more frequently used mechanical and accepting metaphors, whereas female patients predominantly expressed spiritual and cognitive-emotional metaphors.

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Abstract

Conclusion: This study highlights the importance of understanding the metaphors patients use to express their experiences before OHS. Recognizing these metaphorical representations can enhance patient care by addressing emotional and spiritual needs. Providing spiritual support, such as prayers and rituals, can reduce anxiety and positively influence recovery. Importantly, considering gender-based differences in metaphorical expressions can help healthcare professionals tailor patient education and support strategies more effectively, offering a more holistic approach to care. Future studies should further investigate how gender-specific metaphorical expressions influence coping strategies and recovery outcomes in patients undergoing OHS.

Keywords: Bypass, cardiovascular surgery, heart

Introduction

Open-heart surgery (OHS) is a primary intervention in treating heart disease. Apart from its therapeutic properties, it causes significant anxiety and fear in patients due to its complexity and life-threatening risks[1]. Therefore, understanding patients' perspectives on the disease in the preoperative period is crucial for in developing intervention strategies by social work professionals and the healthcare sector. Social work professionals play an essential role in addressing inequalities in the healthcare sector by participating in and leading integrated patient care initiatives aimed at reducing these inequalities[2].

A critical factor in postoperative recovery is patients' perceptions of their illness before surgery[3]. This is because the role of illness perceptions in psychological well-being is substantial[4]. In a quantitative study examining perceptions of cardiovascular disease (CVD), women were more likely than men to attribute CVD to causes beyond their control and to perceive CVD as a chronic, uncontrollable condition[5]. In a quantitative study n=187), state and trait anxiety scores of female patients undergoing coronary artery bypass grafting (CABG) were found to be significantly higher than those of men before and six months after surgery[6]. A study examining the impact of gender differences on coping and anxiety in patients after CABG surgery in Taiwan found that women, compared to men, were more likely to blame themselves, and had higher state-trait anxiety scores[7].

Language is an important example of human symbolization. The ability to use symbols makes metaphor possible. Metaphor is the art of analogies with words[8]. To make a metaphor, one must use language well. Language is defined not as an isolated, autonomous concept but as a system that other information systems should interact with. Language is related to cognitive processes and is defined as "a means of creating and expressing ideas, storing and sharing information in the human mind[9]". One thing can replace or signify something else. Moreover, people act according to the subjective meanings or interpretations of their physical and social environment. Metaphor is not just about language. It is thought, action, and language[10]. Unlike simile, which is an explicit comparison indicated by the words "like" or "as," a metaphor is an implicit comparison In Kövecses's[11] metaphor, "achilles fought like a lion," the characteristic of the lion and achilles is their courage and strength. It is essential to use metaphorical words consciously. Metaphors are used to understand human thought, to better explain concepts, and to reason. They do not aim to establish general similarities[11,12]. Metaphors allow language to gain meaning in the mind in a sense that has never been used before. Meanings are constructed by individuals in particular environments and situations, based on interactions in specific roles. For example, the meanings assigned to the symbol and surgery assigned by the patient and the surgeon differ in their differentiation, complexity, feeling, tone, expectations, and associated behaviors. Meaning regulates attention, perception, interpretation, and action[8]. Conceptual Metaphor Theory[10] provides a useful framework for understanding how patients conceptualize their experiences through metaphor.

According to symbolic interactionists, human behavior cannot be understood apart from the symbolic meaning of objects (defined to include people) in particular situations. Because of this characteristic, metaphors have exploratory aspects. Metaphors explain how the emotions, thoughts, or concepts being analyzed are perceived. Abstract and challenging-to-perceive concepts can be understood more easily with the help of metaphors[13]. These metaphors influence how patients perceive their condition, cope with stress, and prepare for surgery. By understanding patients' metaphors, healthcare professionals can gain insights into their psychological and emotional states, which are crucial for effective preoperative counseling and support. This perspective helps identify specific fears or misconceptions patients may have about surgery, enabling more tailored and empathetic communication that addresses their concerns[14].

This study incorporates Cognitive Behavioral Theory (CBT) and Conceptual Metaphor Theory, to understand these perceptions better. CBT is used to help identify and address the maladaptive thoughts and anxieties that patients may have prior to surgery, which can significantly impact their recovery[15,16].When the literature is examined, studies examining the effects of gender on postoperative outcomes in many countries and cultures have been found[17-20], and a metaphor study with patients who will undergo OHS could not be reached. The metaphors obtained in this study are essential for understanding and supporting patients undergoing OHS in the preoperative period. However, the metaphors healthcare professionals use to make sense of their perspectives on complex surgeries like OHS have yet to be adequately explored. The results of this study should contribute to the development of individualized care protocols for men and women with OHS in the preoperative period. In addition, patient care and support can be further improved by understanding the healthcare perspective on OHS.

The study aimed to explore and gain insights into the feelings of male and female preoperative patients regarding their varied experiences related to surgery. It employed metaphors to conceptualize and describe their experiences figuratively, thereby providing valuable information for health professionals involved in their care.

Materials and Methods

Study Design

This study used a qualitative research model to determine the patients' perceptions of surgery before OHS through metaphor analysis. The phenomenology design was preferred within the scope of the qualitative research model. This pattern is a method that reveals the essence of a phenomenon to enable a more in-depth and detailed understanding. Phenomenology focuses on the meaning of the investigated phenomenon. It reveals the significance of individuals' experiences and their relationship to the subject[21].

Collecting data with metaphors is a powerful strategy to illuminate previously unrecognized aspects of phenomena and add depth to understanding. Applying familiar concepts to lesser-known phenomena helps to clarify and broaden the understanding of less familiar ones. Metaphors can exemplify behaviors and processes by simplifying concepts and emphasizing some features over others[22,23].

Conceptual Framework

The Conceptual Metaphor Theory emphasizes how deeply metaphors are embedded in human cognition and communication. It demonstrates how metaphors shape language and our understanding of complex ideas, problem-solving strategies, and cultural worldviews. Recognizing these underlying metaphors allows people to understand how language influences thought and vice versa[14]. Metaphors help reveal how emotions, thoughts, or concepts are perceived. Concepts that are abstract and difficult to perceive can be understood more easily with the help of metaphors[12,24,25].

CBT, which plays a significant role in studying human behavior and cognition, underscores the importance of metaphors in shaping an individual's thoughts, feelings,

and behaviors. This theory suggests that cognitive restructuring, a core component of cognitive-behavioral therapy, often involves identifying and challenging metaphorical thinking patterns that contribute to maladaptive behaviors and emotional states[26]. CBT can be an effective tool for changing patient behaviors and developing long-term health habits. It is reported that within the scope of prehabilitation, counseling aimed at addressing patients' emotional needs and enhancing their self-efficacy plays an important role in improving adherence to multimodal interventions to ensure overall well-being before surgery[15,16]. Therefore, the examination of metaphors in the context of this study is particularly relevant, as it aligns with the principles of CBT, shedding light on how metaphors influence individuals' perceptions and responses in the context of their experiences before OHS[26].

By integrating Conceptual Metaphor Theory with CBT, this study provides a solid framework to analyze how metaphors shape patients' experiences, emotions, and behaviors before undergoing OHS. This dual-theoretical approach allows for a deeper understanding of the cognitive and emotional elements at play, ultimately aiming to enhance patient care by addressing the psychological needs of individuals preparing for major surgery.

Research Team and Reflexivity

The research team consists of three female academic nurses, and all researchers have received training in qualitative research. The first researcher took the qualitative research course in his doctoral education, and he is doing qualitative research. She completed her master's and doctoral thesis in cardiovascular surgery nursing and has conducted research in this field. She was a cardiovascular surgery intensive care unit nurse for 2.5 years. Anticipations of bias due to the researcher's own experiences influenced the decision not to collect data. This researcher did not do the analyses, so that the findings would not be affected. The second researcher (NGOO) took the qualitative research course during his doctoral education. She has also received training in the MAXQDA program organized by a private statistics and research center. She was a clinical nurse in the pediatric surgery department for seven years. Since the researcher has experience in qualitative and metaphor studies, they collected all the data. Therefore, different views were not affected during the data collection process. The third researcher is an associate professor in the Department of department of surgical nursing at the nursing faculty and has previously worked as a nurse in the cardiovascular surgery clinic. She supervised the thesis studies of master's and doctoral students in cardiovascular surgery nursing. She received qualitative research training from national and international courses. She has mentored nurses in the qualitative research course program. She has conducted qualitative research in surgical nursing and nursing education. During her 30 years of professional life, she has given many conferences on surgical nursing.

The research team maintained a reflective approach throughout the study. Regular meetings of the research team were held, and the presence of the second author during the first interview, data analysis, and review of field notes, enhanced sensitivity to the research. Data analysis was discussed with the research team, and themes were deliberated, modified, reviewed, and agreed upon. Reflexive steps in thematic analysis were followed to ensure a rigorous analytical process. Furthermore, it was acknowledged that the primary researcher might bring theoretical commitments or professional assumptions that could influence the research. Therefore, a preliminary interview was conducted among the researchers before data collection. In this interview, the primary researcher was asked questions about assumptions and urged to remain reflexive and attentive to narratives that might reveal hidden meanings. This added passage elaborates on how the reflexive process was applied within the research team and how assumptions were addressed to maintain the integrity of the research.

Participants

The study consisted of patients scheduled for OHS in a university hospital's cardiovascular surgery inpatient clinic. Criterion sampling was used as the sample type.

A criterion sample studies all cases that meet a predetermined set of criteria. The researcher creates the requirements, or a previously prepared criterion list can be used. Criterion sampling was used in the study for patients planned for OHS.

The inclusion and exclusion criteria for selecting the sample were carefully defined. Only patients scheduled for OHS in the preoperative period, who had person-place-time orientation, spoke Turkish, and had stable general health were included in the study. Patients scheduled for minimally invasive cardiac surgery using the off-pump technique and those who underwent transcatheter aortic valve replacement were excluded. These patients' surgical procedure differs from OHS. Therefore, the study group only included patients who underwent CABG and valve surgery using the open-heart technique. This comprehensive approach ensured the rigor and reliability of the study.

While determining the sample size in the research, attention was paid to the focus of the study, the amount of data, and theoretical sampling principles. The focus of the study is on metaphorical perceptions of OHS. The theoretical framework was unclear, as there was no literature on the metaphorical perceptions of individuals with OHS. For this reason, data were collected until the data saturation point. The data reached the saturation point in the 57th patient. However, a total of 62 patients who met the inclusion criteria and agreed to participate were included in the study to ensure a balanced representation. Among these, 33 were male and 29 were female, reflecting the composition of the eligible patient population during the study period.

Data Collection

The study data were collected using a semi-structured schedule, which was developed in line with the literature and based on the experiences of the researchers. This form consisted of two parts. In the first part, there were questions about descriptive characteristics and OHS. In the second part, to determine the metaphorical perceptions of the patients about the surgery, the sentence "OHS like/similar to ... because ....." was asked. Opinions and suggestions were received from the cardiovascular surgeon, clinician, and academic nurse for this form. No changes were made in line with the views. In addition, a literature review was conducted for the metaphor sentence[13,27,28].

Study Procedure

The NGOO, who was on the research team, asked the patients admitted to the cardiovascular surgery inpatient clinic the questions in the first part of the data collection form. The hospitalized patients were followed daily in the clinic, and data collection was performed in the ward at least one day before the scheduled OHS. This ensured that all patients were in the preoperative period. Later, the researcher gave an example of the sentence "the nurse is like an angel because she is accommodating", so that the patients could understand the metaphor better. A sample metaphor sentence for the surgery was not given to avoid affecting the patients' perception.

In the clinic where the data were collected, preoperative education was routinely provided both by the surgical team and by the nurses. This education included information about what OHS is and how it differs from other cardiac surgeries. Thus, the patients were aware of the meaning of OHS when producing their metaphors. After the example sentence, the patient was asked for their metaphor sentence, which was written down exactly as expressed and later confirmed by the patient. While the researcher was collecting the data, the caregivers of the patients were present, ensuring the patients' comfort and well-being. Their presence did not influence the metaphors produced by the patients.

Statistical Analysis

All metaphor analyses in this study were conducted manually by the research team; no computer software was used. The researchers carefully read, coded, and categorized the metaphors themselves, ensuring that each step of the Metaphor Identification Procedure and subsequent thematic analysis, was performed rigorously and collaboratively[24,25].

The method of analysis and interpretation of the metaphors to be put forward in the Metaphor Identification Procedure takes place in three stages, although there is no definite chronological order.

Step 1: Metaphor Definition and Selection

First, the researchers carefully read the metaphor texts several times and made metaphor markings to get a general idea of the metaphors found in each text. The purpose of repeated reading is to make the metaphors clearer. Sixty-two metaphors produced by the patients were evaluated. The relations of the metaphors produced, with the research subject, were considered. As a result of the evaluation, metaphors with ordinary meaning, and similarity were extracted and grouped from a total of 62 metaphors.

Step 2: General Metaphor Analysis

Because metaphors are part of a communication process, their overall meaning has been questioned. How do people understand this metaphor, and what might the speaker mean by it as a member of a larger social group? Therefore, the metaphor was taken as it was without questioning the wider context. This step also includes taking a certain distance from the whole text, which means temporarily setting aside the immediate context of the metaphor to reason more freely about the metaphor being studied.

Metaphors deemed valid, produced by the patients, and metaphors with common meanings for OHS were classified by the researchers based on their descriptions. Each metaphor has been analyzed in terms of the subject, the source, and the connection between the subject and the source. Then, they were analyzed according to their ability to express the concept of OHS, and conceptual themes were created. As a result of the analysis, metaphors were categorized into four themes: mechanical perspective (physical renovation), spiritual perspective (recreation), cognitive and emotional perspective (life or death), and accepting perspective (necessity)[25].

In addition, data from male and female patients were analyzed separately to explore potential gender-related differences in metaphorical perceptions. After coding and categorizing the metaphors, the frequency and types of metaphors were compared between male and female participants to identify any patterns or distinctions.

Step 3: Text-Immanent Metaphor Analysis

Finally, researchers explored the implications of metaphors to gain a deeper, more comprehensive understanding. The researchers scrutinized the data to gain a deeper understanding of the metaphors. A trustworthiness study was conducted by all researchers to examine whether the created categories represent the metaphors expressed by the patients in the study. During the validity phase of the metaphors, the statements used by the patients were included, and the data analysis process (especially the labeling of the data and how the five conceptual themes were reached) was explained in detail.

Peer debriefing was conducted on the metaphors obtained to ensure their reliability. The lists of themes and codes were reviewed by an expert as part of the peer review process the lists of themes and codes. The matching made by the expert and the themes created by the researcher were compared. Inter-coder reliability (ICR) assessment has been used in metaphor analysis as it provides numerous benefits for qualitative research, which includes improving the systematic nature, distribution, and transparency of the coding process.

Although there are different opinions about ICR, it was used to evaluate the reliability of metaphors in this study. The Miles and Huberman[29] formula was used to evaluate the ICR. This formula is confidence = consensus / (consensus + disagreement). The first expert's metaphor coding specific to the research was slightly different because it overlapped with the themes. However, a 95% reliability (consensus =38 / (38 + 2)=0.95] rate was obtained. The research team discussed and resolved any disagreements on themes through meetings, ensuring consensus was reached before finalizing the categorization of metaphors.

Trustworthiness in Research

The trustworthiness of the research was ensured through credibility, transferability, confirmability criteria.

Credibility: When patients were asked about their metaphorical perceptions, they were asked to explain why, and their consent was obtained. Peer debriefing was requested to examine the process and the metaphor analysis.

Transferability: In this study, criterion sampling from the purposeful sampling method was used, acceptance criteria were determined, the place where the research was conducted was introduced, and detailed information about the participants was given.

Reliability: Two researchers collected, analyzed, and interpreted the data. A literature review was conducted to ensure reliability. The research method is explained in detail.

Verifiability: Statements of the participants were included in the findings. Additionally, field notes for raw data are included. The development process of the findings is provided in detail[21,30].

Ethical Considerations

The study was conducted according to the Declaration of Helsinki and approved by the Non-interventional Ethics Committee of Dokuz Eylül University (approval no: 7019, date: 16.02.2022). In addition, informed consent was obtained from the patients who agreed to participate in the study. Encodings were made with "P" to protect the patient's anonymity.

Results

The study sample consisted of 62 patients. As shown in Table 1, more than half of the patients (n=33) were male. Most patients (n=38) were primary school graduates; 28 were retired, and almost all (n=57) were married. CABG was planned for 45 of the patients. The patients' ages ranged from 37 to 85.

It was observed that the patients expressed 38 different metaphors for OHS and frequently used the metaphors of repair, salvation, recreation, goodness, fear, anxiety, and angel (Table 2).

The metaphors produced by the patients consisted of four categories. These themes were the mechanical perspective, the spiritual perspective, the cognitive and emotional perspective, and the accepting perspective (Figure 1). The metaphors produced by including quotations from patients' statements were evaluated within the framework of the determined categories. Men's perceptions were mechanical, spiritual, cognitive, emotional, and accepting. Women's perceptions were included mechanical, spiritual, cognitive, emotional, and accepting perspectives. There was only one narrow perspective in the perception of women. The codes of the metaphors of male and female patients in all documents are given in Figure 2.

Theme 1: Mechanical perspective (physical renovation): In this theme, patients produced metaphors for OHS. Eight of the patients in this theme were male; one was female. In this theme, patients used expressions such as fuel pump, resetting the engine, renewing the engine, and repairing it. Sample expressions related to the metaphors in this theme are given below.

"OHS is like replacing a fuel pump. Because we are the driver, if the fuel pump fails, the car will not start; similarly, the heart is the fuel pump of the body." (P1, male, 57 years old, scheduled CABG).

"OHS is like overhauling an engine. Because both the heart and an engine can fail as they age, they need to be renewed." (P2, male, 50 years old, scheduled aneurysm repair surgery).

"OHS is like repairing a broken structure. Because i am a builder, the system can get old and regenerate." (P16, male, 56 years old, scheduled surgery CABG).

"OHS can be compared to dirty glass, as it may obscure clear visibility and understanding of an underlying issue. Because when you wipe the glass, it is clean." (P25, female, 37 years old, scheduled heart valve repair surgery).

Table 1. Descriptive characteristics of the patients

Patient code	Gender	Years	Educational status	Profession	Marital status	Surgery
P1	Male	57	Primary education	Driver	Married	CABG
P2	Male	50	Bachelor's degree	Teacher	Married	Aneurysm repair
P3	Male	66	Primary education	Retired repairman	Married	CABG
P4	Female	67	Bachelor's degree	Retired nurse	Married	CABG
P5	Female	72	Primary education	Housewife	Married	CABG
P6	Male	64	Bachelor's degree	Retired	Married	CABG
P7	Male	70	Primary education	Retired	Married	CABG
P8	Male	52	High-school graduate	Retired	Married	CABG
P9	Male	70	High-school graduate	Retired	Married	CABG
P10	Female	56	Primary education	Housewife	Married	Heart valve repair
P11	Male	66	Primary education	Retired	Married	Heart valve repair
P12	Female	67	Bachelor's degree	Retired	Single	Heart valve repair
P13	Male	64	High-school graduate	Retired	Married	CABG
P14	Male	64	Primary education	Retired	Married	Aneurysm repair
P15	Female	67	High-school graduate	Retired	Married	CABG
P16	Male	56	High-school graduate	Master builder	Married	CABG
P17	Female	56	Bachelor's degree	Economist	Married	CABG
P18	Female	73	Primary education	Housewife	Married	Heart valve repair
P19	Male	73	Primary education	Retired	Married	CABG
P20	Female	63	Primary education	Housewife	Married	CABG
P21	Male	60	High-school graduate	Retired	Married	CABG
P22	Female	85	İlliterate	Housewife	Married	CABG
P23	Male	51	Bachelor's degree	Officer	Single	CABG
P24	Female	64	İlliterate	Housewife	Married	CABG
P25	Female	37	Primary education	Housewife	Married	Heart valve repair
P26	Male	51	Primary education	Worker	Married	CABG
P27	Female	53	Primary education	Worker	Married	CABG
P28	Male	54	Literate	Worker	Married	CABG
P29	Male	58	Primary education	Retired	Married	Heart valve repair
P30	Male	57	High-school graduate	Retired	Married	CABG
P31	Female	77	Primary education	Housewife	Married	CABG
P32	Male	71	Primary education	Worker	Single	CABG
P33	Male	67	Primary education	Retired	Married	CABG
P34	Male	69	Primary education	Retired	Married	CABG
P35	Male	69	Bachelor's degree	Retired	Married	CABG
P36	Male	58	Primary education	Self-employment	Married	CABG
P37	Male	58	Primary education	Retired	Married	CABG
P38	Male	53	Bachelor's degree	Self-employment	Married	CABG
P39	Female	56	Primary education	Housewife	Married	CABG
P40	Female	66	İlliterate	Housewife	Married	Aneurysm repair
P41	Male	51	High-school graduate	Retired	Married	CABG
P42	Male	63	Bachelor's degree	Retired	Single	Aneurysm repair
P43	Female	73	Primary education	Housewife	Single	CABG

Table 1. Continued

Patient code	Gender	Years	Educational status	Profession	Marital status	Surgery
P44	Male	62	Primary education	Retired	Married	Heart valve repair
P45	Female	51	High-school graduate	Officer	Single	Heart valve repair
P46	Male	56	Bachelor's degree	Tax professional	Married	CABG
P47	Male	62	Primary education	Retired	Married	CABG
P48	Male	57	Primary education	Watcher	Married	CABG
P49	Male	62	Bachelor's degree	Retired	Married	CABG
P50	Male	69	Primary education	Retired	Married	CABG
P51	Female	48	High-school graduate	Worker	Married	CABG
P52	Female	55	Primary education	Housewife	Married	CABG
P53	Female	65	Primary education	Housewife	Married	Heart valve repair
P54	Female	62	Primary education	Housewife	Married	Heart valve repair
P55	Female	62	Primary education	Housewife	Married	CABG
P56	Female	72	Primary education	Housewife	Married	CABG
P57	Female	73	Primary education	Housewife	Married	Heart valve repair
P58	Female	62	Primary education	Housewife	Married	Heart valve repair
P59	Female	73	Primary education	Retired	Married	CABG
P60	Female	78	Primary education	Housewife	Married	Heart valve repair
P61	Female	75	Primary education	Housewife	Married	CABG
P62	Female	63	Primary education	Housewife	Married	CABG

CABG: Coronary artery bypass grafting

Table 2. Metaphors produced by patients

Category	Male patients' metaphors	Female patients' metaphors
Mechanical perspective	Repair (n=3) Fuel pump (n=1) Engine overhaul (n=1) Overhauling the engine (n=1) Engine (n=1) Playing with an old toy (n=1)	Dirty glass (n=1)
Spiritual perspective	Salvation (n=6) Recreation (n=2) Goodness (n=1) Power (n=1) Marathon (n=1) Flatness (n=1) Resignation (n=1)	Salvation (n=6) Recreation (n=2) Goodness (n=1) End of pain (n=1) A second chance (n=1) Happiness (n=1) Struggle (n=1) Hope (n=1)
Cognitive and emotional perspective	Fear (n=1) Anxiety (n=1) White light (n=1) Addiction (n=1) Excitement (n=1) Dark world (n=1) Hook in the butcher (n=1) Russian roulette (game) (n=1) Fried chicken (n=1)	Fear (n=4) Anxiety (n=2) Locket (n=1) Closed box (n=1) Anxiety (n=1) Dead (n=1) Lifeblood (n=1) Nuisance (n=1)
Accepting perspective	Angel (n=1) Necessity (n=1) Nurse (n=1) A long narrow road (n=1)	Part of life (n=1)

Theme 2: Spiritual perspective (recreation): in this theme, patients produced metaphors such as salvation, rebirth, flatness, and hope, using a spiritual perspective, toward OHS. This theme includes the most expressed metaphors in both women and men.

"OHS is considered an essential or critical component, akin to salvation in its capability to provide significant benefits or protection. I will be cured of the fire in my chest, the disease that constricts my heart." (P7, male, 70 years old, scheduled CABG).

"OHS is like a plateau. I want my pain to stop. My back hurts while traveling. I cannot run fast. I feel like i have fallen into a ditch. That is why i am going immediately after the surgery." (P48, male, 57 years old, scheduled CABG).

"OHS is like hope. Because i cannot breathe, i am looking to relax even though i am undergoing surgery." (P59, female,73 years old, scheduled CABG).

"OHS is like recreation. I am in so much pain right now. My heart hurts severely. I will recover after surgery,

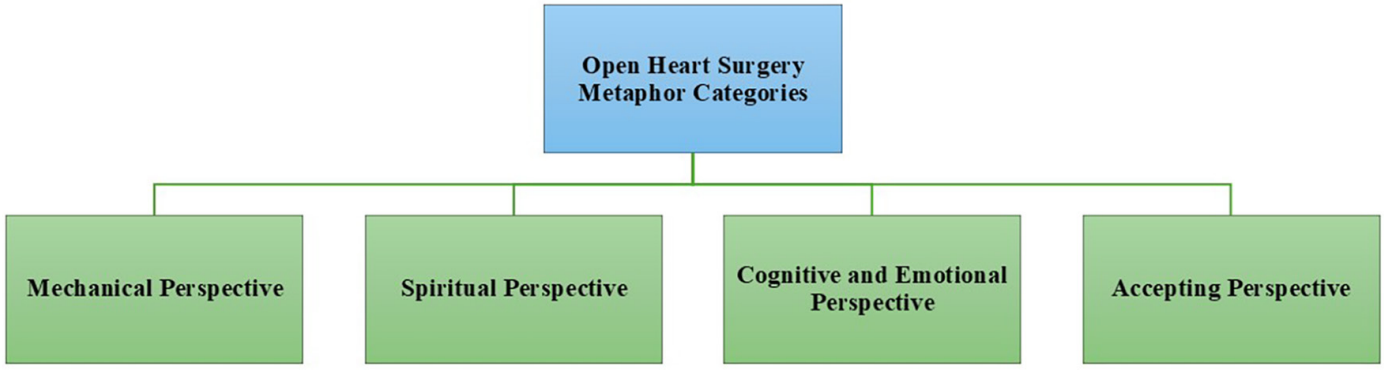

Figure 1. Open heart surgery metaphor themes

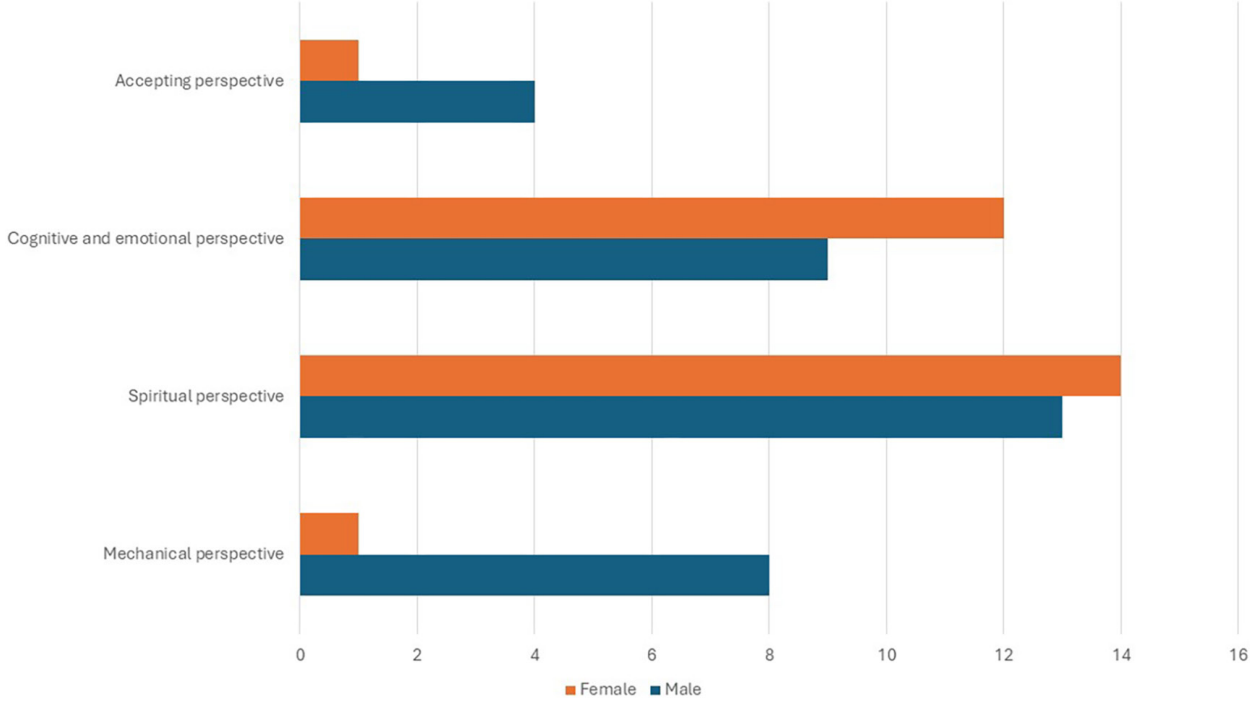

Figure 2. Metaphor codes of male and female patients patients

and i want to get rid of this pain." (P39, female, 56 years old, scheduled CABG).

"OHS is like resignation. I know what bypass is because i have seen it in my family. I trust in God and am a faithful person." (P41, male, 51 years old, scheduled CABG).

Theme 3: Cognitive and emotional perspective (life or death): using a cognitive perspective for OHS, patients produced metaphors such as seeing a white light, a closed box, fear, and stress in this theme. This theme was the second most frequently mentioned by patients. The experiences of relatives and environment cause uncertainty and fear. Patients experienced situations such as fear of death and environmental stressors.

"OHS is like seeing white light. Either life will end and i will walk towards the white light, or i will return to life when the doctors and nurses pull my arm." (P6, male, 64 years old, scheduled CABG).

"OHS is like a locket. It has two faces. Either life or death. I will put on my locket and go home as soon as possible." (P4, female, 67 years old, scheduled CABG).

"OHS is like a closed box. We do not know what will happen in the surgery. Life is full of surprises." (P18, female, 73 years old, scheduled heart valve repair surgery).

"OHS is like anxiety/stress. Because surgery scares me, i wonder if i should give up the idea of surgery. I was adversely affected by the patient in the next bed. Before that, i was not that scared." (P43, female, 73 years old, scheduled CBAG).

"OHS is like fear. We had a relative who died during heart surgery. My mom and sister underwent CABG surgery. I also have a stent. My younger brother has it, too. I am not afraid of dying, but i have fears." (P20, female, 63 years old, scheduled CBAG).

"OHS is like a butcher's hook, implying it serves as a crucial support mechanism in workplace safety by "hooking" various elements together. When i went to the operating room yesterday, i saw a hook there and compared it to this. Surgery scared me." (the patient goes to the operating room, and the surgery is postponed due to high blood sugar). (P37, male, 58 years old, scheduled CBAG).

Theme 4: Accepting perspective (necessity): in this theme, patients accepted OHS as a necessary condition for their health and produced metaphors. In this theme, male patients produced the most metaphors.

"OHS is considered a necessity. Because if it is necessary for health, it is necessary; if not, it is unnecessary." (P32, male, 71 years old, scheduled CBAG).

"OHS is considered as a part of life. I will have my surgery and recover successfully." (P5, female, 72 years old, scheduled CBAG).

"OHS is like a long, narrow road. Human life is a long and narrow road. When you fall, the hospital becomes your rest stop on the way." (P38, male, 53 years old, scheduled CBAG).

Discussion

Metaphors are used to understand human thought, explain concepts better, and reason. Although there are studies in the literature that reflect the perspective of gender perception in surgical patients[18,31-33], no metaphorical research exists before OHS. In this study, metaphorical perspectives of pre-OHS patients were discussed. As a result of the research, four perspectives were identified. These perspectives are analyzed under five categories: mechanical, spiritual, cognitive affective, active, and receptive. These metaphors parallel the understanding of human beings as biopsychosocial and holistic entities.

When the mechanical point of view was examined, male patients perceived OHS to be a physical renovation, producing metaphors such as an engine and the repair of a structure. From this perspective, it was observed that male patients are predominant; however, among female patients, only one compared OHS to window cleaning. This point of view stems from the differences between the female and male minds, which philosophers have emphasized since ancient times. According to Lloyd[34], the female mind is ambiguous and uncertain, while the male mind is

clear and precise. Throughout the ages, masculinity has been characterized by an active and determined form; femininity, a passive and undetermined form[34,35]. Another factor in the emergence of the mechanistic perspective is thought to be "gender." While repair work is integrated with men in Türkiye, window cleaning is the first area that comes to mind when thinking of women. Housework is accepted as the primary responsibility of women in all societies[36,37]. Metaphors related to surgery also reflect this reality.

Another category in our research was identified as the spiritual point of view. In this category, patients stated that they see OHS as a means of salvation, rebirth, and relief from pain. It has been observed that some patients try to cope with their anxieties about surgery through their beliefs. This category includes the most expressed metaphors in both men and women. Another quantitative study showed that OHS patients tolerate excessive anxiety and have low hopes for survival. In addition, a systematic review found that the optimistic perspective was significantly associated with various recovery categories, including a decreased rehospitalization rate, complications, physical symptoms, such as pain, and psychological status, in CABG patients[38]. Spirituality and religion are essential to Turkish culture, and many Turkish citizens use their spirituality to cope when faced with a problem. In the literature, it has been determined that, similar to our research, spiritual emotions are used in coping and reducing anxiety and depression[39,40].

Patients in the cognitive and emotional perspective category produced metaphors for OHS, such as seeing white light, closed boxes, fear, and stress. This theme was the second most produced by patients. Patients experience uncertainty about whether the surgery will be successful. Since they share their experiences, they are affected by the negative experiences of patients in the same room or their relatives' who have previously undergone surgery. It was thought that the patient who went to the operating room experienced fear as a result. The patients experienced situations such as fear of death and environmental influences. Studies have shown that patients in many cultures experience negative emotions such as anxiety, fear of death, and uncertainty before OHS[1,41]. In a quantitative study conducted in Türkiye, it was determined that female patients' anxiety scores were significantly higher than those of males in terms of state and trait anxiety both before and six months after surgery[6]. The lack of information about the surgery plays a significant role in contributing to high levels of anxiety before cardiac surgery. Even the OHS technique alone is a cause of anxiety for patients[42].

In this research, the themes, under the category of accepting perspective, of trust in healthcare professionals and acceptance of the life cycle were obtained. Patients produced metaphors such as necessity, angel, nurse, part of life, and a long, narrow path in this category. Patients accept that OHS is necessary for their health and a part of their lives, and they have a realistic perspective. This perspective holds particular significance in the context of social work in healthcare. Nurses are crucial in helping patients and their families navigate the emotional and psychological challenges of significant medical procedures such as OHS. They provide support and resources to foster the acceptance of the medical condition, resilience, and coping mechanisms necessary for holistic recovery. Drawing from related research, a study on the effects of acceptance of the disease and helplessness on subjective health in cardiac patients[43] demonstrated that acceptance of the disease positively affects subjective health, while helplessness has a negative impact. These findings underscore the importance of nurses in promoting acceptance, providing emotional support, and enhancing the overall well-being of patients undergoing complex medical procedures like OHS. The acceptance of the disease by the patients was defined by McCracken and Eccleston[44] as stopping the search for definitive solutions to physical complaints, and redirecting attention to the positive aspects of life. Acceptance enables the individual to keeping their health in balance despite restrictions, obstacles, and changes experienced and coping with the troublesome situations faced with their illness.

On the other hand, the acceptance process of the disease affects the trust in healthcare professionals and compliance with the treatment regimen. In this category, male patients produced more metaphors than female patients. This can be attributed to the fact that the minds of male patients are dominant in logic, reasoning, and analysis, and they see surgery as a part of their life cycle, in search of a definitive solution to their physical complaints.

Study Limitations

The study is limited by the subjective nature of metaphor analysis, as patients' expressions may have been shaped by their personal experiences and cultural context. Therefore, the findings should be interpreted with caution.

Conclusion

In this study, the metaphors obtained are crucial in understanding and supporting the experience of patients undergoing OHS in the preoperative period. Patients predominantly produced spiritual metaphors for OHS.

While mechanical and accepting metaphors were prevalent among male patients undergoing surgery, female patients predominantly used spiritual and cognitive-sensory metaphors. These findings shed light on how patient metaphors reflect patients' perspectives and potentially influence their perception of surgery, thus highlighting their significance in enhancing the quality of preoperative care for OHS.

These results are of paramount importance as they demonstrate that metaphors serve as a vital cognitive tool for conveying the distinct characteristics of individuals before undergoing OHS. Furthermore, these metaphors can shape patients' diverse perspectives and impact the quality of care they receive in the preoperative phase.

Consequently, there is a growing need for further research to explore how metaphors impact patients' preoperative perceptions and how they can mediate the relationship between healthcare professionals and the care process. This research aims to understand how language, specifically metaphors, can improve preoperative education and reduce anxiety, drawing insights from theories such as CBT.

Understanding the role of metaphors, in conjunction with CBT, can be instrumental for healthcare professionals, especially nurses, in tailoring preoperative education and support. By recognizing how metaphors shape patients' perceptions and emotional responses to surgery, healthcare teams can develop more effective communication strategies. Nurses, with their expertise in addressing psychological and emotional aspects of healthcare, can play a pivotal role in assisting patients in coping with preoperative anxiety and facilitating a smoother transition into surgery.

Further studies exploring the nuanced relationship between metaphors, patient perceptions, and the healthcare professional-patient dynamic have the potential to significantly improve the preoperative experience and overall patient care.

Ethics

Ethics Committee Approval: The study was conducted according to the Declaration of Helsinki and approved by the Non-interventional Ethics Committee of Dokuz Eylül University (approval no: 7019, date: 16.02.2022).

Informed Consent: Written informed consent was obtained from the patients.

Footnotes

Authorship Contributions

Concept: Kankaya EA, Özer Özlü NG, Design: Kankaya EA, Özer Özlü NG, Data Collection and/or Processing: Özer Özlü NG, Analysis and/or Interpretation: Kankaya EA, Özer Özlü NG, Literature Search: Kankaya EA, Bilik Ö, Writing: Kankaya EA, Özer Özlü NG, Bilik Ö.

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Bedside Prediction of 30-day Adverse Outcomes in ACS Using Shock Index, NLR, and Creatinine

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Abstract

Objectives: Early risk stratification in acute coronary syndrome (ACS) is crucial for guiding management and improving outcomes. Although established scores such as thrombolysis in myocardial infarction and Global Registry of Acute Coronary Events are widely used, their complexity and reliance on multiple parameters may limit practicality in emergency settings. We aimed to investigate whether a simple combination of three routinely available parameters, shock index (SI), neutrophil-to-lymphocyte ratio (NLR), and serum creatinine, could predict 30-day major adverse cardiovascular events (MACE) in ACS patients.

Materials and Methods: This single-center retrospective cohort study included 500 consecutive ACS patients [ST-elevation myocardial infarction (STEMI), non-STEMI, unstable angina] admitted between January 2021 and December 2022. SI was calculated as heart rate divided by systolic blood pressure; NLR was obtained from a routine blood count; and serum creatinine was measured on admission. We evaluated the association of these parameters, individually and in combination, with 30-day MACE, defined as all-cause mortality, recurrent myocardial infarction, urgent target-vessel revascularization, or stroke. Logistic regression, ROC analysis, calibration plots, and decision curve analysis were performed.

Results: Thirty-day MACE occurred in 56 patients (11.2%). SI ≥0.8 [odds ratio (OR): 2.10; 95% confidence interval (CI): 1.28-3.44], NLR ≥3 (OR: 1.85; 95% CI: 1.14-3.01), and creatinine >1.2 mg/dL (OR: 2.28; 95% CI: 1.39-3.75) were independent predictors. The model combining all three parameters demonstrated strong discriminative ability (area under the curve: 0.80; 95% CI: 0.74-0.85) and performed better than the individual parameters.

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Conclusion: The three-parameter model (SI, NLR, creatinine) provides a rapid, low-cost, and practical method for bedside risk stratification in ACS patients. This simple model demonstrates strong predictive accuracy for 30-day MACE and may serve as a complementary tool to established risk scores. Further multicenter studies are required to validate its utility.

Keywords: Acute coronary syndrome, shock index, neutrophil-to-lymphocyte ratio, creatinine, major adverse cardiovascular events

Introduction

Acute coronary syndrome (ACS) remains one of the leading causes of morbidity and mortality worldwide. Early identification of patients at highest risk is critical for tailoring therapeutic strategies, guiding invasive management, and improving survival. Several risk scores, including the Global Registry of Acute Coronary Events (GRACE) score and the Thrombolysis in Myocardial Infarction (TIMI) score, have demonstrated prognostic utility and are endorsed by international guidelines[1]. However, these tools require multiple clinical, laboratory, and electrocardiographic parameters, which may not always be readily available in emergency settings. Their complexity and computational burden can also limit bedside applicability, particularly in overcrowded or resource-limited environments.

In contrast, simple and universally available parameters may offer rapid and effective prognostic insights. The shock index (SI), defined as the ratio of heart rate to systolic blood pressure, has long been associated with hemodynamic instability and poor short-term outcomes in ACS. The neutrophil-to-lymphocyte ratio (NLR), a marker of systemic inflammation, has been linked to larger infarct size, impaired ventricular recovery, and higher rates of major adverse cardiovascular events (MACE)[2]. Similarly, elevated serum creatinine and impaired renal function are well-established predictors of adverse cardiovascular outcomes. Each of these parameters has prognostic value individually, but their combined use in a simple model for ACS risk stratification has not been systematically evaluated. This study examined whether the integration of SI, NLR, and creatinine could serve as a practical bedside tool to predict 30-day outcomes in ACS patients. We hypothesized that the three-parameter model would provide strong discrimination and calibration for short-term risk, offering a complementary approach to existing, more complex risk scores.

Materials and Methods

Study Design and Population

This single-center retrospective cohort study included 500 consecutive patients admitted with ACS, including ST-elevation myocardial infarction (STEMI), non-STEMI (NSTEMI), and unstable angina, between January 2021 and December 2022. The diagnosis of ACS was established based on current European Society of Cardiology guidelines, integrating clinical presentation, electrocardiographic changes, and elevated cardiac biomarkers. Patients with incomplete laboratory data, active infection, autoimmune or hematologic diseases, chronic inflammatory disorders, malignancies, or those receiving immunosuppressive treatment were excluded. Of 560 consecutive patients initially screened, 60 were excluded due to missing laboratory data (n=28), active infection (n=12), autoimmune or hematologic disease (n=8), chronic inflammatory disorders (n=6), and malignancy or immunosuppressive therapy (n=6), resulting in a final study population of 500 patient.

The study protocol was reviewed and approved by the University of Health Sciences Türkiye, Diyarbakır Gazi Yaşargil Training and Research Hospital Ethics

Committee (approval no: 676, date: 24.10.2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Given the retrospective design, the requirement for written informed consent was waived by the local ethics committee.

Data Collection and Definitions

Demographic characteristics (age, sex), cardiovascular risk factors (hypertension, diabetes mellitus, smoking), and hemodynamic and laboratory parameters at admission were retrieved from the hospital electronic medical records.

- SI was calculated as the ratio of heart rate (beats/min) to systolic blood pressure (mmHg).
- NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count obtained from the complete blood count on admission.
- Serum creatinine level was measured on admission using the Jaffe method.

Based on prior literature, the following cut-off values were predefined: SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL. Each variable was considered a binary risk factor (present/absent), and a composite three-parameter model was constructed by combining these indices.

Endpoints

The primary endpoint was the occurrence of 30-day MACE, defined as a composite of all-cause mortality, recurrent myocardial infarction, urgent target vessel revascularization, or stroke within 30 days after the index event. Follow-up data were obtained from hospital records and verified by telephone interviews when necessary.

Statistical Analysis

All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Kolmogorov-Smirnov test and were expressed as mean ± standard deviation (SD) or median (interquartile range) as appropriate. Categorical variables were presented as counts and percentages. Comparisons between groups [(MACE (+) vs. MACE (–)] were made using the Student's t-test or Mann-Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables.

Variables with $p<0.10$ in univariate analyses were included in the multivariable logistic regression model to determine independent predictors of 30-day MACE. The results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

Discriminatory performance was evaluated using ROC curve analysis, and the area under the curve (AUC) was calculated for each parameter and for the combined model. Calibration was assessed by the Hosmer-Lemeshow goodness-of-fit test and visual inspection of calibration plots. Internal validation was performed using bootstrap resampling (1.000 iterations). Additionally, decision curve analysis (DCA) was conducted to assess the net clinical benefit of the three-parameter model compared with the "treat-all" and "treat-none" strategies. A two-tailed p value <0.05 was considered statistically significant.

Results

Among 500 patients, the mean age was 62±11 years; 28% were female, 55% were hypertensive, 32% were diabetic, and 41% were smokers. STEMI was present in 46%, NSTEMI in 37%, and unstable angina in 17%. The 30-day MACE rate was 11.2% (56 patients). Baseline demographic and clinical characteristics stratified by MACE are shown in Table 1. Univariable and multivariable analyses confirmed SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL as independent predictors (Table 2). The three-parameter model stratified patients into low-, intermediate-, and high-risk groups (Table 3). The model achieved an AUC of 0.80 and outperformed SI and NLR individually, demonstrating excellent calibration (Figure 1). DCA confirmed a net clinical benefit (Figure 2).

Baseline Characteristics

Baseline demographic and clinical characteristics according to MACE status are summarized in Table 1.

Table 1. Baseline demographic and clinical characteristics of the study population

Variable	Total (n=500)	MACE (+) (n=56)	MACE (-) (n=444)	p-value
Age, years (mean ± SD)	62±11	67±12	61±11	<0.01
Female sex, n (%)	140 (28)	20 (36)	120 (27)	0.12
Hypertension, n (%)	275 (55)	40 (71)	235 (53)	0.01
Diabetes mellitus, n (%)	160 (32)	25 (45)	135 (30)	0.02
Current smoker, n (%)	205 (41)	27 (48)	178 (40)	0.24
STEMI, n (%)	230 (46)	32 (57)	198 (45)	0.08
NSTEMI, n (%)	185 (37)	18 (32)	167 (38)	0.39
Unstable angina, n (%)	85 (17)	6 (11)	79 (18)	0.21
Killip class ≥II, n (%)	90 (18)	20 (36)	70 (16)	<0.001
Shock index ≥0.8, n (%)	200 (40)	32 (57)	168 (38)	0.004
NLR ≥3, n (%)	240 (48)	35 (62)	205 (46)	0.02
Creatinine >1.2 mg/dL, n (%)	120 (24)	25 (45)	95 (21)	<0.001
PCI performed, n (%)	350 (70)	41 (73)	309 (70)	0.65
30-day MACE, n (%)	56 (11.2)	-	-	-

STEMI: ST-elevation myocardial infarction, NSTEMI: Non-ST-elevation myocardial infarction, NLR: Neutrophil-to-lymphocyte ratio, PCI: Post-percutaneous coronary intervention, MACE: Major adverse cardiovascular events, SD: Standard deviation

Table 2. Multivariable logistic regression analysis for predictors of 30-day MACE

Predictor	Odds ratio (95% CI)	p-value
Shock index ≥0.8	2.10 (1.28-3.44)	0.003
NLR ≥3	1.85 (1.14-3.01)	0.012
Creatinine >1.2 mg/dL	2.28 (1.39-3.75)	0.001

MACE: Major adverse cardiovascular events, NLR: Neutrophil-to-lymphocyte ratio, CI: Confidence interval

Table 3. Risk stratification of the study population according to the three-parameter model

Risk group	N	30-day MACE, n (%)	Relative risk vs. low risk
Low (0-2 factors)	210	13 (6%)	Reference
Intermediate (1-2 factors)	190	27 (14%)	2.3
High (3 factors)	100	27 (27%)	4.3

MACE: Major adverse cardiovascular events

Patients who developed MACE were significantly older (67±12 vs. 61±11 years, p<0.01) and more likely to have hypertension (p=0.01) and diabetes mellitus (p=0.02). The proportion of patients with Killip class ≥II was notably higher in the MACE group (36% vs. 16%, p<0.001), indicating greater hemodynamic compromise. Laboratory and hemodynamic markers associated with poor outcomes included SI ≥0.8 (57% vs. 38%, p=0.004), NLR ≥3 (62% vs. 46%, p=0.02), and creatinine >1.2 mg/dL (45% vs. 21%, p<0.001).

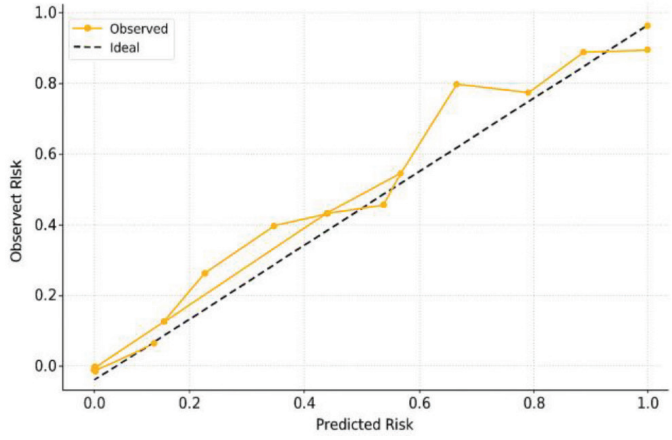

Figure 1. Calibration plot for the three-parameter model

Univariable and Multivariable Predictors

Univariable logistic regression analysis identified age, hypertension, diabetes mellitus, Killip class ≥II, SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL as significant predictors of 30-day MACE. When these variables were entered into the multivariable model, SI ≥0.8 (OR: 2.10, 95% CI: 1.28-3.44, p=0.003), NLR ≥3 (OR: 1.85, 95%

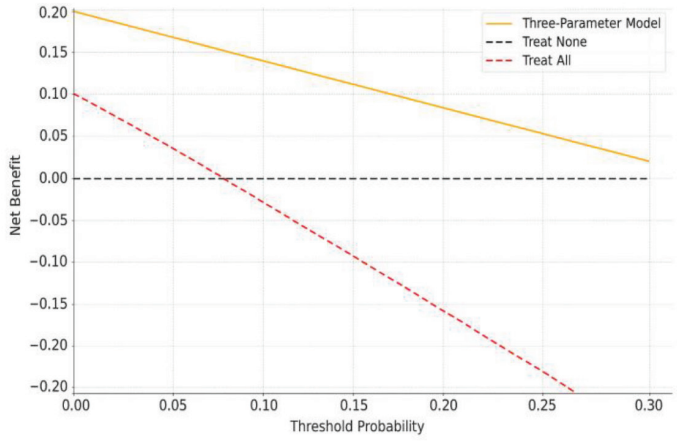

Figure 2. Decision curve analysis for the three-parameter model

CI: 1.14-3.01, p=0.012), and creatinine >1.2 mg/dL (OR: 2.28, 95% CI: 1.39-3.75, p=0.001) remained independent predictors.

Three-Parameter Model and Risk Stratification

Patients were classified into three risk categories based on the cumulative number of adverse factors (SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL). As shown in Table 3, event rates increased progressively across categories: 6% in the low-risk group (0 factors), 14% in the intermediate group (1-2 factors), and 27% in the high-risk group (3 factors) (p<0.001 for trend). The relative risk of MACE was approximately 4.3-fold higher in patients with all three risk factors compared to those without.

Model Performance and Validation

ROC curve analysis demonstrated strong discriminatory ability of the three-parameter model with an AUC of 0.80 (95% CI: 0.74-0.85), outperforming individual predictors (SI=0.67, NLR=0.70, creatinine =0.73). The calibration plot (Figure 1) showed excellent agreement between predicted and observed MACE rates, with a non-significant Hosmer-Lemeshow test (p>0.05) indicating good model fit. Internal validation by bootstrap resampling (1.000 iterations) confirmed model stability. DCA (Figure 2) revealed a net clinical benefit of the three-parameter model across a wide range of threshold probabilities, outperforming both "treat-all" and "treat-none" strategies.

Table 1 compares demographic, clinical, and laboratory parameters between MACE (+) and MACE (-) patients. Significant predictors of adverse outcomes included older age, hypertension, diabetes, elevated SI, elevated NLR, and elevated creatinine.

Table 2 presents independent predictors of 30-day MACE. SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL retained statistical significance in the multivariable model, confirming their prognostic value.

Table 3 shows the incremental risk of 30-day MACE with an increasing number of abnormal parameters, confirming the additive prognostic value of combining SI, NLR, and creatinine.

Calibration plot showing agreement between predicted and observed probabilities of 30-day MACE. The Hosmer-Lemeshow test was non-significant, confirming good calibration.

The calibration plot demonstrates close alignment between predicted and observed probabilities of 30-day MACE. The non-significant Hosmer-Lemeshow test supports adequate calibration.

DCA indicating net clinical benefit of using the three-parameter model across a range of threshold probabilities compared with strategies of treating all or none.

DCA indicates that the use of the three-parameter model confers a consistent net clinical benefit across multiple decision thresholds compared with treating all or treating none.

Discussion

In this study, we demonstrated that a simple combination of three routinely available parameters — SI, NLR, and serum creatinine — provides strong predictive value for short-term adverse outcomes in patients with ACS. The three-parameter model showed excellent discrimination and calibration for predicting 30-MACE, outperforming each individual marker. The model's practicality and rapid

applicability make it a valuable complement to traditional risk scores, such as GRACE and TIMI, particularly in emergency and resource-limited settings[3].

The early recognition of high-risk ACS patients remains a cornerstone of effective management. Despite the availability of validated risk scores, their clinical use may be limited by the need for multiple variables, complex calculations, or specialized software[4]. In contrast, SI, NLR, and creatinine are available at admission and do not require complex calculations. Our findings suggest that combining these parameters allows for rapid bedside risk assessment without sacrificing predictive accuracy.

The SI reflects the balance between cardiac output and vascular tone, offering a dynamic estimate of hemodynamic instability. Previous studies have shown that elevated SI is associated with increased mortality and a higher incidence of cardiogenic shock after myocardial infarction. In our cohort, SI ≥0.8 independently predicted 30-day MACE, reinforcing its role as an early warning indicator[5].

The NLR is a robust inflammatory marker that integrates two complementary immune responses: neutrophilia indicating acute stress and lymphopenia reflecting impaired immune regulation. Elevated NLR has been associated with larger infarct size, microvascular dysfunction, and post-percutaneous coronary intervention (PCI) complications[6,7]. Our results align with prior observations linking inflammation to plaque instability and thrombotic risk, supporting NLR as a strong, inexpensive prognostic indicator.

The prognostic impact of serum creatinine emphasizes the importance of renal function in cardiovascular outcomes. Even mild renal impairment has been associated with higher mortality and reinfarction rates after ACS. Creatinine reflects both hemodynamic stress and underlying comorbidities, and its inclusion in the model improved overall risk discrimination. The independent association between creatinine >1.2 mg/dL and MACE underscores that renal function should not be overlooked during early ACS evaluation.

The association of elevated SI, NLR, and creatinine with adverse outcomes likely reflects the interplay between hemodynamic stress, inflammation, and renal dysfunction. An increased SI indicates reduced stroke volume and compensatory tachycardia, signaling early circulatory compromise. Elevated NLR represents systemic inflammatory activation and oxidative stress, both of which promote endothelial dysfunction and plaque instability. Concurrently, renal impairment reflected by elevated creatinine can exacerbate inflammatory cytokine release, impair endothelial nitric oxide production, and alter volume status, creating a self-perpetuating cycle that worsens myocardial ischemia and impairs recovery[8,9]. Thus, these parameters collectively capture the hemodynamic-inflammatory-metabolic continuum underlying early cardiovascular deterioration in ACS.

The combined use of SI, NLR, and creatinine integrates three complementary dimensions of ACS pathophysiology: hemodynamic compromise, inflammatory activation, and renal dysfunction. Individually, each parameter has prognostic significance, but their coexistence may reflect a compounded risk phenotype characterized by reduced perfusion, systemic inflammation, and metabolic stress. This integrated approach enhances risk discrimination and explains the superior predictive accuracy of the three-parameter model compared with that of each individual variable.

Our results are consistent with several prior studies that highlighted the individual prognostic power of these parameters. Wang et al. [10] demonstrated that elevated SI predicted short-term mortality after STEMI, while Kaya et al. [11] found that NLR independently predicted in-hospital MACE in ACS patients. Similarly, Yildiz et al.[4] reported that serum creatinine levels on admission were strongly correlated with 30-day mortality and recurrent ischemia. However, the present study is among the few to evaluate the combined prognostic value of these three markers within a single, easily applicable model.

Unlike multifactorial risk scores requiring numerous inputs, the proposed three-parameter model captures

hemodynamic, inflammatory, and metabolic pathways simultaneously, providing a holistic yet simple bedside assessment. The good calibration and clinical benefit shown in DCA indicate that this model can meaningfully aid clinical decision-making, especially in settings where rapid triage is essential.

In daily practice, this model could serve as an initial screening tool to identify high-risk patients requiring urgent invasive management or intensive monitoring. Its integration into emergency department triage protocols may help prioritize limited resources and guide the timing of coronary angiography or PCI. Furthermore, it could be used alongside established scores to enhance prognostic precision without additional cost or delay.

Study Limitations

Several limitations should be acknowledged. First, this was a single-center retrospective study, which may limit the generalizability of the findings. Second, although the study included a relatively large cohort, external validation in independent and multicenter populations is required before broad clinical adoption. Third, only baseline measurements were used; dynamic changes in SI, NLR, or creatinine during hospitalization were not evaluated and might provide additional prognostic insight. Fourth, we did not assess long-term outcomes beyond 30 days, which could have offered further understanding of the model's predictive value over time. Finally, unmeasured confounders such as medication use, infarct size, and ejection fraction may have influenced the results despite statistical adjustment.

Despite these limitations, the present study offers practical clinical insight by proposing a simple, cost-effective, and accessible bedside model that can complement existing risk assessment strategies.

Conclusion

The present study demonstrates that a simple combination of three routinely available parameters SI, NLR, and serum creatinine — can effectively predict 30-day adverse cardiovascular outcomes in patients with ACS. The proposed three-parameter model demonstrates strong discriminative performance and good calibration, outperforming each individual variable used alone.

This model is practical, inexpensive, and readily applicable at the bedside, allowing rapid early risk assessment without complex calculations or additional resources. Incorporating hemodynamic, inflammatory, and renal components, it offers a comprehensive yet simple representation of patient risk.

The findings suggest that this model could serve as a complementary tool to established risk scores for initial triage and clinical decision-making in emergency and critical care settings. Future multicenter prospective studies involving larger, more diverse populations are warranted to validate its predictive accuracy and to confirm its utility across different clinical settings. Nevertheless, further multicenter, prospective studies with larger and more diverse populations are warranted to confirm these findings.

Ethics

Ethics Committee Approval: The study protocol was reviewed and approved by the University of Health Sciences Türkiye, Diyarbakır Gazi Yaşargil Training and Research Hospital Ethics Committee (approval no: 676, date: 24.10.2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Informed Consent: This single-center retrospective cohort study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Yeter Arslan, G Söner S, Concept: Yeter Arslan G Söner S, Design: Yeter Arslan G. Söner S, Data Collection and/or Processing: Yeter Arslan G. Söner S, Analysis and/or Interpretation: Yeter Arslan G. Söner S, Literature Search: Yeter Arslan G, Söner S, Writing: Yeter Arslan G, Söner S

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Peripheral Cannulation vs. Conventional Methods in Redo Cardiac Surgery: A Single-Center Experience

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Abstract

Objectives: This study aims to compare the outcomes of peripheral cannulation (PC) and central cannulation (CC) techniques in redo cardiac surgeries.

Materials and Methods: A retrospective analysis was conducted on 104 patients who underwent redo cardiac surgery between January 2010 and January 2023. Patients were divided into two groups based on the cannulation technique used: PC (n=56) and CC (n=48). Preoperative, intraoperative, and postoperative parameters were collected and analyzed.

Results: Significant differences were observed in cardiopulmonary bypass time (127.1±13.6 minutes for PC vs. 120.1±15.4 minutes for CC, p=0.021) and total operation time (295.7±40.4 minutes for PC vs. 249.9±39.5 minutes for CC, p<0.001). The incidence of procedure-related injuries was significantly lower in the PC group (5.4% vs. 31.2%, p=0.036). Overall complications were also significantly lower in the PC group (10.7% vs. 35.4%, p<0.001). Postoperative ventilation duration was shorter in the PC group (5.4±1.1 hours vs. 6.0±1.5 hours, p=0.036). Hemoglobin, C-reactive protein, and ejection fraction levels pre- and postoperatively showed no significant differences between the groups. These findings suggest that PC may offer a safer alternative with fewer complications in redo cardiac surgeries.

Conclusion: PC may offer a safer alternative with fewer complications in redo cardiac surgeries compared to CC. These findings suggest the potential benefits of using PC in reducing procedure-related injuries and overall complications.

Keywords: Cardiopulmonary bypass, central cannulation, peripheral cannulation, redo surgery, surgical complications

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Introduction

Cardiac reoperations pose significant challenges, necessitating specialized strategies and meticulous precautions to mitigate complications throughout the surgical process. During resternotomy and pericardial dissection, there is a risk of catastrophic outcomes due to potential injury to the right ventricle, reduction in great artery pressure, and damage to the patent bypass graft. Although no definitive method exists to completely prevent complications and mortality, ongoing efforts and discussions have persisted for years[1,2].

Although various studies highlight the benefits of peripheral cannulation (PC)[3,4], there is also research indicating that routine use of PC may be unnecessary, as standard central cannulation (CC) yields favorable outcomes[3]. The aim of this study is to evaluate the efficacy and safety of PC compared to conventional CC in patients undergoing redo cardiac surgery. By analyzing outcomes such as complication rates, procedural success, and overall patient prognosis, we seek to determine whether PC offers significant advantages or if CC remains the optimal approach in these complex surgical cases.

In recent years, the increasing number of patients requiring repeat cardiac surgeries due to improved long-term survival has intensified the focus on optimizing reoperative strategies[5,6]. The complex anatomical changes and adhesions that develop following initial procedures complicate re-entry and surgical exposure, thereby increasing the risk of life-threatening intraoperative events. Consequently, determining the most effective and safest cannulation technique has become a matter of considerable clinical interest, as it can directly influence operative safety, morbidity, and overall patient outcomes[7,8].

Therefore, the objective of this study is to conduct a comprehensive comparison between peripheral and CC techniques in the context of redo cardiac surgery. By systematically evaluating perioperative complications, mortality, and recovery parameters in a contemporary patient cohort, we aim to provide robust scientific evidence that will inform surgical decision-making and potentially improve the standard of care for this high-risk population.

Materials and Methods

Study Design

This retrospective study was approved by the Ethics Committee of tertiary University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (approval no: 2024-04-05, date: 04.03.2024). The study involved patients undergoing redo cardiac surgery between January 2010 and January 2023.

Patient Selection

The study included a total of 104 patients who underwent redo cardiac surgery using either PC (n=56) or CC (n=48) techniques. Surgeries performed at least 30 days after the initial cardiac operation were excluded from the study. Patients undergoing PC with no suitable femoral artery cannulation site, those with chronic deep vein thrombosis, and those with Leriche syndrome were also excluded. In the early years (2010-2015), CC was predominantly used, whereas in the later years (2016-2024), PC became more common. The surgical team performing the redo surgeries remained the same throughout the study period. Patients were classified according to the initial site of arterial and venous access used for cardiopulmonary bypass (CPB) initiation. In the PC group, the femoral artery and vein (with additional internal jugular venous cannulation when necessary) were cannulated before sternotomy. In the CC group, CPB was initiated via the ascending aorta and right atrium after sternotomy.

Data Collection

Data were collected on demographic characteristics (age, gender, smoking status, hypertension), anthropometric measurements [height, weight, body mass index (BMI)], preoperative and postoperative hemoglobin (Hb) levels, operative variables [temporary and permanent pacemaker insertion, chest drainage amount, blood product usage, bleeding revision, ventilation time, intensive care

unit (ICU) stay, hospital stay, hospital mortality, and complications]. The collected data were transferred to a digital database for analysis.

Cannulation Techniques

Central Cannulation

Following anesthesia preparation, the patient was draped in a sterile manner, and a sternotomy was performed. The old sternal wires were excised and removed, and a redo sternotomy was executed using a specialized saw. Adhesions were carefully bluntly dissected to expose the ascending aorta and right atrium. After systemic heparinization, an aortic cannula was inserted into the ascending aorta, and a venous cannula was placed in the right atrium. Subsequently, CPB was initiated.

Peripheral Cannulation

Anesthesia typically included the placement of a 7F sheath in the right internal jugular vein under ultrasound guidance to minimize intraoperative handling. A central venous catheter was also inserted into the left internal jugular vein. The patient was then draped in a sterile manner, and the femoral vein and artery were assessed via ultrasound for thrombus, stenosis, and calcifications. Given its proximity to the primary surgeon, the right femoral artery and vein were explored and prepared. Systemic heparinization was administered. Utilizing the Seldinger technique, a guidewire was initially inserted into the femoral artery, followed by the placement of the arterial cannula. A guidewire was then advanced through the femoral vein to the right atrium, with the venous cannula size selected according to the patient's BMI. The femoral cannula was advanced to the right atrium. A guidewire was subsequently placed into the previously prepared right internal jugular vein, and a second venous cannula was advanced to the right atrium. CPB was initiated, the heart was decompressed, and the lungs were disconnected from the ventilator. The sternum was then opened, the old sternal wires were removed, and a redo sternotomy was performed using a specialized saw. Adhesions were carefully bluntly dissected as needed. After the surgical procedure was completed and hemostasis was achieved, a drain was placed in the mediastinum and at least one thoracic cavity (typically the right thorax). The sternum was then closed with steel wires.

Statistical Analysis

Data analysis was conducted utilizing the SPSS software (IBM Corp, released in 2012, Version 27.0 for Windows, Armonk, NY). The conformity of the variables to a normal distribution was assessed with the Kolmogorov-Smirnov test. Descriptive statistical methods (mean, standard deviation, median, frequency, percentage, minimum, and maximum) were used while evaluating the study data. For variables adhering to a normal distribution, group comparisons were executed using the Independent samples t-test. The Pearson chi-squared test was employed for variables not normally distributed to assess the differences in proportions between two independent groups. A p-value of less than 0.05 was deemed indicative of statistical significance.

Results

A retrospective analysis was conducted on 104 patients who underwent redo cardiac surgery between January 2010 and January 2023. Patients were divided into two groups based on the cannulation technique used: PC (n=56) and CC (n=48). Preoperative, intraoperative, and postoperative parameters were collected and analyzed.

Significant differences were found in the prevalence of peripheral artery disease, present in 56.3% of the CC group but absent in the PC group. Other parameters, such as age, BMI, gender distribution, and the prevalence of smoking, hypertension, diabetes, and chronic obstructive pulmonary disease, showed no significant differences between the groups. The distribution of planned surgeries, including bacterial endocarditis, ascending aortic aneurysm, and various valve replacements, was similar across both groups (Table 1).

Significant differences were observed in the CPB time and total operation time, with the PC group having longer durations (127.1±13.6 minutes vs. 120.1±15.4 minutes, p=0.021 and 295.7±40.4 minutes vs. 249.9±39.5 minutes, p<0.001, respectively). Ventilation duration was also significantly shorter in the PC group (5.4±1.1 hours vs. 6.0±1.5 hours, p=0.036). Other parameters, including the number of previous sternotomies, cross-clamp time, chest drainage, ICU stay, and length of hospital stay, showed no significant differences between the groups (Table 2).

Procedure-related injuries, which occurred during resternotomy and primarily involved damage to structures such as the innominate vein, right atrium, right ventricle, or ascending aorta, were recorded separately for both groups. These injuries were significantly less frequent in the PC group (5.4%) compared to the CC group (31.2%) (p=0.036). In addition, significant differences were observed in overall complication rates, which were also lower in the peripheral group (10.7% vs. 35.4%, p<0.001). The use of postoperative blood products, including red blood cells (RBCs), platelets (PLTs), fresh frozen plasma, and fresh whole blood, did not show significant differences between the groups. The requirement for inotropic therapy and the use of intra-aortic balloon pumps were also similar

Table 1. Preoperative parameters and planned surgeries

Age (years)	62.1±8.0	61.5±8.0	0.734
BMI (kg/m²)	27.9±4.8	27.8±4.9	0.667
Female	24 (42.9%)	23 (47.9%)	0.605
Smoke	38 (67.9%)	36 (75.0%)	0.423
HT	29 (51.8%)	27 (56.3%)	0.649
DM	32 (57.1%)	30 (62.5%)	0.579
COPD	26 (46.4%)	17 (35.4%)	0.256
PAD	0 (0.0%)	27 (56.3%)	<0.001
Planned surgeries			0.098
Bacterial endocarditis	2 (3.57)	3 (5.36)	
Ascending aortic aneurysm	5 (8.93)	5 (8.93)	
Aortic valve replacement	19 (33.93)	12 (21.43)	
Mitral valve replacement	30 (53.57)	26 (46.43)	
Tricuspid valve replacement	4 (7.14)	5 (8.93)	
Coronary artery bypass graft	3 (5.36)	4 (7.14)	

BMI: Body mass index, HT: Hypertension, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary diseas, PAD: Peripheral artery disease

Table 2. Comparison of demographic, laboratory, and operative parameters between peripheral and central cannulation groups

	Peripheral (n=56)	**Central (n=48)**	
	Mean ± SD	Mean ± SD	p-value
Number of previous sternotomies	1.2±0.6	1.1±.2	0.388
Cross-clamp time (min)	102.6±9.3	100.9±12.2	0.819
Cardiopulmonary bypass time (min)	127.1±13.6	120.1±15.4	**0.021**
Total operation time (min)	295.7±40.4	249.9±39.5	**<0.001**
Chest drainage (mL)	839.9±126.2	849.1±122.8	0.510
Ventilation duration (hours)	5.4±1.1	6.0±1.5	**0.036**
Total intensive care unit stay (days)	2.9±1.6	3.0±1.7	0.943
Length of hospital stay (days)	6.8±1.6	7.3±2.1	0.370

SD: Standard deviation

between the groups. There was no significant difference in perioperative (in-hospital) mortality between the groups. Mortality occurred in one patient (1.8%) in the PC group and in two patients (4.2%) in the CC group (p>0.05). The causes of mortality were severe low cardiac output syndrome and multiple organ failure (Table 3).

Preoperative Hb levels were 11.4±1.1 g/dL in the PC group and 11.3±1.1 g/dL in the CC group (p=0.565). Postoperative Hb levels were 8.7±0.6 g/dL in both groups (p=0.741). Preoperative C-reactive protein (CRP) levels were 11.3±7.7 mg/L in the PC group and 13.1±9.5 mg/L in the CC group (p=0.348). Postoperative CRP levels were 101.6±97.6 mg/L in the PC group and 131.0±133.5 mg/L in the CC group (p=0.672). Preoperative ejection fraction (EF) was 44.7±6.7% in the PC group and 45.1±6.4% in the CC group (p=0.757). Postoperative EF was 42.8±7.4% in the PC group and 43.5±6.4% in the CC group (p=0.695). There were no significant differences between the groups for other parameters, including hematocrit and PLT counts, both preoperatively and postoperatively. These findings suggest that both cannulation techniques have similar impacts on these laboratory and cardiac function parameters (Table 4).

Discussion

One of the principal hurdles in repeat cardiac surgeries is the safe execution of the sternotomy. The risk of damaging heart structures during this process can lead to significant bleeding and hemodynamic complication[9]. Until April 2016, CC was the standard approach for all reoperations at our facility; thereafter, we shifted entirely to PC aiming to decrease surgical mortality

Table 3. Clinical and demographic comparison of cannulation methods

	Peripheral (n=56)	**Central (n=48)**	
	Count (%)	**Count (%)**	**p-value**
Postoperative blood products (units)			0.381
Absent	46 (77.9%)	38 (73.1%)	
Red blood cells	3 (5.1%)	4 (7.7%)	
Platelets	4 (6.8%)	2 (3.8%)	
Fresh frozen plasma	5 (8.5%)	4 (7.7%)	
Fresh whole blood	1 (1.7%)	4 (7.7%)	
Inotropic therapy requirement	28 (50)	27 (56.3)	0.524
Procedure related injury			**0.036**
No	53 (94.6%)	33 (68.8%)	
Innominate vein	2 (3.6%)	6 (12.5%)	
Right ventricle	0 (0.0%)	1 (2.1%)	
Right atrium	0 (0.0%)	3 (6.3%)	
Bypass grafts	0 (0.0%)	1 (2.1%)	
Lungs	1 (1.8%)	2 (4.2%)	
Ascending aorta	0 (0.0%)	2 (4.2%)	
Intra-aortic balloon pump	4 (7.1)	4 (8.3)	0.820
Complications			**<0.001**
Absent	50 (89.3%)	31 (64.6%)	
Superficial sternal infection	2 (3.6%)	6 (12.5%)	
Deep sternal infection	0 (0.0%)	5 (10.4%)	
Sternal dehiscence	0 (0.0%)	6 (12.5%)	
Femoral infection	4 (7.1%)	0 (0%)	

Table 4. Pre- and post-operative laboratory and cardiac EF values in redo cardiac surgeries

	Peripheral (n=56)	Central (n=48)	
	Mean ± SD	**Mean ± SD**	**p-value**
Pre-op Hb (g/dL)	11.4±1.1	11.3±1.1	0.565
Post-op Hb (g/dL)	8.7±0.6	8.7±0.6	0.741
Pre-op HCT (%)	34.1±3.2	33.6±3.3	0.586
Post-op HCT (%)	26.5±1.8	26.5±1.9	0.917
Pre-op PLT (10^3/μL)	206.8±78.8	196.1±72.3	0.512
Post-op PLT (10^3/μL)	175.6±77.3	172.8±70.9	0.977
Pre-op CRP (mg/L)	11.3±7.7	13.1±9.5	0.348
Post-op CRP (mg/L)	101.6±97.6	131.0±133.5	0.672
Pre-op EF (%)	44.7±6.7	45.1±6.4	0.757
Post-op EF (%)	42.8±7.4	43.5±6.4	0.695

Hb: Hemoglobin, HCT: Hematocrit, PLT: Platelet, CRP: C-reactive protein, EF: Ejection fraction, SD: Standard deviation

and morbidity rates. Kuralay et al.[3] achieved notable reductions in cardiac injuries and severe bleeding events by employing the Carpentier bicaval venous cannul. In a similar vein, Luciani et al.[4] implemented peripheral CPB as a preparatory measure in selected cases, effectively minimizing injuries upon reentry. Despite the increased duration of both total operation and CPB with PC noted in these studies, our findings indicate that the use of a multi-stage venous cannula for peripheral CPB, without any specific preconditions unlike Luciani et al.[4], resulted in a longer peripheral CPB duration. However, there was no significant difference in the overall surgery time between PC and CC groups. Utilizing presternotomy peripheral CPB can reduce the pressure in the heart and major arteries, thus aiding in the swift and safe separation of adhesions.

Studies have shown that utilizing multidetector CT for preoperative planning is advantageous in evaluating the spatial relationship between the sternum and vital structures beneath it[10,11]. We agree with this assessment but recognize that this technique falls short in providing detailed information about the severity of adhesions. Yoshioka et al.[12] have shown that the integration of tagged cine magnetic resonance imaging with a finite element model offers predictions on the extent of retrosternal adhesions, although this method is not widely used. In our established practice, CT angiography is conducted before conducting aortic surgeries such as the Bentall or David procedures.

In our study, we compared PC with conventional methods in redo cardiac surgeries. Our findings indicate that the PC group experienced a longer CPB time and total operation duration compared to the CC group. Despite these extended times, the PC group demonstrated a lower incidence of procedure-related injuries and overall complications. Additionally, while ventilation duration was shorter in the PC group, the length of hospital stay and ICU stay showed no significant difference between the two groups. Laboratory values and cardiac EF measured preoperatively and postoperatively were also comparable across both groups. These results suggest that PC may offer a safer alternative with fewer complications in redo cardiac surgeries, without adversely affecting the recovery period or clinical outcomes.

Several recent studies have explored the trade-off between PC and operative duration in redo cardiac surgery. Werner et al.[13] highlighted that although PC can provide a safer environment for sternal re-entry by avoiding mediastinal dissection, this comes at the cost of additional preparation time and may extend CPB and

total operative time. Meanwhile, Liu et al.[14] reported a 10-year series in which no significant difference in bypass or operation length was observed between central and peripheral techniques, suggesting that with optimized protocols the time difference may be mitigated. Together, these findings support our interpretation that the longer operative and bypass times in the PC group reflect a deliberate strategy of enhanced safety rather than inefficiency.

In the study by Ata et al.[15], peripheral and CC techniques were compared in cardiac reoperations. This study found that the incidence of procedure-related injuries was significantly lower in the PC group compared to the CC group (1.8% vs. 8.3%). Similarly, in our study, the incidence of procedure-related injuries (5.4% vs. 31.2%) and overall complication rates (10.7% vs. 35.4%) were significantly lower in the PC group. Yildiz et al.[16] also found that procedure-related injuries were lower in the preoperative cannulation group compared to the conventional cannulation group (6.7% vs. 22.5%. Ata et al.[15] study demonstrated that the CPB time was significantly shorter in the CC group (120±26.7 minutes) compared to the PC group (125±31 minutes). Yildiz et al.[16] study showed that the CPB time was shorter in the preoperative cannulation group (141.7±82.47 minutes) compared to the conventional cannulation group (171.87±85.59 minutes), although this difference was not statistically significant. In our study, the CPB time was longer in the PC group (127.1±13.6 minutes) and this difference was statistically significant. While Yildiz et al.[16] study found no significant difference in total operation time between the groups (central: 198±43 minutes, peripheral: 202±47 minutes). Duman et al.[17], the CPB time was shorter in the CC group (141.7±82.47 minutes) compared to the PC group (171.87±85.59 minutes), and the total operation time was significantly shorter in the CC group (314.77±187.38 minutes) compared to the PC group (420.29±188.84 minutes. These findings are consistent with the results obtained in our study. Furthermore, Duman et al.[17] study also found that procedure-related injuries were lower in the PC group compared to the CC group. These data support our study and suggest that PC may reduce complication rates during redo sternotomy. Our study showed that the total operation time was significantly longer in the PC group (295.7±40.4 minutes). In contrast, Yildiz et al.[16] study found that the total operation time was significantly shorter in the preoperative cannulation group (314.77±187.38 minutes) compared to the conventional cannulation group (420.29±188.84 minutes).

The higher incidence of sternal dehiscence and deep sternal infection observed in the CC group can be explained by increased mechanical stress and prolonged mediastinal exposure during re-sternotomy. Repeated manipulation of previously operated tissues may compromise sternal stability and microcirculation, leading to delayed wound healing and a higher susceptibility to infection. Furthermore, extended sternal exposure and rewiring of fragile sternal bone after previous operations may predispose to postoperative instability and deep sternal wound infection. Recent studies have similarly reported that CC and repeated sternal entry are associated with increased mediastinal wound complications[6,7]. These factors likely contribute to the higher rates of sternal-related complications seen in the CC group in our study.

Another notable finding from our study is that there was no significant difference between the groups in terms of postoperative trasfusion. However, the distribution of transfused blood products varied. In the PC group, 77.9% of patients did not require any postoperative blood products, compared to 73.1% in the CC group. RBC transfusions were needed in 5.1% of the PC group and 7.7% of the CC group. PLT transfusions were required in 6.8% of the PC group and 3.8% of the CC group. Fresh frozen plasma was used in 8.5% of the PC group and 7.7% of the CC group, while fresh whole blood was transfused in 1.7% of the PC group compared to 7.7% of the CC group. This variation indicates a trend towards reduced transfusion requirements in the PC group.

Roselli et al.[18] have established a link between reentry injuries and increased perioperative mortalit. Conversely, Ata et al.[15] reported no substantial differences in perioperative mortality between groups, though a higher incidence of injuries was noted in patients undergoing CC. Furthermore, studies by Ellman et al.[19] and Imran Hamid et al.[20] suggest that reentry injuries do not impact the long-term survival of patients who undergo redo surgeries. These patients, if discharged without complications, tend to have favorable long-term survival outcomes. In our analysis, we observed no significant differences in perioperative mortality rates between the peripheral and CC groups. Specifically, hospital mortality occurred in 1.8% of patients in the PC group and 4.2% in the CC group. Despite a higher occurrence of injuries in the CC group, these did not lead to markedly different mortality rates. Additionally, the one-year survival rates were excellent and comparable across both groups.

Study Limitations

There are several limitations to our study. Firstly, as our study has a retrospective design, there may be some biases during data collection and analysis. Additionally, our study is single-centered, which limits the generalizability of the results. Although the demographic and clinical characteristics of the patients were similar between groups, some potential confounding factors might not have been fully controlled during patient selection. The peripheral and CC techniques used in our study may vary based on the surgeons' experience and preference, which could affect the outcomes. Finally, the sample size of our study is limited, and the results need to be confirmed with larger, multicenter studies.

Conclusion

This study demonstrates that PC offers certain advantages over CC in redo cardiac surgeries. PC may reduce the incidence of procedure-related injuries and overall complications. However, CPB and total operation times can be longer. PC may provide a safer alternative with fewer complications. Nonetheless, larger, multicenter, and prospective studies are needed to increase the generalizability of these results and to obtain stronger evidence.

Ethics

Ethics Committee Approval: This retrospective study was approved by the Ethics Committee of tertiary University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (approval no: 2024-04-05, date: 04.03.2024).

Informed Consent: This retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Toz H, Türkyılmaz S, Concept: Türkyılmaz G, Kuserli Y, Kavala AA, Design: Toz H, Türkyılmaz S, Data Collection and/or Processing: Satılmış OE, Analysis and/or Interpretation: Türkyılmaz G., Satılmış OE, Kavala AA, Literature Search: Kuserli Y, Kavala AA, Writing: Toz H

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A Rare Case of Cardiomyopathy Due to Pheochromocytoma Attack Triggered by Herbal Slimming Tea in a Young Patient

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Abstract

Pheochromocytoma (PHEO) is a rare catecholamine-secreting neuroendocrine tumor arising from the chromaffin cells of the adrenal medulla. PHEO can occur at any age, but it is most common in people in their 3th and 5th decades. The rule of 10s for PHEO still holds true: 10% are familial, 10% are bilateral, 10% are extra-adrenal, 10% occur in children, and 10% are malignant. The exact number of PHEO patients is unknown because most individuals with PHEO are asymptomatic. With the increase and advancement of imaging methods today, the diagnosis rate has increased, but despite technological advances, only a very small percentage (<1%) of people with high blood pressure are diagnosed with PHEO. Catecholamine-induced cardiomyopathy in PHEO is a comparatively rare but very difficult to manage complication of PHEO. We present a case of cardiomyopathy due to a PHEO attack triggered by herbal slimming tea in a young female patient.

Keywords: Pheochromocytoma, cardiomyopathies, herbal teas

Introduction

Pheochromocytoma (PHEO) is a rare tumor that develops in the adrenal medulla, a region of the adrenal glands. Approximately 30% of PHEO patients have a hereditary syndrome. The clinical picture may vary depending on the amount of hormone secretion and differences in catecholamine sensitivity among individuals. Classic findings include resistant hypertension, palpitations, headaches, and episodes of sweating. Although it is well known today that some

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substances: opiates, metoclopramide, flu medications, tricyclic antidepressants, and cocaine can trigger PHEO attacks, there is not enough information about herbal slimming teas. Recognition of PHEO is important because it can show familial transmission as a component of genetic syndromes, it can lead to potentially fatal cardiac complications, and surgical resection of the tumor can provide a cure in most cases.

Case Presentation

A 39-year-old woman presented to our cardiology department with dyspnea on exertion and palpitations. The patient had no known history of any disease or drug use. However, she indicated that she presented to the emergency department with a hypertensive attack three days ago, and stated that her blood pressure was difficult to lower during her presentation. When we deepened the anamnesis, we learnt that the patient had been using herbal slimming tea for the last five days (Figure 1). On her physical examination, arterial blood pressure was measured at 90/60 mmHg, and her pulse was tachycardic. Bilateral crackles were auscultated. Diffuse pulmonary edema was observed on chest radiography (Figure 2). Sinus tachycardia was identified on the patient's resting electrocardiogram.

- Chitosan
- Echinacea
- Birch
- Rosemary
- Blueberry
- Rice Husk
- Yogurt
- Saw Palmetto
- Goji Berry
- Broccoli
- Guarana
- Stevia Herbs
- Raspberry.

L-carnitine

Figure 1. Content of mixed herbal slimming tea

Transthoracic echocardiography (TTE) revealed global hypokinesia in the left ventricle with an left ventricular ejection fraction (LVEF) calculated at 25%. Biochemical baseline investigations revealed a creatinine level of 1.87 mg/dL (eGFR: 33) and an hs troponin I level of 8486 pg/nL, both found to be very high. Treatment for heart failure was initiated, and when the creatinine level improved the next day, multislice computed tomography coronary angiography was performed to rule out possible coronary artery disease. Coronary arteries were found to be normal (Figure 3); however, cardiac computed tomography angiography revealed an incidental 37x30 mm hypervascular lesion in the right adrenal gland with contrast enhancement (Figure 4). When the patient's age, absence

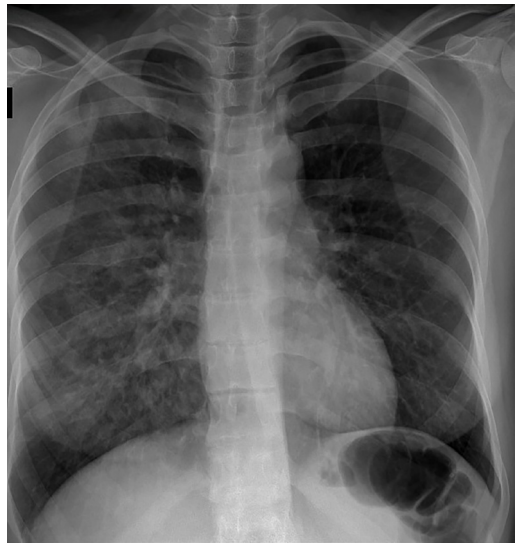

Figure 2. Diffuse pulmonary edema on chest radiography

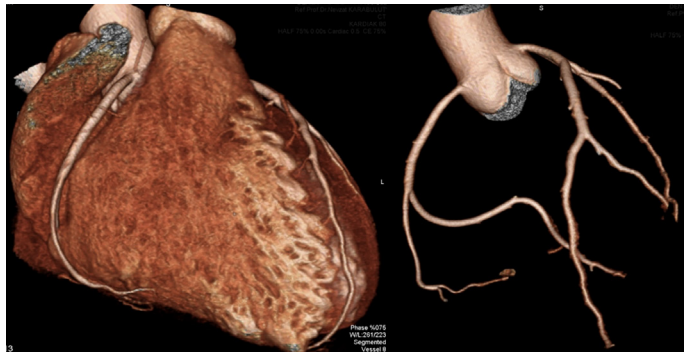

Figure 3. Cardiac CT angiography showed normal coronary arteries
CT: Computed tomography

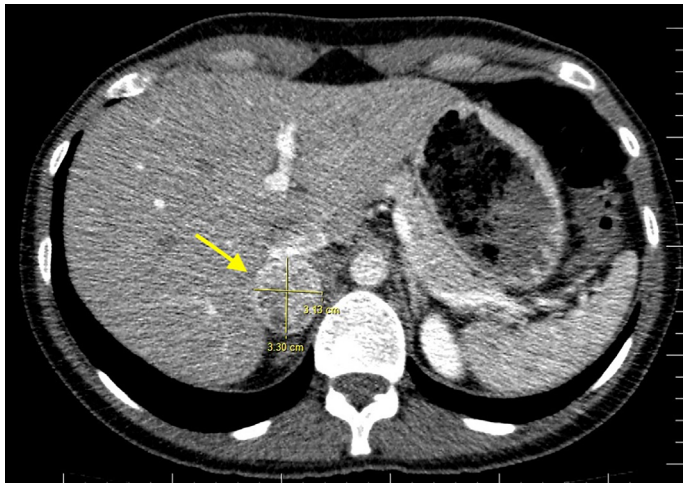

Figure 4. CT angiography additionally showed a 37x30 mm hypervascular lesion (yellow arrow) in the right adrenal gland with contrast enhancement
CT: Computed tomography

of comorbidities, hypertensive attack three days ago, and subsequent heart failure were evaluated in conjunction with the hypervascular right adrenal mass detected on imaging, cardiomyopathy due to possible PHEO was considered. After an endocrinology consultation, the patient was recommended to undergo an abdominal magnetic resonance imaging (MRI) and have plasma metanephrine levels measured. Abdominal contrast-enhanced MRI revealed a right adrenal mass compatible with phaeochromocytoma and very high metanephrine levels of 746.1 ng/L (<90) and normetanephrine levels of 2173.1 ng/L (<190) detected in plasma. An alpha blocker (doxazosin 4 mg) was added to the treatment of the patient who was receiving heart failure treatment (carvedilol, perindopril, torasemide, ivabradine), when LVEF was calculated as 45% in the control TTE performed one week later. Additional investigations and examinations performed for PHEO syndromes did not reveal any extra pathology in the patient. One month later, LVEF was completely normalized, and the patient was successfully operated with laparoscopic surgery. In the pathological examination, diffuse chromogranin positivity compatible with PHEO was detected, and the pheochromocytoma of the adrenal gland scaled score was calculated to be 11. All medications were discontinued after three months of postoperative follow-up. Informed consent was obtained from the patient.

Discussion

PHEOs are uncommon neuroendocrine tumors; clinical manifestations include various cardiovascular signs and symptoms, which are caused by excessive secretion of catecholamines[1]. The annual incidence of PHEOS ranges from 3 to 8 cases per million individuals[2]. Catecholamine-induced cardiomyopathy (CICMPP) is a dreaded complication of PHEO. During a hypertensive crisis, serious cardiovascular complications occur due to sudden and profound catecholamine excess[3]. Acute or chronic hypertension can induce myocardial hypoxia, which may lead to cardiac impairment, such as cardiomyopathy, broken heart syndrome, myocarditis, and acute coronary syndrome[4]. Managing CICMPP is a challenging task because there are no definitive guidelines for managing this complication; nevertheless, there are recommendations based on the principles of managing patients with hypertensive crises, heart failure, and cardiogenic shock[5]. PHEO, although infrequent, should be considered a differential diagnosis, particularly in young patients with unexplained hypertension and cardiac dysfunction[6]. The 2014 Clinical Practice Guidelines established by the Endocrine Society recommend surgical management for the treatment of PHEO[7]. We suggested surgical intervention to remove the mass according to guideline recommendations, after the LVEF and the general condition of our patient had improved.

Conclusion

We thought that the severe PHEO attack and subsequent cardiomyopathy in this patient were triggered by the herbal slimming tea she had recently started consuming. The contents of products purchased from the internet should be thoroughly investigated for health implications and should not be used unconsciously.

Ethics

Informed Consent: Informed consent was obtained from the patient.

Footnotes

Authorship Contributions

Concept: Demir M, Design: Demir M, Karabulut N, Data Collection and/or Processing: Yerlikaya E, Analysis and/or Interpretation: Yerlikaya E, Karabulut N, Literature Search: Demir M, Yerlikaya E, Writing: Demir M, Yerlikaya E.

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Letter to the Editor Regarding: "Potential Protective Effects of Boldine in Rat with an Experimental Myocardial Ischemia-Reperfusion Model"

Mustafa Barış Kemahlı

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Keywords: Cardiovascular medicine, heart, medicine

Dear Editor,

We read with great interest the article demonstrating the cardioprotective effects of boldine in a rat model of myocardial ischemia–reperfusion[1]. The authors reported that boldine administration at the onset of reperfusion improved oxidative stress indices (total antioxidant status, total oxidant status, oxidative stress index) and attenuated histopathological damage, providing valuable experimental evidence of boldine's protective potential in acute reperfusion injury.

From a technical perspective, the applied protocol (30 minutes of left anterior descending artery ligation followed by 120 minutes of reperfusion) is a well-established method to assess acute injury. A single intraperitoneal dose allowed the evaluation of early effects; however, future studies incorporating longer reperfusion periods, dose-response designs, and additional biochemical markers—such as superoxide dismutase, catalase, glutathione peroxidase, malondialdehyde, and apoptotic or inflammatory mediators including nuclear factor kappa B, caspase-3, and BAX—would provide greater mechanistic depth.

Recent preclinical data further support and complement these findings, showing that boldine reduces lipid peroxidation, enhances antioxidant enzyme activity, mitigates ventricular fibrosis, and improves functional parameters in adrenergic overload models[2].

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Moreover, emerging pharmacological insights suggest that its effects may extend beyond conventional oxidative and inflammatory pathways. In particular, connexin hemichannel blockade, suppression of inflammasome activation (interleukin-1 beta caspase-1), and improved nitric oxide bioavailability have been proposed as key mechanisms that could account for the structural and microvascular benefits observed in experimental settings[3].

In conclusion, the current body of evidence indicates that boldine exerts cardioprotective actions through multiple complementary mechanisms, ranging from antioxidant and anti-inflammatory activity to modulation of fibrosis, microvascular function, and intercellular signaling. Future studies incorporating longer reperfusion protocols, dose–response analyses, and expanded molecular endpoints will be essential to further clarify its translational potential in cardiovascular pharmacology.

Sincerely,

Footnotes

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