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Founder
Cardiovascular Thoracic Anaesthesia and Intensive Care Society

Owner
Zerrin Sungur
President of the Association on behalf of Society of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care
Istanbul University, Department of Anesthesiology, İstanbul, Türkiye
zerrin_sr@yahoo.com

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Tel: 0216 550 61 11 - **Fax:** 0216 550 61 12
E-mail: kare@karepb.com
Web page: www.kareyayincilik.com

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

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Gümüşsuyu, Taksim / İstanbul
Phone: Tel: 0212 292 92 71
e-mail: info@gkda.org.tr

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Address: Göztepe Mah. Fahrettin Kerim Gökay Cad. No: 200 D: 2 Göztepe, Kadıköy, İstanbul-Türkiye
Phone: +90 216 550 61 11
Fax: +90 212 550 61 12
e-mail: kareyayincilik@gmail.com
web: www.kareyayincilik.com

Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

EDITORIAL BOARD

The board ensure the determination and implementation of the publication policy of the journal. It supposed toformed from editor in chief, assistant editors and academicians who will contribute to the journal policy and the academic accumulation of the journal, and how journal should be noted up-to-date. If its possible, people from different institutions should take part.

ABOUT

The Journal of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society (GKDAYB Journal) is an official scientific journal of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society journal (GKDA-YBD).

The journal publishes clinical and experimental studies, case reports, editorial letters, review articles and reports of scientific meetings related to fields of Thoracic, Cardiovascular Anesthesia and Intensive Care the both in English, Review articles written upon request of the editor are not accepted.

The journal is published every three months namely in March, June, September and December. One volume is completed after publication of 4 issues (one year). GKDAYB is an open access, free and peer-reviewed journal and all published content is freely available at www.gkdaybd.org Printed copies are distributed to members of the Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society free of charge.

GKDAYB Journal is included in Excerpta Medica / Electronic Publ., EBSCO Publishing Inc. Database; Turkish Medline National Health Sciences Periodicals Database, Turkish Citation Index and ULAKBIM National Database (from 2016), GALE Cengage (from 2023), Scilit (from 2023) and Open Ukranian Citation Index (from 2023).

Scopus coverage (2003-2017). Discontinued.

AIMS & SCOPE

The aim of the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society is to disseminate significant and cutting-edge professional information related to the fields of thoracic, cardiac, and vascular anesthesia and intensive care. The journal serves as a platform for sharing clinical and experimental studies reflecting new advancements and research in these specialized medical areas.

Our objective is not only to publish original research and findings but also to offer a comprehensive overview of contemporary topics and issues facing today's medical practitioners within these disciplines. The Journal eagerly welcomes the submission of original research, detailed and practical reviews, and clinical observations from experienced authors in the field.

Submissions can encompass a wide range of topics including, but not limited to, surgical techniques, pharmacological advancements, perioperative care, pain management, and patient safety and recovery protocols related to thoracic, cardiac, and vascular surgery anesthesia and intensive care. Case reports offering insights or novel perspectives on clinical practices and challenges are also encouraged.

By fostering collaboration and discussion among medical professionals, researchers, and practitioners, the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society aims to contribute to the ongoing development and enhancement of patient care and treatment outcomes in thoracic, cardiac, and vascular anesthesia and intensive care.

Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

PUBLICATION POLICIES

This guideline has been prepared by Kare Publishing, by examining the leading national and international institutions of the publishing sector, and it has been found appropriate and adopted by the editorial board of the journal. It is recommended that all researchers who will send their studies to the journal should examine this guide carefully. The resources and international authorities used during the preparation proces of these policies are indicated at the end of the guideline.

Utilized Resources

Budapest Open Access Initiative

Creative Commons

COPE (Committee on Publication Ethics)

DOAJ Principles Of Transparency And Best Practice In Scholarly Publishing, Version 3

Education and Science Journal Publication Policies

ICMJE (International Committee Of Medical Journal Editors)

COHE Scientific Research and Publication Ethics Directive

Open Access Policy

The Journal of Cardiovascular-Thoracic Anaesthesia and Intensive Care Society supports the Budapest Open Access Initiative statement of principles that promotes free access to research literature. The declaration defines open access to academic literature as free availability on the internet, permitting users to read, record, copy, print, search, or link to the full text, examine them for indexing, use them as data for software or other lawful purposes without financial, legal, or technical barriers. Information sharing represents a public good, and is essential to the advancement of science. Therefore, articles published in this journal are available for use by researchers and other readers without permission from the author or the publisher provided that the author and the original source are cited. The articles in Journal of Cardiovascular-Thoracic Anaesthesia and Intensive Care Society are accessible through search engines, websites, blogs, and other digital platforms. Additional details on the Budapest Open Access Initiative and their guidelines are available at https://www.budapestopenaccessinitiative.org/.

Open Access Statement

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Publication Charges

The Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society assesses no submission fees, publication fees, or page charges.

ETHICS POLICY

It is targeted that all parties participating in the creation of a scientific study (author, editor, reviewer, publisher and reader) contribute to the proper progress of science. Compliance with scientific ethical principles is important in the scientific studies prepared in accordance with this target. Kare Media adopted the ethical principles based on the directive prepared by the Committee on Publication Ethics (COPE) and recommended its adoption by all individuals contributing in the creation of a scientific work. Some items of this directive are mentioned below.

Ethical Responsibilities of the Authors

To ensure that the data related to the study is correct, to keep the records of the study regularly and to provide access to these data upon a possible request.

To ensure that the article he/she submitted is not published or accepted elsewhere.

If the content submitted by the author matches the already published or presented content, to accept and quote this conflict and, when necessary, to provide the editor with a copy of any work that may have similar content related to his / her work, to obtain permission to reproduce, and use any content from other sources, and cite it as a reference.

To ensure that all studies involving human or animal subjects comply with national and international laws and guidelines (eg WMA Helsinki Declaration, NIH Policy on the Use of Laboratory Animals, EU Directive on the Use of Animals) to approve that necessary approvals have been obtained, to respect subject privacy, to indicate the relevant ethics committee approvals and research details in "Materials and Methods" section of the study.

In case of any conflict of interest, when he / she finds an ethical violation related to his / her article, he / she will share it with the editor and publisher, and publish a statement of error, addendum, indemnity notice or withdraw the work if deemed it necessary.

Ethical Duties and Responsibilities of the Editors

Acting in a balanced, objective and fair manner while performing their duties without any discrimination based on gender, religious or political beliefs, ethnic or geographical origin of the authors.

To evaluate the work submitted to the journal according to its content without showing any privilege to any author.

To take necessary measures to prevent potential conflicts of interest and to evaluate existing statements, if any.

To deal with sponsored works or special studies in the same way as other studies,

In case of complaints related to violation of ethics, to enforce necessary procedures by adhering to the policies and procedures of the journal. To give the authors an opportunity to respond to the complaint, and without refraining from imposing the necessary sanctions, regardless of the identity of the owner of the work To reject the study if it does not meet the purpose and scope of the journal.

Ethical Responsibilities of the Reviewers

In order to contribute to the editor's decision-making process, the manuscript should be scrutinized in a timely fashion and reviews should only accept the critical evaluation of the study of his/her expertise.

The assessment should be done in an objective manner only in relation to the content of the study. The study should be evaluated without considering religious, political and economic interests.

To make suggestions to help improve the quality of the article to be published and to critically review the study. To communicate his/her comments to the author in a constructive and gentle language.

To protect the confidentiality of the information provided by the editor and the author, to destroy the work after the evaluation process in accordance with the principle of confidentiality, to report to the editor if there is anything contrary to the blind review process and not to evaluate this study.

To be cognizant of potential conflicts of interest (financial, institutional, collaborative, or other relationships between the author and the author), and, if necessary, to alert the editor to withdraw his or her assistance for this article.

Ethical Responsibilities of the Publisher

Among the parties involved in a creation of a scientific study, the publisher should act within all these ethical principles.

In addition to these, the publisher is obliged to use its communication power without any individual interest and to direct the target audience correctly.

It protects the ownership and copyright of each work published in its journals/books and undertakes the task of archiving every published work.

People should not hesitate to get contact with the publisher when they encounter an unethical situation.

Some of the actions considered to be against scientific research and publication ethics

- Plagiarism: To adopt the original ideas, methods, data or works of others partially or wholly without referencing them in compliance with scientific rules,
- Fraud: to use data that is not actually present or falsified in scientific research,
- Distortion: Distorting the research records or data obtained, demonstrating unused devices or materials as if they were used in the research, and distorting or shaping the results of research in the interests of the people and organizations that sponsored the study;
- Republication: To present duplicates as separate publications in academic appointments and elevations,
- Slicing: To present the results of a research as separate publications in academic appointments and upgrades by disseminating and publishing the results of a research in a way that disrupts the integrity of the research and submit them as separate publications more than once;
- Unfair authorship: to include people who are not active contributors or not to include those who are contributing to the study, to change the ranking of the authors inappropriately without any justification and, to remove the names of those who offered their active contributions in t the previous editions, to include their names among the writers by using their influence even though they did not actively contributed to the work,
- Not specifying the people, institutions or organizations that support the publications realized as a result of the researches carried out with their support, and contributions,
- To use the thesis or studies which have not been submitted yet or have not been accepted as a source without the permission of the owner,
- Failure to comply with ethical rules in human and animal researches, not to respect patient rights in its publications, to harm animal health and ecological balance, to refrain from obtaining necessary permissions,
- To misuse resources, places, facilities and devices provided for scientific research,
- To make false or misleading statements regarding scientific research and publications in academic appointments and elevations.

Artificial Intelligence (AI)-Assisted Technology

At submission, the journal should require authors to disclose whether they used artificial intelligence (AI)-assisted technologies (such as Large Language Models [LLMs], chatbots, or image creators) in the production of submitted work. Authors who use such technology should describe, in both the cover letter and the submitted work, how they used it.

Chatbots (such as ChatGPT) should not be listed as authors because they cannot be responsible for the accuracy, integrity, and originality of the work, and these responsibilities are required for authorship. Therefore, humans are responsible for any submitted material that included the use of AI-assisted technologies. Authors should carefully review and edit the result because AI can generate authoritative-sounding output that can be incorrect, incomplete, or biased. Authors should not list AI and AIassisted technologies as an author or co-author, nor cite AI as an author. Authors should be able to assert that there is no plagiarism in their paper, including in text and images produced by the AI.

Humans must ensure there is appropriate attribution of all quoted material, including full citations.

PLAGIARISM POLICY

Plagiarism (cheating) is a violation of ethics, regardless of whether it is intentional or not. It is a crime and an unacceptable code of conduct as it is unethical to submit, and publish manuscripts imitating other sources, without citing references,. For this reason, due to publication policies Kare Publishing, for all studies to be published in all of its periodicals, necessitates use of a plagiarism checker.

All studies submitted to our periodicals and passed the evaluation of the reviewers blinded to the studies, are evaluated by us using Turnitin or iThenticate software programs.

In our study, our criterion is not a percentage of matching. An auditng is carried out by a specialized team excluding percentages of matching but considering the parameters, such as identification of matching paragraphs, whether or not citations and references are properly written in accordance with the writing rules of the journal, the places of the matching sentences/paragraphs in the article, and the sources with which they are matched. The prepared plagiarism report is sent to the relevant editor of the study. In consideration of the report, the editorial board may request from the author correction of the errors in the manuscript and sent it again or accept or reject it. The acceptance of the study is on the initiative of the editor.

The Editorial Board may act in accordance with the COPE rules against allegations, and suspicions related to plagiarism, citation manipulation and fraudulent misrepresentation of the works submitted to the journal.

COPYRIGHT TRANSFER

CONFLICT ON INTEREST

Conditions which provide financial or personal benefit bring about a conflict of interest. The reliability of the scientific process and the published articles is directly related to the objective consideration of conflicts of interest during the planning, implementation, writing, evaluation, editing and publication of scientific studies.

Financial relations are the most easily identified conflicts of interest and it is inevitable that they will undermine the credibility of the journal, the authors and the science. These conflicts can be caused by individual relations, academic competition or intellectual approaches. The authors should refrain as much as possible from making agreements with sponsors in the opinion of gaining profit or any other advantage that restrict their ability to access to all data of the study or analyze, interpret, prepare, and publish their articles In order to prevent conflicts of interest, editors should refrain from bringing together those who may have any relationship between them during the evaluation of the studies. The editors, who make the final decision about the articles, should not have any personal, professional or financial ties with any of the issues they are going to decide. Authors should inform the

editorial board concerning potential conflicts of interest to ensure that their articles will be evaluated within the framework of ethical principles through an independent assessment process.

Our publication team works devotedly to ensure that the evaluation process is conducted in an impartial manner, taking all these situations into consideration.

You can review the conflict of interest form and the related link to get more detailed information and to declare an conflict of interest.

WRITING GUIDE

Double-Blind Review And Evaluation Process

The decision to publish all articles submitted to the journal belongs to the editor in chief. However, editors shape these decisions in line with the reviewers' recommendations.

The double blind review process is the process of evaluating the work completely anonymously. In this system, only the editor knows each stage. In this system authors do not know who the reviewer is, and the reviewers do not know whose work they are evaluating. Thus, biased evaluation of the work by the reviewers is prevented. In addition, since the author does not know the reviewers, he/she can not possibly get contact with the reviewer, and influence him/her through 'special routes'. From this point of view, the double- blind review process is thought to provide objective evaluation and increase the equal opportunity.

For these reasons, all studies submitted to GKDAYB Journal are subject to double-blind review. At least two reviewers expert in their fields, will evaluate each submitted work. Every effort is spent by the editors for quick evaluation of the articles. The editor is the final decision-making authority in the evaluation processes of all articles.

First Evaluation

The relevant editor or journal secretary examines the work regarding the purpose and scope of the journal, its conformity to the rules of writing, and its English and Turkish language proficiency. As a result of this assessment, the manuscripts which do not comply with the publication rules and the publication policy of the journal are returned to the responsible author.

Preliminary Evaluation Process

n the pre-evaluation process; the study that left a positive impression on the editor is directed to the field editors. Field editors examine summary, introduction, material / method, discussion and conclusion sections of the manuscript as well as its scientific, and formal conformity to the writing rules of the journal. As a result of this review, manuscripts which are found suitable are taken into the process of reviewers' evaluation.

Reviewers' Evaluation Process

According to the content of the manuscript, at least two expert reviewers who had current studies in the relevant field are determined. Suggestions of the field editor regarding the selection of reviewers are appraised by the chief editor, and reviewers are assigned for the assessments of the manuscripts. The reviewers evaluate the study and prepare a report.

Reports of the Reviewers

The reviewers evaluate the objective, material / method, results and discussion sections of the study, and its conformity to scientific principles. The work may be accepted directly, its revision may be requested or rejected. If correction in the manuscript is required, the suggestions coming from the reviewers are communicated to the authors and the authors are asked to revise their work.The results of correction coming from the authors are reexamined by the reviewers and their decisions are reported to the editor. In case of disagreement between the assigned reviewers, the manuscript is sent to a designated third reviewer.

Statistical Analysis

Manuscripts deemed appropriate for publication by the reviewers are sent to the statistical editor. Articles that are approved by the statistical editor are accepted for publication.

Publication Printing Process

Clinical studies or experimental research articles accepted for publication are usually included in the first issue to be published. Case presentations can wait 6-9 months according to the intensity.

CHECKLIST FOR AUTHORS

- Make sure that name of the author (s), information about the institution thank you letter about ethics committee etc. are not included in the study. This issue is important according to the 'double- blind review principle' concerning the evaluation process of your work so that it can be dealt with impartially.
- You should not forget that your study will be subject to plagiarism audit if it is deemed to be adequate and appropriate in terms of the subject and you should avoid making quotations that will be covered by plagiarism when preparing the work
- If your article is derived from a study, a thesis, abstract of a case report, poster, etc. be sure to cite it in a footnote and specify its date.
- Please fill out the form and upload it to the system, as you cannot proceed to the next step without uploading the copyright transfer form to your system. It is sufficient to communicate it in the online system, you do not need to communicate this information in printed form.
- If your work has been returned to you for revision, and you have made a change in the title and summary of your work, please update it during preparation of the article
- There cannot be any changes in your article once its published. Therefore we advise you strongly to examine your article carefully when last check e-mail sent to you and if there is any neccesary revisions you have to make please send them to us before the journal is published.

MANUSCRIPT PREPARATION

Manuscripts should preferably be written using the Microsoft Word program. The manuscripts should be typed in 12 point Times New Roman characters. Manuscripts should be written double- spaced on one side of the A4 (21x29.7 cm) white paper and throughout the entire manuscript (including headings, abstracts in Turkish and English, main text, references, tables and subtitles) and justified leaving 3-cm margin from both sides. They should be written in accordance with word processor's page layout settings.

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The authors are kindly requested to submit their **ORCID** numbers obtained the website from **www.orcid.org** and indicate them in the relevant area at this stage. Abstract and full text should not containinformation about the individuals and institutions participating in the study.

The files must be loaded in the following order.

- The electronic article file (Full Text) should be named with the title of the article in capital letters. They should only include "Title (Turkish-English) - Short Title (Turkish-English)", "**Introduction**", "**Materials and Methods**", "**Results**", "**Discussion**", "**Acknowledgement** (if) - **Conflict of Interest**". Each of the sections should be presented on separate pages. The titles of the text sections should appear at the left of the page with capital letters. All pages should be numbered sequentially from the bottom right corner.

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Anaesthesia and Intensive Care Society

- The file "**References**" should be recorded separately.
- **Tables** should be prepared and written double-spaced on a separate sheet, and the number and title of each table must be written on top of the table. If abbreviations are given in the table, these abbreviations should be written in alphabetical order as subheadigs. . When previously printed or electronically published tables are used, written permission must be obtained from both the author and the publisher, and it must be sent by fax or mail to the editor of the journal.
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- **Copyright transfer form**

Authors must declare that all or part of the material in the manuscript has not been published and is not currently being evaluated elsewhere for publication. Each author must declare that he/she participated in the investigation enough to share the responsibility of its content.

This participation may involve the following issues:

- Creation of concepts and designs of experiments,
- Collection, analysis or expression of the data;
- The preparation of the draft of the mauscript or the review of the scientific content
- Approval of the final format of the manuscript ready for publication
- Ethics committee approval letter
- Original articles and review articles should not exceed 10, case reports 4, letters to editors 1 page (excluding references, tables and graphics).

In the manuscript, the sections and contents of the manuscript should be presented as follows.

Title: A short title should be used whenever possible. The title of the research, and review articles should not exceed 95 characters (each letter, space, and punctuation marks are considered as one character), in case of case reports, letters and presentations of surgical techniques it should not contain more than 80 characters. Abbreviations should not be used in the title. The title should be written in Turkish and English. A short title should be added as a subtitle which should not exceed 40 characters.

Funds and organizations supporting the research should be mentioned here, If the study is planned to be presented in any congress or if it has been presented before, the name, place, and date (day-month-year) of the congress should be written.

The abstracts should not exceed 250 words in the research papers Headings should not be used in summaries (the English translation of the title should be written on the title page). Abstract in Turkish should consist of four subheadings as While abstract in English should include subheadings of Aim, Material and Method, Results, and Conclusion) In case reports and review articles donot contain these sections, and abstracts should not exceed 100 words. English title, and abstract should be. English title and abstract should be word by word translation of the Turksih abstract. Letters to editor, and Editorials do not require abstracts.

Use of abbreviations should be avoided as much as possible in summaries. If absolutely required, abbreviation should be used after its definition is provided in parenthesis at the first mention of the term. Reference should not be used in the abstract.

Key words: In accordance with "Index Medicus Medical Subject Headings (MeSH)" there should be no more than five key words under the summary written both in Turkish and English. Available terms can be used if there is no appropriate term for the "Index Medicus" medical subject headings for the newly entered terms.

Introduction: The general conditions of the study settings, the structure and significance of the problem, the specific objective of the study or research tested in the study or observation should be clearly indicated. The primary and secondary objectives of the work should be clearly stated and the predefined subgroup analyzes should be transferred. Only references related to the topic should be used and the data or results of the presented work should not be included in these references.

Material and Method: The informed consent of the patient and the approval of the ethics committee should be acknowledged. A statement must be added that the informed consent was obtained from each participant in clinical trials. It should be noted in experimental studies that all animals were subjected to a humane treatment in accordance with the Guide for the Care and Use of Laboratory Animals (www.nap.edu/catalog/5140.html).

Definition of optimal working conditions, exclusion criteria and referenced population; the participants in the observational or experimental study must be clearly indicated. Since the relevance of the variables such as age and gender for the purpose of the research is not always obvious, the authors should explain the purpose of using these variables in a research article. The main principles that determine how and why the study is performed using such a method should be clear. References should be shown for established methods, brief descriptions should be given for new methods.

The methods, tools (manufacturer's name and address are written in parentheses) and the operations performed should be described in detail to the extent of interpretation of the results. The initials of the drug names should be in lower case, the pharmacological names of the drugs should be used and at their first mention in the text they should be written in brackets in the following order"Generic name, trade name, and Manufacturing firm ". Example: "midazolam (Dormicum, Roche)". The terms should be written in their explicit forms at their first mention in the text, and then their abbreviations (if any) should be enclosed in parentheses. Frequently used abbreviations should be used as accustomed (iv, im, po and sc). Units must be used in compliance with the International system of units (SIU (Le Système international d'unités),Examples: mg / kg, mL / kg, mL / kg / min, mL / kg.

Statistical methods should be provided in sufficient detail so that the readers can reach the original data and evaluate the reported results. Findings should be measured as much as possible and the appropriate margin of error and uncertainty (such as confidence intervals) should be indicated. It is important to avoid relying only on the p-values ??of statistical hypothesis measures that are insufficient to convey important information about the dimensions of the effects. P values ??must be given explicitly. Statistical terms, abbreviations and symbols should be defined. In the last paragraph of this section, statistical analyses used, and the values given by the (±) sign after the arithmetic mean or proportion should be indicated.

Results: The findings, tables and visual material obtained in the study should be written in the order of a certain logic so that the most important ones will take precedence in the text. Graphics, tables, illustrations, and figures should be numbered according to the order of their mention in the text, and should be indicated in parentheses in the text. Data contained in the tables and visual materials should not be repeated in the text. Only important observations should be emphasized or summarized. Tables and figures are placed collectively after the last reference at the end of the text. Only the top title of the table, and graphic or the subheading of figures, illustrations, photos are written in their appropriate places in the text.

The numerical results summarized in the Results section should be given not only as derivatives (eg percentages), but with exact numerical values, and the statistical methods used to analyze them should be specified.

When scientifically appropriate, data should be analyzed in terms of variables such as age and gender. Tables and pictures should be limited to those necessary to explain and support the discussion expressed in the article. As an alternative to the tables, you should use some kind of graphics on which many entries can be made, and data should not be repeated on graphics and tables. Using non-technical terms such as "random", "explicit", "links" and "example" in the statistics section should be avoided.

Discussion: The results of the study are evaluated by comparing them with the international, and domestic literature. New and important aspects of the study and its outcomes should be emphasized. Data and other information presented in the Introduction and Results sections should not be repeated. In experimental studies, we should briefly summarize the main findings and then analyze explanations with possible mechanisms and compare them with other similar studies. It would be appropriate to comment on the implications of these findings for future researches and clinical practices. The objectives of the work should be correlated with the results. However, unmeasured situations and outcomes that are not adequately reinforced by the data should be avoided. The resulting decision arrived must be stated in the last paragraph of the discussion. If the article does not include appropriate economic data and analysis, no particular comment should be made on economic interests and costs. Claims on an incomplete study should be avoided, new hypotheses must be specified when they are confirmed, and their novelty should be clearly emphasized.

Acknowledgment (if any): If you also want to thank the people who can not fulfill the criteria for authorship involved in fundraising, technical assistance, data collection, supervisor of the research group, writing, or department chiefs who just provided general support, and those providing finance and material support, a brief paragraph can be written under the heading of "Acknowledgement". Written consent must be obtained from the individuals to be mentioned in the acknowledgment section since they may make a sense of data and conclusions they contributed

Conflict of Interest: The authors are requested to declare any existing commercial association that might potentially have a conflict of interest regarding their articles. (eg employment, direct payments, holding shares, holding, consultancy, patent licensing arrangements, or granting honorarium). All financial resources supporting the study should also be declared as footnotes.

Tables and Charts: Charts can be saved in a single chart file, tables can be placed in one spreadsheet file on each page. Titles, descriptions and footnotes should be placed on each sheet of paper.

The tables reflect the information in a concise and effective way. They also provide information of the desired quality and precision. The fact that the data are given in the tables rather than in the text usually makes it possible to shorten the text. The tables should not be a repetition of the information in the article.

The tables should be demonstrated in brackets in the text. It should carry a short self-heading. According to their appearance in the text, each one should be given a short title, starting from the top left, and numbered sequentially by Roman numerals. There should be no lines on the background, they should be drawn on a white background.. Horizontal and vertical lines should not be used in the table . Each column is given a short or a concise title. Explanatory information should be placed in footnotes, not in headings. Abbreviations should be explained in footnotes. The explanations of the abbreviations should be in the form of subtitles under the table and in alphabetical order. The following symbols should be used in the footnotes, in the following order: *, †, ‡, §, ||, ¶, **, ††, ‡‡. Measures of statistical variables such as standard deviation and standard mean error should be defined. Make sure that each table and graph are mentioned in the text.

There should be no frame around the graphics, no lines on its background, and the background should be white.

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RESEARCH ARTICLE

Effects of the Anesthesia Type on Hematological Parameters in Coronary Artery Bypass Grafting

Tuna Şahin,[1] Semiha Görgün,[1] Suat Karaca,[2] İbrahim Özsöyler[2]

[1]Department of Anesthesiology and Reanimation, Adana City Training and Research Hospital, Adana, Türkiye
[2]Department of Cardiovascular Surgery, Adana City Training and Research Hospital, Adana, Türkiye

ABSTRACT

Objectives: This study evaluated the effects of sevoflurane-based inhalation anesthesia and propofol-based total intravenous anesthesia on hematological parameters in coronary artery bypass grafting (CABG).

Methods: In this study, 125 patients who underwent elective on-pump CABG between November 2021 and April 2022 were retrospectively analyzed. Patients aged 35–80 years with an ejection fraction of ≥25% were included. The patients were separated into two groups: The sevoflurane group (Group SEVO) and the total intravenous anesthesia group (Group TIVA). Patient characteristics, operative clinical data, and preoperative and postoperative hematological parameters: [white blood cell (WBC) count, red cell distribution width (RDW), neutrophil/lymphocyte ratio (NLR)] were analyzed.

Results: The mean age of the patients was 62.0±8.7 years. Group SEVO comprised 70 patients, and Group TIVA comprised 55 patients. Significant increases in postoperative WBC count, RDW, and NLR values were observed in both groups. No statistically significant differences in WBC count, RDW, and NLR values were observed between the two groups (p>0.05).

Conclusion: The effects of sevoflurane-based inhalation anesthesia or propofol-based total intravenous anesthesia on WBC count, RDW, and NLR values among patients undergoing elective on-pump CABG were similar.

Keywords: Anesthesia, coronary artery bypass grafting, neutrophil/lymphocyte ratio, red cell distribution width, white blood cell count

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Introduction

Coronary artery bypass grafting (CABG) is commonly performed worldwide.[1] The choice of anesthesia with inhalation agents, intravenous anesthetics, or a combination of inhalation and intravenous agents during CABG is controversial. Volatile anesthetics have cardioprotective effects that depend on multiple mechanisms, including modulation of G-protein-coupled receptors, gene expression, mitochondrial function, signaling pathways, and potassium channels.[2,3] It has been reported that propofol has an anti-inflammatory effect and that propofol-based total intravenous anesthesia (TIVA) reduces the inflammatory effect in CABG.[4–6]

The white blood cell (WBC) count, red cell distribution width (RDW), and neutrophil/lymphocyte ratio (NLR) are the parameters used in hemogram analysis. They are inflammatory biomarkers and predictive indicators of the risk of cardiovascular events.[7–9] Changes in WBC count, RDW, and NLR values may occur in patients who have undergone cardiac surgery.

In this study, we evaluated the effects of sevoflurane-based inhalation anesthesia and propofol-based TIVA on WBC count, RDW, and NLR values in patients undergoing CABG.

Methods

Study Design

The study protocol was approved by the Ethics Committee of Adana City Training and Research Hospital (approval number: 2011 on June 23, 2022). We retrospectively analyzed 125 patients who underwent elective on-pump CABG between November 2021 and April 2022.

Address for correspondence: Tuna Şahin, MD. Adana Şehir Eğitim ve Araştırma Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Adana, Türkiye
Phone: +90 322 455 90 00 **E-mail:** drtunas@hotmail.com

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Clinical Data

Data were obtained from the written and electronic medical charts of the patients. The analyzed data comprised patient demographics; preoperative history of comorbidities; ejection fraction values; preoperative and postoperative WBC count, RDW, and NLR values; anesthesia duration; surgery duration; cardiopulmonary bypass and cross-clamping duration; inotropic and vasopressor support administration (i.e., dopamine and norepinephrine); and the number of grafts, red blood cell (RBC) units, and fresh frozen plasma given were recorded.

The study comprised patients aged 35–80 years. Patients with an ejection fraction of ≥25% were included. Patients who underwent concurrent heart valve surgery, off-pump surgery, and emergency surgery and those with thyroid dysfunction, atrial arrhythmias, autoimmune and systemic inflammatory diseases, and preoperative inotropic medication support or intra-aortic balloon pump (IABP) were excluded.

Anesthetic Management

All patients were premedicated with midazolam (0.05 mg/kg) and fentanyl (0.5 mcg/kg). Anesthesia was induced with midazolam (0.15 mg/kg), fentanyl (5–10 mcg/kg), and rocuronium (0.6 mg/kg). The patients were separated into two groups according to the anesthesia type: the sevoflurane group (Group SEVO) and the total intravenous anesthesia group (Group TIVA). Anesthesia in-Group SEVO was maintained with 2%–3% sevoflurane (1–2 minimum alveolar concentration) + 0.05–2 mcg/kg/min remifentanil + 5–12 mcg/kg/min rocuronium. Anesthesia in-Group TIVA was maintained with 25–100 mcg/kg/min propofol + 0.05–2 mcg/kg/min remifentanil + 5–12 mcg/kg/min rocuronium. Because of the absence of a waste gas scavenging system that would allow sevoflurane to be directed to the outlet central waste system in the operating room, all patients received TIVA (propofol+ remifentanil) during cardiopulmonary bypass. Cardiopulmonary bypass was performed using a roller pump, open reservoir, and membrane oxygenator with a target flow of 2.2–2.4 L/min/m2 at 36°C. Moderate hypothermia (30°C–32°C) was applied. Crystalloid cardioplegia was used. Target hemoglobin concentrations were maintained above 7.5 g/dL and above 8.5 g/dL after the operation. Heparin administration was reversed with protamine sulfate after cardiopulmonary bypass.

Blood samples were taken before surgery and at the 6th postoperative hour.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (version 25.0; Armonk, NY: IBM Corp.) and MedCalc 15.8 (MedCalc Software bbba, Ostend, Belgium). While evaluating the study data, descriptive statistical methods (i.e., frequency, percentage, mean, standard deviation, median, and min–max) were used. To compare qualitative data, chi-square tests (i.e., Pearson's chi-square test, Yates' corrected chi-square test, and Fisher's exact test) were employed. The suitability of the data to the normal distribution was evaluated using the Kolmogorov–Smirnov test, skewness–kurtosis, and graphical methods (i.e., histogram, Q-Q plots, stem and leaf plots, and boxplots). In the comparison of normally distributed quantitative data between the groups, the independent samples t-test (t-test in independent groups) was used. Paired samples t-test (t-test in dependent groups) or McNemar's test was used for in-group comparisons. P-values <0.05 were used to denote statistical significance.

For comparisons between groups, power analysis was performed using G*Power 3.1.9.7 (Franz Foul, Universitat Kiel, Germany). For n1=70, n2=55, α=0.05, effect size (d)=0.6, and power=91%.

Results

The mean age of the patients included in the study was 62.0±8.7 years (range, 37–82 years); 36 patients were women and 89 were men. Among the 125 patients included in the study, 70 were in-Group SEVO and 55 were in-Group TIVA.

Of the 125 patients, 105 had a preoperative history of comorbidities, and the most common comorbidities were diabetes mellitus, hypertension, hyperlipidemia, cerebrovascular disease, asthma, and chronic obstructive pulmonary disease (Table 1).

No statistically significant differences in sex, age, ejection fraction values, and chronic diseases were observed between the two groups (p>0.05) (Table 1).

Preoperative and postoperative values and preoperative–postoperative change percentage values for WBC count, RDW, and NLR in both groups are presented in Table 2. When preoperative and postoperative WBC count, RDW, and NLR values in both Groups SEVO and TIVA were examined, a statistically significant difference in these values was observed (p<0.05), and postoperative values were higher in all cases. In the comparisons between the groups, no statistically significant differences in WBC count, RDW, and NLR values were observed between the groups (p>0.05).

The intraoperative data in both groups, such as the number of grafts, cross clamp duration, cardiopulmonary bypass duration, duration of surgery, duration of anesthesia, inotropic and vasopressor support administrations (dopamine and norepinephrine), and blood product transfusions, are shown in Table 3. No statistically significant

Table 1. Demographic and preoperative data of the groups

Variables	Group SEVO		Group TIVA		p
	n	%	n	%	
Age (years)	61.8±8.7		62.3±8.7		0.787[a]
Sex					
Female	15	21.4	21	38.2	0.064[b]
Male	55	78.6	34	61.8	
Diabetes mellitus	36	51.4	35	63.6	0.236[b]
Hypertension	35	50.0	30	54.5	0.614[c]
Hyperlipidemia	36	51.4	28	50.9	0.954[c]
Cerebrovascular diseases	5	7.1	5	9.1	0.748[d]
Asthma	3	4.3	3	5.5	1.000[d]
Chronic obstructive pulmonary disease	2	2.9	2	3.6	1.000[d]
Ejection fraction (%)	50.3±10.6		51.4±8.9		0.567[a]

Data are presented as numbers (%) or means±standard deviations. [a]: Independent samples t-test; [b]: Yates' corrected chi-square test; [c]: Pearson's chi-square test; [d]: Fisher's exact test. SEVO: Sevoflurane; TIVA: Total intravenous anesthesia.

Table 2. Comparisons of NLR, WBC count, and RDW values between groups and in groups

Value	Group SEVO	Group TIVA	p
NLR			
Preoperative	2.4±1.3	2.6±1.1	0.293[a]
Postoperative	27.1±12.4	28.7±15.7	0.524[a]
p[b]	**0.000**	**0.000**	
Pre-post change %	1.363.40±1.436.56	1.085.26±579.93	0.179[a]
WBC			
Preoperative	6.8±2.0	6.7±1.6	0.604[a]
Postoperative	14.9±3.9	14.0±4.0	0.202[a]
p[b]	**0.000**	**0.000**	
Pre-post change %	131.43±80.17	115.70±62.90	0.235[a]
RDW			
Preoperative	14.0±2.4	14.4±2.6	0.382[a]
Postoperative	14.6±2.0	15.3±3.5	0.168[a]
p[b]	**0.045**	**0.020**	
Pre-post change %	6.92±24.98	7.09±21.76	0.969[a]

Data are presented as means±standard deviations. [a]: Independent samples t-test; [b]: paired samples t-test. NLR: Neutrophil/lymphocyte ratio; WBC: White blood cell; RDW: Red cell distribution width.

differences in these intraoperative data were observed between the groups (p>0.05).

Discussion

In this study, no difference was found between sevoflurane-based inhalation anesthesia and propofol-based TIVA in terms of effects on WBC count, RDW, and NLR values in patients undergoing CABG.

Choosing an anesthesia technique in cardiac surgery as an inhalation agent, TIVA, or a combination of inhalation and intravenous agents commonly depends on the clinician's practices.

It has been reported that volatile anesthetics have cardioprotective effects with a preconditioning effect on myocardial ischemia and reduce the incidence of infarction in cardiac surgery.[10,11]

On the other hand, TIVA with remifentanil and propofol has been suggested as a safe anesthetic option for cardiac surgery in patients with severe left ventricular dysfunction.[12,13]

In the literature, many studies have compared inhalation anesthesia with TIVA.

A systematic review and meta-analysis of randomized controlled trials (RCTs), which comprised 58 studies, including 6,105 patients, compared inhalation anesthesia

Table 3. Intraoperative data in the groups

Value	Group SEVO		Group TIVA		p
	n	%	n	%	
Number of grafts	3.0±0.9		3.0±0.7		0.918[a]
Cross clamp duration (min)	53.0±20.0		50.2±14.9		0.394[a]
Cardiopulmonary bypass duration (min)	97.3±29.6		97.2±25.7		0.984[a]
Duration of surgery (min)	206.9±43.1		205.5±37.2		0.848[a]
Duration of anesthesia (min)	238.6±42.3		237.5±35.4		0.881[a]
Dopamine(mcg/kg/dk) (n_1=48/n_2=26)	4.98±2.57		4.42±1.64		0.259[a]
Norepinephrine(mcg/kg/dk) (n_1=11/n_2=7)	0.09±0.03		0.08±0.03		0.539[a]
Blood product transfusions					
1 unit of RBC+2 units of FFP	11	15.7	13	23.6	0.385[b]
2 units of RBC+2 unit FFP	22	31.4	21	38.2	
2 units of FFP	28	40.0	17	30.9	
3 units of RBC+2 units of FFP	9	12.9	4	7.3	

Data are presented as means±standard deviations. [a]: Independent samples t-test; [b]: Pearson's chi-square test. RBC: Red blood cell; FFP: Fresh frozen plasma.

with TIVA in patients who underwent on-pump or off-pump CABG. It has been reported that there is high-quality evidence that sevoflurane reduces death within 180–365 days of surgery and inotropic and vasoconstrictor support compared with propofol. The cardiac index was also reported to be minimally influenced by sevoflurane and desflurane compared with propofol, with some evidence.[14]

The Mortality in Cardiac Surgery Randomized Controlled Trial of Volatile Anesthetics trial compared volatile anesthetics (desflurane, isoflurane, or sevoflurane) with TIVA in 5,400 patients undergoing elective on-pump and off-pump CABG. The number of deaths at 1 year was investigated. It was reported that intraoperative anesthesia with volatile anesthetics did not result in significantly fewer deaths at 30 days or 1 year than TIVA.[15]

Another meta-analysis which comprised 89 RCTs, including 14,387 patients, compared volatile anesthetics with TIVA in patients who underwent CABG. Arrhythmia, myocardial infarction, heart failure, delirium, stroke, acute kidney injury, postoperative cognitive impairment, and the use of IABP or other mechanical circulatory support were defined as postoperative safety outcomes. It was reported that the length of stay in the intensive care unit and hospital was shorter with volatile anesthetics than with TIVA. However, operative mortality, 1-year mortality, and postoperative safety outcomes were not reduced with the use of volatile anesthetics compared with TIVA.[16]

As seen in the literature, studies comparing inhalation anesthesia with TIVA have mainly focused on 30-, 180-, and 365-day mortality, length of stay in the intensive care unit and hospital, and adverse postoperative outcomes. Unlike these studies, our study focused on the effects of inhalation anesthesia and TIVA on hemogram parameters that is, WBC count, RDW, and NLR.

CABG with cardiopulmonary bypass triggers a systemic inflammatory response.[17]

The complete blood cell count parameters WBC count, RDW, and NLR are also inflammatory biomarkers, and in several studies, they have been used to predict clinical outcomes following cardiac surgery.[18–20]

Aydınlı et al.[21] investigated five parameters of hemogram analysis–hemoglobin, RDW, NLR, mean platelet volume (MPV), and platelet/lymphocyte ratio (PLR)–as predictive data following cardiac surgery. They reported that the prediction success of NLR (4.8 times) was higher than that of RDW (1.8 times) and MPV. Furthermore, they reported that the predictive success of the combination of the parameters NLR, RDW, and MPV was the highest of all combinations.

The use of these hemogram parameters for predicting outcomes after cardiac surgery is well defined in the literature. However, the effects of anesthesia type on these hematological parameters have not been thoroughly examined in the literature.

Aldemir et al.[22] investigated the effects of propofol and desflurane anesthesia on NLR in patients who underwent CABG. They reported that the NLR values at the 12th and 24th postoperative hours were lower in propofol anesthesia than in desflurane anesthesia.

Özay et al.[23] compared the effects of midazolam-based TIVA with those of sevoflurane-based inhalation anesthesia on RDW and MPV in patients who underwent CABG. They reported that RDW values were significantly lower in the inhalation group. MPV values were not significantly different between the two groups.

Unlike these studies, we did not find any difference between the inhalation and TIVA groups in terms of either NLR or RDW values. The reason for this may be that we evaluated NLR values at the 6th postoperative hour; however, Aldemir et al. evaluated NLR at the 12th and 24th postoperative hours. Unlike our study, Aldemir et al. compared propofol with desflurane, whereas Özay et al. compared midazolam with sevoflurane.

We found that the postoperative WBC count, RDW, and NLR values were elevated in both groups.

Limitations of the Study

This study adopted a retrospective study design, and because of institutional resource limitations, the implementation of anesthetic depth-measuring techniques, such as BIS monitors, is impossible in our hospital's routine practice. The depth of anesthesia was standardized by maintaining the end-tidal sevoflurane concentration at 1 MAC, with standard monitoring of hemodynamic parameters, such as mean arterial blood pressure and pulse, and clinical parameters, such as tears, sweating, and pupil size. A prospective study with large number of patients and monitoring the depth of anesthesia would be meaningful. We analyzed only on-pump CABG. Further studies, including off-pump CABG, are warranted.

In conclusion, this study found that the effects of sevoflurane-based inhalation anesthesia and propofol-based TIVA on WBC, RDW, and NLR values in patients undergoing elective on-pump CABG were similar.

Disclosures

Ethics Committee Approval: The study was approved by The Adana City Training and Research Hospital Clinical Research Ethics Committee (Date: 23/06/2022, No: 2011).

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

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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Authorship Contributions: Concept – T.Ş.; Design – T.Ş.; Supervision – T.Ş., S.G.; Data collection &/or processing – T.Ş., S.G.; Analysis and/or interpretation – T.Ş., S.G., S.K.; Literature search – S.K., İ.Ö.; Writing – T.Ş.; Critical review – S.G., İ.Ö.

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RESEARCH ARTICLE

Anesthesia Management in Non-Intubated Thoracoscopic Surgery (NIVATS): A Retrospective Study

Mete Manici, Eren Yavuz Açıkalın, Yavuz Gürkan

Department of Anesthesiology and Reanimation, Koç University Faculty of Medicine, İstanbul, Türkiye

ABSTRACT

Objectives: Video-assisted thoracoscopic surgery (VATS) is a widely used technique for thoracic operations. Non-intubated VATS (NIVATS) under regional or local anesthesia can be performed in selected patients. Epidural analgesia or interfascial plane blocks can be used for successful NIVATS. Erector spinae plane block (ESPB) is a type of interfascial plane block that is effective for NIVATS procedures. At our clinic, we successfully perform NIVATS with ESPB or rhomboid intercostal plane block (RIB). In this paper, we assess the effectiveness of these anesthesia methods used during NIVATS procedures.

Methods: We retrospectively reviewed 61 patients that underwent NIVATS procedures at our clinic between November 2017 and August 2023. This study received ethical committee approval (2023.255.IRB1.084). These 61 patients were assessed based on their demographic information, ASA grades, procedure indication, procedure duration, post-procedure complications, and type of anesthesia.

Results: All 61 patients received intraoperative sedation. Of these,16 received epidural analgesia, 10 received ESPB, 6 received RIB, and 29 received local anesthesia. Perioperative care did not differ between groups and all surgeries were completed without complications. No patients required transition to general anesthesia.

Conclusion: Patients in the epidural group were younger, which we think correlates with increasing comorbidities and anticoagulant usage with age. Other parameters were similar between groups. Overall, we recommend further prospective studies with larger sample sizes to evaluate the outcomes of different anesthesia techniques for NIVATS procedures.

Keywords: Epidural analgesia, regional anesthesia, video-assisted thoracic surgery.

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Introduction

Video-assisted thoracoscopy (VATS) has become a widely used technique for various aspects of thoracic operations, from acquiring biopsy samples to pneumonectomy. VATS procedures are generally performed under general anesthesia with single lung ventilation. Non-intubated VATS (NIVATS), which is performed without general anesthesia or intubation, is a recently introduced technique with numerous applications.[1–3] NIVATS diminishes risks related to general anesthesia and single lung ventilation and enables surgery on patients that are not good candidates for general anesthesia.

NIVATS is commonly performed under epidural anesthesia, various thoracic interfascial plane blocks, or local anesthesia.[1–5] Erector spinae planar block (ESPB) is a regional block that is effective as an analgesic and anesthesia method for VATS procedure.[6–8] The advantage of ESPB over epidural anesthesia is decreased risks related to neuraxial blockage, such as hemodynamic instability, motor blockage, or respiratory compromise. ESPB, as a superficial block, is safe with anticoagulant or antiaggregant usage and its hemorrhagic complications have lower morbidity than neuraxial interventions.[9]

Rhomboid intercostal block (RIB) is another type of regional anesthesia that is utilized for analgesia in thoracic operations including VATS.[10,11] Its advantages are similar to those of ESPB and the greater distance from the central nervous system results in decreased complications with an analgesic effect similar to ESPB. There are previous reports of NIVATS with ESPB and epidural analgesia. At our clinic,

Address for correspondence: Mete Manici, MD. Koç Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İstanbul, Türkiye
Phone: +90 533 474 77 64 **E-mail:** metemanici@yahoo.com

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we have successfully performed these procedures under RIB. In this study, we analyze data from NIVATS cases at our clinic and assess the effectiveness of anesthetic methods used in NIVATS procedures.

Methods

At our clinic, preoperative approval is routinely obtained from patients for academic usage of their medical and demographic data. Following ethical committee approval (2023.255.IRB1.084), we screened NIVATS procedures performed at our clinic between November 2017 and August 2023. Patient records indicated 61 cases. We obtained demographic data, anesthesiology assessment forms, anesthesiology reports, and post-anesthesia care unit (PACU) forms for these patients. American Society of Anaesthesiologists (ASA score) classification was chosen as an indicator of functional capacity.

We grouped patients based on anesthetic type and analyzed demographic data, ASA score classification, anesthetic method, local anesthetic drugs used during regional anesthesia, surgery indication, surgery duration, and anesthesia-related complications. Statistical analysis was performed using SPSS 29 (Armonk, NY: IBM Corp, USA). Variables are reported as the average±standard deviation. The independent sample t test was used to compare the means for continuous variables between groups. Pearson's χ^2 test was used to compare categorical variables. After these analyses, variables with $p<0.20$ significance were included in a logistic regression model. Significance was set at $p<0.05$.

Results

In our sample, the average patient age was 66.6 years. On average, patients in the epidural group were significantly younger than the other patients. Significant differences were not found for other demographic variables. All patients were ASA class III or IV, most of which were ASA class III. Distribution of ASA classes was similar between all groups. Of the 61 patients, 16 received thoracal epidural catheter preoperatively. Of these, 10 patients received ESPB and 6 patients received RIB. The remaining 29 patients received local anesthesia and sedation. No patients required conversion to general anesthesia. All 61 patients received intraoperative sedative agents to increase their comfort during the operation. These sedative agents included midazolam, fentanyl, and intermittent small boluses of propofol. Detailed anesthesia methods are provided in Table 1.

Regional anesthesia in these patients included continuous epidural anesthesia, ESPB, and RIB. All regional anesthesia techniques were administered by the same anesthetist experienced in these techniques.

Regarding regional anesthesia techniques, epidural analgesia was applied with an epidural catheter placed between the T5–T7 levels. 2% prilocaine was administered during surgery. ESPB was applied using ultrasound guidance and localized at the T5–T6 levels. A 22G 50 mm needle was placed between the transverse spinal processes and erector spinae fascia and 20 mL 0.25% bupivacaine was administered to the operation side. RIB was also applied with ultrasound guidance. The rhomboid major muscle fascia and intercostal muscle fascia were localized at T4–T5. A 22G 50 mm needle was placed at the interfacial plane and 20 mL 0.25% bupivacaine was applied to the operation side.

NIVATS indications for the 61 patients were as follows: malign pleural effusion (43), empyema (12), hemothorax (2), interstitial lung disease (1), lymphoma (1), and lymph node biopsy (2). Talk pleurodesis was applied to 36 patients. One patient with interstitial lung disease underwent wedge resection under epidural analgesia because intubation was risky due to severe fungal infection. The average operation time for these patients was 25.4 min. The operation took longer than 45 min for three patients because of pleural adhesions. The operation duration did not differ significantly between groups.

No patients developed significant complications during the procedures, such as significant pain, marked respiratory distress, severe bleeding, or hemodynamical instability.

Table 1. Characteristics of the 61 cases included in this study grouped by anesthesia type

	Epidural anesthesia	ESPB	RIB	Local anesthesia
Number of patients	16	10	6	29
Age	63.6±4.9	66.1±4.0	65.3±4.4	68.8±5.5
Sex (Male/Female)	10/6	6/4	4/2	20/9
ASA score (III/IV)	12/3	8/2	5/1	20/7
Thoracoscopy indication	Malign pleural effusion 12 Lymph node biopsies 2 Lymphoma 1 Interstitial lung disease 1	Malign pleural effusion 7 Empyema 3 Lymph node biopsy 1	Malign pleural effusion 4 Empyema 2	Malign pleural effusion 20 Empyema 7 Hemothorax 2
Procedure duration (min)	25.6±9.6	24.5±5.7	23.3±7.5	25.5±8.3

ESPB: Erector spinae plane block; RIB: Rhomboid intercostal plane block; ASA: American Society of Anesthesiology.

Vasoactive agents were not used. To facilitate the operation, both ESP and RIB patients received mild sedation during the procedure. After uncomplicated follow-up, all patients were discharged to the ward.

Discussion

Patients in the epidural group were significantly younger than the other patients. Increasing comorbidities and anticoagulant usage in older patients may direct the anesthetist away from neuraxial anesthesia, resulting in lower usage of epidural analgesia in older patients. In such patients, peripheral regional anesthesia or local anesthesia can be safely used.

ASA scores were similar between groups. As ASA score is a broad assessment of functionality, individual differences between patients might direct the anesthesiologist and surgeon toward specific anesthetic management, which may be central or peripheral regional anesthesia or local anesthesia.

The procedure indications were diverse, ranging from pleural drainage to wedge resection. In the literature, usage of NIVATS for such operations has been reported. Our results are consistent with prior reports, as all operations were completed with regional or local anesthesia. No patients had significant complications, such as marked respiratory distress, significant pain, marked respiratory distress, severe bleeding, or hemodynamical instability, and no cases required transition to general anesthesia.

The limitations of this study include the small number of patients in each group and the retrospective nature of the analysis. Larger, prospective cohort studies and randomized trials are recommended to further analyze intraoperative and postoperative outcomes related to regional anesthesia techniques in NIVATS procedures.

In conclusion, interfascial plane blocks with sedation are effective as a sole anesthetic method for NIVATS procedures. Although ESPB in NIVATS was described in previous studies, our observations show that RIB can be included among the armamentarium used by anesthesiologists for NIVATS. Further studies with larger sample sizes are necessary to evaluate the outcomes of interfascial plane blocks in NIVATS procedures.

Disclosures

Ethics Committee Approval: The study was approved by The Koç University Ethics Committee (Date: 04/08/2023, No: 2023.255. IRB1.084).

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

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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RESEARCH ARTICLE

The Effects of Iron Therapy on Blood Transfusion, Length of Intensive Care Stay and Mortality in Patients with Iron Deficiency Anemia in the Intensive Care Unit

Yusuf Özgüner, Savaş Altınsoy, Eda Macit Aydın, Gülten Ütebey, Mehmet Murat Sayın, Jülide Ergil

Department of Anesthesiology and Reanimation, Ankara Etlik City Hospital, Ankara, Türkiye

ABSTRACT

Objectives: The most prevalent form of anemia is iron deficiency anemia (IDA). In the intensive care unit (ICU) setting, frequent blood sampling for diagnostic purposes is one of the most important causes of anemia among patients. In our study, we aimed to retrospectively scan and compare patients diagnosed with IDA in our institution's ICU, with and without iron therapy.

Methods: In this study, patients with IDA who were hospitalized in our ICU for more than 21 days were included. The patients were divided into two groups: group 1 (patients with iron therapy) and group 2 (patients without iron therapy). Information regarding demographics (age and sex), comorbidities, total volume of blood samples drawn, hemoglobin, hematocrit, ferritin values, requirement for blood transfusion, length of ICU stay, Acute Physiology and Chronic Health Evaluation II score, Glasgow coma scale, and mortality rates were recorded.

Results: In this study, 48 patients were analyzed, including 25 (18 women, 7 men) with iron therapy and 23 (13 women, 10 men) without iron therapy. A statistically significant difference was found in the mean blood volume per patient transfused over the 21-day period between the two groups.

Conclusion: We noted that oral iron therapy was effective in reducing blood transfusions in patients with prolonged ICU stays. We believe that studies with larger patient groups are warranted regarding this topic.

Keywords: Anemia, intensive care, iron therapy

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Introduction

In the general population, anemia is a relatively common condition. The most prevalent form of anemia worldwide is iron deficiency anemia (IDA). Although IDA is more common in the elderly and female population, it can occur at any age.[1] According to the World Health Organization, anemia is defined as a hemoglobin (Hb) concentration of <13.0 g/dL in men over 15 years and a Hb concentration of <12.0 g/dL in nonpregnant women over 15 years of age. Moreover, anemia in pregnant women is defined as a Hb concentration <11.0 g/dL. Anemia is also associated with an increased length of postoperative hospital stay and a higher rate of intensive care unit (ICU) admission, morbidity, and mortality.[2]

IDA is a common condition in patients admitted to the ICU. To manage IDA, inexpensive, effective, and reliable oral iron supplements are used.[3] In the literature, doses higher than 60–120 mg of elemental iron per day are not recommended because they are unlikely to offer significant benefit in terms of iron repletion and can cause unintended side effects.[4] It has been reported that providing iron supplements daily as divided doses increases serum hepcidin and reduces iron absorption, and daily oral iron supplements are more effective as a single dose.[5] Moreover, it has been reported that Hb usually responds rapidly to effective oral iron therapy and indicates an adequate therapeutic response as a Hb increase of at least 2 g/dL after 3 weeks of therapy. However, repletion of iron stores may require 4–6 months of treatment.[6]

Address for correspondence: Yusuf Özgüner, MD. Ankara Etlik Şehir Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Ankara, Türkiye
Phone: +90 542 715 07 25 **E-mail:** y.ozguner@hotmail.com

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Frequent blood sampling from patients for diagnostic purposes is associated with blood loss volume and is one of the most important causes of anemia in the ICU, which is disregarded by clinicians. The average volume of blood samples drawn has been reported to be 40–41 mL/day in studies, and a positive correlation was found between diagnostic phlebotomy and the amount of erythrocyte transfusion.[7,8] A common intervention method for treating anemia in critically ill patients is red blood cell transfusion. Although blood transfusion is life-saving, it is also associated with an increased risk of morbidity and mortality.[3,9,10] An increase in mortality rates has been reported in ICU patients who receive frequent blood transfusions. Transfusion therapy in the ICU is an ever-growing field, with a new understanding of potential complications, new drug therapies to reduce the requirement for transfusion, and new additions in component therapy. Although there have been several large clinical trials that have studied red blood cell transfusion in various ICU patient populations, currently, a widely accepted consensus in terms of its application in the ICU is nonexistent.[11–13]

Iron therapy is a biologically plausible treatment to reduce the need for blood transfusion in ICU patients.[14] This study includes a retrospective comparison of ICU patients diagnosed with IDA with and without iron therapy. This study aimed to reveal the effects of iron therapy through a comparison of the demographic data of the patients, the blood sample volume drawn, Hb, hematocrit, ferritin values, requirement for blood transfusion, and length of ICU stay.

Methods

This study was approved by the Ethics Committee of Diskapi Yildirim Beyazit Training and Research Hospital (No: 128/17; January 10, 2022). Patients with IDA who were hospitalized in the ICU of our hospital for more than 21 days between July 1, 2021 and January 1, 2022 were included in the study. The exclusion criteria are as follows: patients under 1 year of age, postoperative patients, patients with non-IDA, critically ill patients with active infection, patients with acute and chronic kidney disease, patients with inflammatory diseases, and patients with missing data. Four patients with kidney stones and cysts but with normal kidney function values were not excluded from the study. This research is a descriptive epidemiological study, and it was aimed to include all patients in the study.

Patient data were scanned and recorded retrospectively from the hospital information system and ICU assessment forms. The patients were divided into two groups: group 1 (patients with iron therapy) and group 2 (patients without iron therapy). Oral iron supplementation is not recommended for patients who are allergic to iron preparations and have gastrointestinal system absorption disorders such as inflammatory bowel disease and gastrointestinal malignancy.[15] Therefore, patients who were not administered oral iron therapy were included in the group of patients without iron therapy. Information regarding demographics (age and sex), comorbidities, total volume of blood samples drawn, Hb, hematocrit, ferritin values, requirement for blood transfusion, length of ICU stay, Acute Physiology and Chronic Health Evaluation II (APACHE II) score, Glasgow coma scale (GCS), and mortality rates were recorded.

Laboratory evaluation is required for a definitive diagnosis of the type of anemia. As appropriate to this aim, various blood tests are performed to diagnose anemia in ICU patients on the first day of hospitalization, such as hemogram, iron, ferritin, iron binding capacity, vitamin B12, and folate. After excluding other causes of anemia such as vitamin B12 and folate deficiencies, iron replacement therapy is used in patients with IDA. Hemoglobin levels below 13 g/dL in men and 12 g/dL in women were considered as anemia. In patients with anemia with ferritin levels below 30 µg/L and iron levels below 33 µg/dL, iron deficiency was considered.

In this study, the effects of daily oral iron treatment in a single dose for 21 days were examined. Patients in the ICU in our institution diagnosed with IDA were administered 270 mg/day of ferrous sulfate (80 mg elemental iron) orally as a single daily dose for 21 days, and monitoring of daily blood results and complications related to iron therapy was conducted. Oral iron therapy was continued for patients with ongoing anemia after discharge from the ICU. Iron therapy was not used in patients with gastrointestinal system absorption disorders or a history of allergy to iron preparations. Treatment was terminated when complications such as allergy, anaphylaxis, severe nausea-vomiting, diarrhea, and melena occurred due to iron treatment. Patients whose treatment was not completed were excluded from the study.

During the hospitalization of the patients included in the study, the total volume of blood drawn daily was recorded via follow-up forms by calculating the amount of blood samples taken in the hospital information system.

Statistical Analysis

The SPSS 21.0 (Version 22.0, SPSS, Inc, Chicago, IL, USA) program was used for statistical analysis. After applying the Shapiro–Wilk test for normality, Student's t-test was used if the distribution was normal for the comparison of continuous variables between groups, and the Mann–Whitney U-test was used if with nonnormal distribution. The chi-square test was used for categorical variables. Statistical significance was set at $p<0.05$.

Results

A total of 66 patients diagnosed with IDA who were hospitalized in the ICU of our hospital for more than 21 days between July 1, 2021 and January 1, 2022 were included in the study. A total of 11 patients were excluded from the study because of missing data, and treatment of seven patients was terminated before the 21-day period because of gastrointestinal system complications during iron supplementation treatment. As a result, data of 48 patients were analyzed, including 25 (18 women, 7 men) with iron therapy and 23 (13 women, 10 men) in group 2 without iron therapy. The female to male ratio was similar in both groups, and there was no statistically significant difference between the groups (p=0,263) (Fig. 1).

The mean age of the patients was 70,17±12,01 years (group 1: 70,96±15,09; group 2: 69,39±8,94). There was no difference in the mean age between the groups (p=0,667) (Table 1).

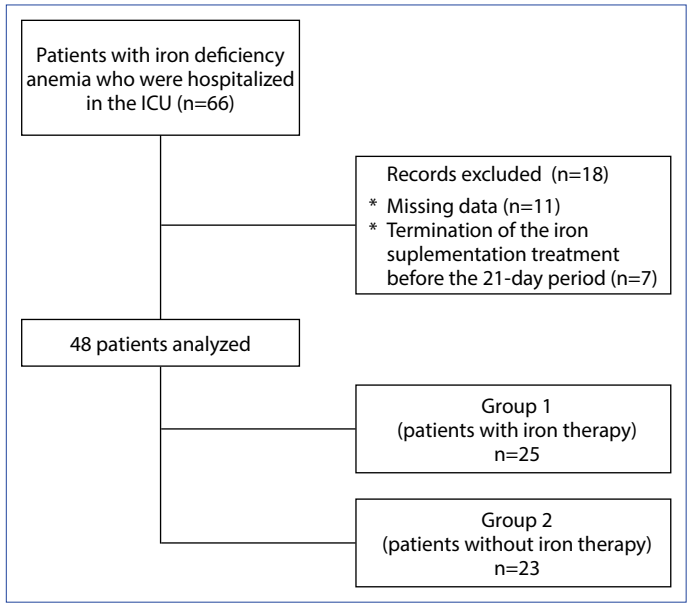

Figure 1. Patient flow chart.

Table 1. Demographic and clinical characteristics

	Group 1 (patients with iron therapy) n=25	Group 2 (patients without iron therapy) n=23	p
Age (year)*	70.96±15.09	69.39±8.94	0.667
Sex (n)			
Female	18	13	0.263
Male	7	10	
Length of ICU stay (day) *	38.20±14.82	37.04±9.23	0.750
APACHE II score *	16.48±6.97	17.65±7.49	0.577
Glasgow coma scale (GCS)*	13.20±2.10	11.78±3.96	0.124
Comorbidity (n)			
COPD	13	14	0.536
CAD	10	10	0.807
Cerebrovascular disease	11	12	0.571
Diabetes mellitus	6	6	0.868
Hypertension	13	8	0.230
Dementia/Alzheimer	4	1	0.187
Renal disease	1	3	0.257
Rheumatological disease	0	2	0.132
Malignancy	1	2	0.502
Mechanical ventilation requirement (n)			
IMV	5	9	0.316
NIMV	4	2	
SP	16	12	
Result (n)			
Exit	2	4	0.274
Discharge	17	17	
Transfer to hospital wards	6	2	

P<0.05 was considered significant. *: Mean±standard deviation. ICU: Intensive care unit; APACHE II score: Acute Physiology and Chronic Health Evaluation II score; COPD: Chronic obstructive pulmonary disease; CAD: Coronary artery disease; IMV: Invasive mechanical ventilation; NIMV: Noninvasive mechanical ventilation; SP: Spontaneous breathing.

Table 2. Comparison of laboratory evaluation and transfusion requirements

	Group 1 (patients with iron therapy) n=25	Group 2 (patients without iron therapy) n=23	p
Hemoglobin values (g/dL)			
0	9.4±1.41	9.28±1.90	0.809
7	9.06±1.13	8.73±1.17	0.323
21	8.79±0.89	8.38±1.27	0.202
Hematocrit values (%)			
0	28.5±4.40	28.38±5.58	0.925
7	28.32±4.06	26.88±3.31	0.188
21	27.17±3.29	25.48±3.39	0.086
Ferritin values (µg/L)			
0	21.73±5.12	22.86±5.35	0.459
7	22.54±4.92	23.60±4.71	0.449
21	23.23±5.34	23.61±4.82	0.797
Total volume of blood drawn (mL)			
0	25.4±13.62	30±9.53	0.186
7	116.8±39.87	127.8±19.76	0.241
21	213.4±77.44	220.87±23.53	0.659
Total volume of blood per patient transfused during the 7-day period (mL)	24±83.06	78.26±134.69	0.097
Total volume of blood per patient transfused during the 21-day period (mL)	60±150	247.82±195.09	<0.001*

*: p<0.05 was considered significant.

Comparisons between comorbidities in the ICU patients are listed in Table 1. No statistical difference was found between the groups (p>0.05).

Comparisons between Hb/hematocrit/ferritin values in the ICU patients are listed in Table 2. No difference between the groups was found (p>0.05).

The mean of the total volume of blood samples drawn per patient on the first day, during the 7-day period, and during the 21-day period are listed in Table 2. No statistically significant difference was found between the groups (p>0.05).

While the mean volume of blood per patient transfused during the 7-day period and during the 21-day period were 24±83.06 mL/60±150 mL in group 1, respectively, they were 78.26±134.69 mL/247.82±195.09 mL in group 2. While there was no difference between the groups on the 7-day period, a statistically significant difference was found on the 21-day period (p=0.097/ p<0.001) (Table 2).

While the mean length of the ICU stay was 38.20±14.82 days in group 1, it was 37.04±9.23 days in group 2. No difference between was found in both groups (p=0.750) (Table 1).

Six patients (group 1: 2; group 2: 4) died in the ICU, 34 patients (group 1: 17; group 2: 17) were discharged, and eight patients (group 1: 6; group 2: 2) were transferred to the hospital wards. When the ICU mortality rates were compared between the groups, these were similar in both groups (p=0.274) (Table 1).

Discussion

In this study, which includes a retrospective comparison of the ICU patients diagnosed with IDA with and without iron therapy, we found that while the volume of blood per patient transfused during the 21-day period was lower in patients with iron therapy, the volume of blood per patient transfused during the 7-day period, the total volume of blood samples drawn, Hb, hematocrit, ferritin values, length of ICU stay, APACHE II score, GCS, and mortality rates of the patients were similar in both groups.

In an intensive care study, the average volume of blood samples drawn for diagnostic purposes was 40–41 mL during the first 24-h period.[7] In another study, the average volume of blood samples drawn for diagnostic purposes in patients in the ICU is 9.62 mL.[8] Conversely, the total volume of blood samples taken during hospitalization was <196 mL in 95% of hospitalized patients. However, for 5% of the patients in the ICU, it was > 200 mL.[16] In our study, we

found that the mean of the total volume of blood samples drawn during the 21-day hospitalization of the patients in the ICU was 217.13 mL, which was similar to that reported in the literature.

In a study comparing iron treatment with placebo in anemic patients admitted to the ICU, iron therapy did not lead to a significant reduction in the need for red blood cell transfusions throughout the hospital stay. However, patients receiving iron had a significantly higher Hb concentration at the time of hospital discharge.[17] In a different study, patients treated with iron therapy in the postoperative critical ICU had a lower blood transfusion rate.[18] In our study, we noted a significant decrease in blood transfusion requirement at the end of the 21-day period in the patient group with iron therapy. We believe that iron therapy is effective in preventing anemia, which occurs as a result of frequent diagnostic blood sampling.

Higher Hb and ferritin values have been reported in patients receiving intravenous iron treatment compared with the control group.[14] In another study, significant changes in the Hb levels were observed in the patient group receiving iron treatment compared with the control group at the 4th week; however, no difference in the 12th week values was observed.[19] Perioperative intravenous iron administration in major abdominal surgeries results in a 60% reduction in allogeneic blood transfusion. However, no significant difference in Hb levels at discharge was observed compared with the control group.[20] We also noted that Hb values were similar in both groups. We believe that this is attributed to more blood transfusions administered to patients who did not receive iron therapy.

In a meta-analysis, intravenous iron therapy was reported to improve exercise capacity and quality of life in patients with heart failure; however, it did not have an effect on all-cause mortality or cardiovascular mortality. Furthermore, oral iron supplements were reported to not only improve exercise capacity and quality of life but also reduce all-cause mortality and hospitalizations for heart failure. The inefficacy of intravenous iron supplements on all-cause mortality or cardiovascular mortality is thought to be due to potential excessive iron accumulation in tissues, leading to tissue damage induced by free radicals.[21] Conversely, in a study conducted in patients on hemodialysis, there is no relationship between iron treatment and mortality.[22] In our study, we observed that the mortality rates during intensive care hospitalization in both groups were similar. However, owing to the retrospective nature of our study, long-term mortality rates after discharge could not be evaluated.

A study reported that iron treatment did not decrease the length of stay.[23] In a study evaluating the efficacy of intravenous iron supplementation in anemic, critically ill trauma patients, no significant difference among groups was found in terms of length of ICU stay and mortality.[24] In our study, similarly, in both patient groups, we found that the length of the ICU stay was similar. We believe that the possible complications and negative effects of anemia were prevented in both groups through iron treatment and blood transfusion, and as a result, we could not find a difference in the length of stay.

The primary recommendation for the treatment of IDA is oral iron therapy. However, in cases where surgery is scheduled within 6 weeks of iron deficiency diagnosis, in patients with an ineffective response to oral iron therapy, or in those intolerant to oral iron, intravenous iron therapy is recommended. However, intravenous iron has a risk of serious transfusion reactions such as anaphylaxis.[3,25] Because the patients in our study had a long-term stay in the ICU and did not have a surgical plan, intravenous iron therapy was not utilized, which has rapid activity. We preferred oral iron therapy, which is considered safer and more cost-effective than intravenous iron therapy.

In a study, mild gastrointestinal side effects were noted in 20.4% of patients receiving oral iron supplements.[26] In a different study, it was reported that the most commonly reported symptoms in patients receiving oral iron therapy were constipation, diarrhea, and nausea at a rate of 12%, 8%, and 11%, respectively.[27] In our study, because 3 of 28 patients who received iron treatment in the ICU had severe nausea and melena, their treatments were terminated. Gastrointestinal side effects were observed in four of the remaining 25 patients; however, their treatment was continued. We noted that the use of oral iron therapy is associated with frequent gastrointestinal side effects, and this rate was approximately 25% in patients who received iron supplements. This rate was similar to the data in the literature.

This study has limitations. First, we could not evaluate the anemia status and long-term mortality rates of patients after discharge because patient data were obtained from the hospital information system and ICU assessment forms. Second, this was a single-center and retrospective study; therefore, the number of patients included in the study was limited.

Conclusion

Anemia is a common condition among patients in the ICU. Frequent diagnostic blood sampling from patients is one of the most important causes of anemia in hospitalized patients. The frequency of blood transfusion is increasing in patients with prolonged ICU stays. Currently, no consensus exists regarding anemia and transfusion treatment in ICUs. In our study, we noted that oral iron therapy was effective in reducing blood transfusions in patients with prolonged ICU stays. Further studies are warranted to explore the implications in larger patient groups.

Disclosures

Ethics Committee Approval: The study was approved by The Diskapi Yildirim Beyazit Training and Research Hospital Ethics Committee (Date: 10/01/2022, No: 128/17).

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

Peer-review: Externally peer-reviewed.

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RESEARCH ARTICLE

Early versus Late Application of Hemoadsorption in Critically Ill COVID-19 Patients with Cytokine Release Syndrome

Berrin Er,[1] Sema Turan,[1] Hayriye Cankar Dal,[1] Çilem Bayındır Dicle,[1] Nilgün Eren Çakaroğlu,[2] Şeyda Özkan,[2] Dilek Kazancı[1]

[1]Department of Intensive Care Unit, University of Health Sciences, Ankara Bilkent City Hospital, Ankara, Türkiye
[2]Department of Anaesthesiology and Reanimation, University of Health Sciences, Ankara Bilkent City Hospital, Ankara, Türkiye

ABSTRACT

Objectives: Cytokine release triggered by severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) depends on a dysregulated immune response and is associated with high mortality. Extracorporeal cytokine hemoadsorption (HA) can be considered a possible adjuvant therapy. This study aimed to review the outcomes of critically ill patients with COVID-19 treated with HA and analyze possible factors associated with mortality.

Methods: Data of patients who received HA for at least one cycle from April 17, 2020, to January 31, 2021, were collected. Clinical and laboratory features were recorded, and mortality was evaluated based on the extracorporeal treatment application time and intensive care units (ICU) admission.

Results: Data from 177 patients among 4733 ICU patients were analyzed. Their mean age was 60.9±10.9, and 40 (22.6%) of them were females. About 83% of them were mechanically ventilated, and the overall mortality was 76%. In univariate analysis, the mean age, median acute physiology and chronic health evaluation (APACHE)-II score, respiratory support rate, and duration between ICU admission and first cytokine filter were lower in the survivor group than in the non-survivor group. In binary logistic regression analysis, higher APACHE-II with an odds ratio of 1.06 (95% confidence interval [CI]: 1.005–1.128, p=0.033), invasive mechanical ventilation with an odds ratio of 138.4 (95%CI: 24.2–791.8, p<0.001), and later application of HA with an odds ratio of 1.190 (95%CI: 1.009–1.404, p=0.039) were independently associated with in-hospital mortality.

Conclusion: Cytokine HA was applied to a large number of patients at our center. Although this was conducted in a severe population with high mortality, besides invasive mechanical ventilation, late application of the cytokine filter was found as one of the factors independently associated with higher mortality.

Keywords: Extracorporeal purification, hemoadsorption, intensive care, SARS-CoV-2

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Introduction

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory disease (SARS-CoV-2) can present with heterogeneous clinical characteristics ranging from mild flu-like syndrome to life-threatening pneumonia with acute hypoxemic respiratory failure.[1] The cytokine release syndrome triggered by the virus in patients with severe COVID-19 is due to a dysregulated immune response and is associated with high mortality.[2] As elevated cytokines and immune markers were considered potential treatment targets, corticosteroids and some anti-interleukin therapies have been used in patients with severe hypoxemia.[3,4] Although the underlying mechanism is not yet fully understood and definite treatment has not yet been established, beneficial effects of immunosuppressant agents have been recorded in particular patients with hypoxemia.[5]

Extracorporeal hemadsorption (HA) techniques for adsorbing pro- and anti-inflammatory cytokines are increasingly used in several clinical conditions such as sepsis and other hyperinflammatory syndromes in intensive care units (ICU).[6,7] However, no specific recommendation has been established regarding hemoadsorption therapies in the survival sepsis guideline, due to the lack of consistent evidence.[8] Hyperinflammation has a significant role in the pathophysiology of multiple organ failure in critically

Address for correspondence: Berrin Er, MD. Sağlık Bilimleri Üniversitesi, Ankara Bilkent Şehir Hastanesi, Yoğun Bakım Kliniği, Ankara, Türkiye
Phone: +90 532 415 41 23 **E-mail:** berriner.md@gmail.com

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ill patients; therefore, as an alternative therapeutic regimen, cytokine HA techniques have been tried in critically ill patients with COVID-19.[9] Different outcomes have been observed due to varied hemoadsorption methods, application times, and patient characteristics, and clear characteristics of the clinical effects have not been elucidated yet.

As a referral hospital for COVID-19 in our region, we could collect data on a large COVID-19 critically ill population treated with HA. Based on the scope of this study, the outcomes of these patients were retrospectively reviewed analyzing possible factors associated with differences in survival.

Methods

This retrospective study was conducted in tertiary ICUs of our hospital, including patients with severe COVID-19 infection. Adult patients with confirmed molecular diagnosis of SARS-CoV-2 infection who were admitted to the ICU due to acute respiratory failure and treated with HA were included in this study.

We collected the data of patients treated with at least one cycle of HA in our hospital during the first and second waves of the COVID-19 pandemic, from April 17, 2020, to January 31, 2021. During this period, ICU admission and treatment were planned based on the Ministry of Health guidelines of the Republic of Türkiye. HA was used as an add-on therapy to the standard regimen consisting of corticosteroids, anticoagulants, favipiravir, and supportive therapies. The national guideline indicated that some patients were treated with anti-interleukin drugs depending on the presence of some clinical findings such as refractory fever, increasing CRP levels despite appropriate therapy, elevated d-dimer, lymphopenia, thrombocytopenia and neutrophilia, and deteriorated liver function tests. HA was administered to some patients who clinically deteriorated and had increased oxygen demand even after receiving the standard regimen. Demographic data (age and sex); comorbidities (diabetes, hypertension, heart failure, asthma, chronic obstructive lung disease, chronic renal disease, and malignancy); acute physiology and chronic health evaluation (APACHE-II) score at the ICU admission; length of ICU stay; respiratory support (noninvasive and invasive mechanical ventilation); drugs used to treat COVID-19 (favipiravir, corticosteroids, and anti-interleukin [IL-6 and IL-1 antagonists]; CRP, ferritin, and procalcitonin levels and lymphocyte count at the first day of cytokine filtration; IL-6 levels at the ICU admission, first day of HA, and after HA administration; number of HA cycles; duration between ICU admission and the first application of HA; and in-hospital mortality data were recorded. HA was performed using a standard extracorporeal circuit with an HA-330 cartridge (Jafron, Zhuhai, China). Priming and delivery of therapy were performed according to the manufacturer's instructions for use. Each session lasted 4 h/day, and the treatment was prescribed for three consecutive days.

The statistical analysis was performed using the statistical software package SPSS 23.0.0.2. Medians (interquartile ranges [IQR]) for non-normally distributed data and percentages for categorical variables were used. Mann–Whitney U-test was used to compare continuous variables, and Fisher's exact test and chi-squared test were used for categorical variables. ROC analysis was used to detect a cut-off for the duration between ICU admission and the first HA application. The clinical and laboratory characteristics of the two groups were compared based on mortality. Inflammatory markers detected in different periods were compared using the Kruskal–Wallis test. Binary logistic regression analysis was used to determine independent variables for mortality after performing the Hosmer–Lemeshow goodness-of-fit test. Clinical and statistically significant variables in univariate analysis were included in the model. Statistical significance was set at two-sided ($p<0.05$) for all of the above analyses.

All procedures performed in studies involving human participants were by the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Institutional Review Board of our hospital (number: E2-22-2388, date: 07/09/2022). Due to the retrospective study design, no informed consent was obtained.

Results

We collected the data of 177 patients from 4733, who were treated with cytokine filtration from April 17, 2020, to January 31, 2021, in our tertiary ICU clinics. Their mean age was 60.9±10.9, and 40 (22.6%) of them were female. Demographic and clinical features are presented in Table 1. Hypertension, diabetes, and coronary artery disease were the most common comorbidities. A significant percentage of patients (83%) were intubated. Corticosteroid was prescribed to all study patients, while 38.4% was treated with anti-interleukin agents. All patients received at least one cycle, and 72.9% received three cycles of cytokine blood filtration using HA330. Median IL-6 levels at the ICU admission, on the first day of cytokine filtration, and after the last filtration were 66.5 pg/ml (25.2–134), 65 pg/ml (24.1–180.5), and 44.5 pg/ml (17–168.5), respectively, reflecting no statistically significant difference between the medians (p=0.62).

Table 2 compares the clinical features of the survivor and non-survivor groups. In univariate analysis, the mean age,

Table 1. Demographic and clinical features of patients

	n=177	
	n	%
Age, (years) (mean±SD)	60.9±10.9	
Sex		
Female	40	22.6
Comorbidities		
Hypertension	74	41.8
Diabetes mellitus	40	22.6
Coronary artery disease	37	20.9
Chronic obstructive pulmonary disease	12	6.8
Solid organ malignancy	9	5.1
Chronic renal disease	8	4.5
Cerebrovascular event	5	2.8
APACHE-II at 24 h of ICU admission, median (IQR)	19 (14–29)	
Laboratory parameters at ICU admission, median (IQR)		
Lymphocyte count (µl)	525 (340–760)	
CRP (mg/dl)	150 (112–210)	
Procalsitonin (ng/ml)	0.19 (0.09–0.71)	
D-dimer (ng/ml)	1.44 (0.78–3.50)	
Ferritin (mg/L)	997 (453–1543)	
IL-6 (pg/ml)	66.5 (45.2–134.0)	
Respiratory support		
High-flow nasal cannula	52	29.4
Noninvasive ventilation	18	10.2
Invasive mechanical ventilation	148	83.6
COVID-19 specific therapies		
Corticosteroid	177	100
Anti-IL-1	52	29.3
Anti-IL-6	16	9
Cytokine filtration		
1 cycle	27	15.2
2 cycles	21	11.9
3 cycles	129	72.9
Time period between ICU admission and first day of cytokine filtration (days), median (IQR)	4 (2–7)	
Length of ICU stay (days), median (IQR)	15 (10–24.5)	

n: Number; SD: Standard deviation; APACHE: Acute physiology and chronic health evaluation; ICU: Intensive care unit; IQR: Interquartile range; CRP: C-reactive protein IL: Interleukin.

median APACHE score, respiratory support rate (high-flow nasal cannula, and invasive mechanical ventilation), and duration from the ICU admission to the first cytokine filter was lower in the survivor group. Inflammatory mediator levels of the survivor and non-survivor groups in the ICU admission and pre- and post-filtration periods are presented in Table 3. In ROC analysis, the area under the curve for the time period from the ICU admission to the first application of the cytokine filter was 0.65 (95% CI: 0.56–0.74; p=0.004), with 7 days cut-off having a sensitivity of 35.3% and specificity of 90.2% (Fig. 1).

Age, APACHE-II score, use of high-flow nasal cannula and invasive mechanical ventilation, and the number of days between the ICU admission and first cytokine filtration were put in a binary logistic regression model (Table 4). The p-value for the Hosmer–Lemeshow test was 0.81. Binary logistic regression analysis showed that a higher APACHE-II score with an odds ratio of 1.06 (95% CI: 1.005–1.128, p=0.033), invasive mechanical ventilation with an odds ratio of 138.4 (95% CI: 24.2–791.8, p<0.001), and later application of cytokine removal with an odds ratio of 1.190 (95% CI: 1.009–1.404, p=0.039) were variables independently associated with mortality.

Table 2. Comparison of demographic and clinical features according to mortality data

	Survivors (n=41, 23.2%)		Non-survivors (n=136, 76.8%)		p
	n	%	n	%	
Age (years) (mean±SD)	55.9±10.8		62.1±10.6		**<0.001**
Sex					
Female	9	22.0	31	22.8	>0.99
Comorbidities					
Hypertension	14	34.1	60	44.1	0.34
Diabetes mellitus	7	17.1	33	24.3	0.45
Coronary artery disease	5	12.2	32	23.5	0.18
Chronic obstructive pulmonary disease	4	9.8	8	5.9	0.48
Solid organ malignancy	1	2.4	8	5.9	0.69
Chronic renal disease	3	7.3	5	3.7	0.39
Cerebrovascular event	1	2.4	4	2.9	>0.99
APACHE-II at 24 h of ICU admission, median (IQR)	15.0 (8.5–29.0)		20.0 (14.0–30.7)		**0.02**
Laboratory parameters at ICU admission, median (IQR)					
Lymphocyte count (µl)	580 (340–820)		515 (330–760)		0.58
C-reactive protein (mg/dl)	160 (98–196)		151 (114–210)		0.57
Procalsitonin (ng/ml)	0.15 (0.10–0.51)		0.26 (0.08–0.75)		0.44
D-dimer (ng/ml)	1.35 (0.79–3.3)		1.49 (0.78–3.54)		0.94
Ferritin (mg/L)	879 (450–1617)		1056 (453–1530)		0.75
IL-6 (pg/ml)	64 (21–103)		68 (26–137)		0.40
Respiratory support					
High-flow nasal cannula	19	46.3	33	24.3	**0.01**
Noninvasive ventilation	5	12.2	13	9.6	0.57
Invasive mechanical ventilation	15	36.6	133	97.8	**<0.001**
COVID-19 specific therapies					
Pulse steroid	41	100	136	100	>0.99
Anti-IL-1	10	24.4	42	30.9	0.55
Anti-IL-6	4	9.8	12	8.8	0.76
Cytokine filtration					0.11
1 cycle	4	9.8	23	16.9	0.26
2 cycles	2	4.9	19	14.0	0.11
3 cycles	35	85.3	94	69.1	**0.04**
Time period between ICU admission and first day of cytokine filtration (days), median (IQR)	3.0 (1.5–5.0)		5.0 (3.0–8.0)		**0.004**
Length of ICU stay (days), median (IQR)	17.0 (11.5–27.5)		15.0 (9.0–24.0)		0.29

Discussion

In this study, we evaluated the mortality outcome of critically ill patients with COVID-19 who were administered at least one cycle of cytokine filters as an add-on therapy to the standard regimen. In univariate analysis, the mean age, median APACHE score, respiratory support (high-flow nasal cannula and invasive mechanical ventilation) rate, and duration between the ICU admission and first cytokine filter were found to be lower in the survivor group. Logistic regression analysis showed that higher APACHE-II score with an odds ratio of 1.06 (95% CI: 1.005–1.128, p=0.033), invasive mechanical ventilation with an odds ratio of 138.4 (95% CI: 24.2–791.8, p<0.001) and later application of cytokine removal with an odds ratio of 1.190 (95% CI: 1.009–1.404, p=0.039) were variables independently associated with mortality.

As a referral hospital for COVID-19 since the beginning of the pandemic, more than 20,000 patients were followed up in our ICU clinics. Many patients with severe respiratory failure were admitted, and to our knowledge, this study is one of the largest population studies conducted in Türkiye on the use of cytokine filtration to manage COVID-19. Mortality did not reflect the general ICU mortality data as only patients treated with cytokine filters were included in the scope of the

Table 3. Inflammatory markers at different periods

	At ICU admission	Pre-filter	Post-filter
Procalcitonin (ng/ml)			
Survivor group	0.15 (0.10–0.51) (n=39)	0.16 (0.06–0.54) (n=41)	0.16 (0.08–0.59) (n=41)
Non-survivor group	0.24 (0.08–0.82) (n=131)	0.56 (0.15–2.52) (n=136)	0.77 (0.22–3.81) (n=134)
p	0.43	<0.001	<0.001
C-reactive protein (mg/dl)			
Survivor group	0.16 (0.09–0.19) (n=39)	0.10 (0.03–0.16) (n=41)	0.47 (0.02–0.15) n=41
Non-survivor group	0.15 (0.11–0.21) (n=132)	0.14 (0.07–0.21) (n=136)	0.11 (0.05–0.17) (n=134)
p	0.57	0.002	0.03
Interleukin-6 (pg/ml)			
Survivor group	64 (21.3–103) (n=39)	31 (14.2–102) (n=41)	22.8 (9.6–53.5) (n=41)
Non-survivor group	67.8 (26–137) (n=127)	68.8 (25.1–196) (n=132)	54.7 (20.8–237) (n=128)
p	0.40	0.004	<0.001

All values are presented as medians (interquartile ranges). P-value is used to compare the survivor and non-survivor groups.

Table 4. Risk factors for mortality

Variables	OR	95% CI	p
Age	1.022	0.973–1.074	0.381
APACHE-II score	1.065	1.005–1.128	**0.033**
High-flow nasal cannula	1.661	0.473–5.837	0.429
Invasive mechanical ventilation	138.489	24.221–791.835	**<0.001**
Days between ICU admission and the first use of the cytokine filter	1.19	1.009–1.404	**0.039**

OR: Odds ratio; CI: Confidence interval.

study. Invasive mechanical ventilation was applied in 83% of them. A study representing the first wave of the pandemic and aiming to assess the effect of early invasive mechanical ventilation on mortality showed that 60-day mortality was 20.8% higher in the invasive ventilation group.[10]

Several studies on sepsis and COVID-19 reported that proinflammatory cytokines were related to endothelial damage, pro-coagulation, multiple organ failure, and increased mortality.[11,12] However, increased inflammatory cytokine levels in severe COVID-19 were lower than those in acute respiratory distress syndrome and sepsis. Individual responses are heterogeneous, and the importance of biomarker levels is still uncertain. In our study, the inflammatory mediator levels were higher in the non-survivor group before and after the cytokine filter, but we do not have enough data to attribute higher mortality to just higher biomarker levels.

HA330 is a synthetic resin hemofilter that adsorbs proinflammatory cytokines such as TNF-alpha, IL-1, and IL-6, and its cytokine removal effect has been considered to be beneficial for the hyperinflammatory state of COVID-19.[13,14] In a study conducted in patients with severe COVID-19, decreased SOFA score, improved chest X-ray, and decreased mortality were recorded in patients who received at least three hemoperfusion sessions.[15] The control group of the concerned study consisted of patients with <3 sessions and the median time for the first filtration was 24 h in the hemoperfusion group. In another study by Esmaeili Vardanjani et al.,[16] early use of hemoperfusion in a patient with COVID-19 prevented the progression of acute respiratory distress syndrome and intubation.[16] The concerned study hypothesized that removing inflammatory mediators might contribute to preventing multiple organ failure, such as acute kidney injury, liver failure, and septic shock in severe patients. The therapeutic benefit of cytokine elimination was considered likely depending on timing. In the present study, however, the median time for starting the first session was shorter (3 vs.

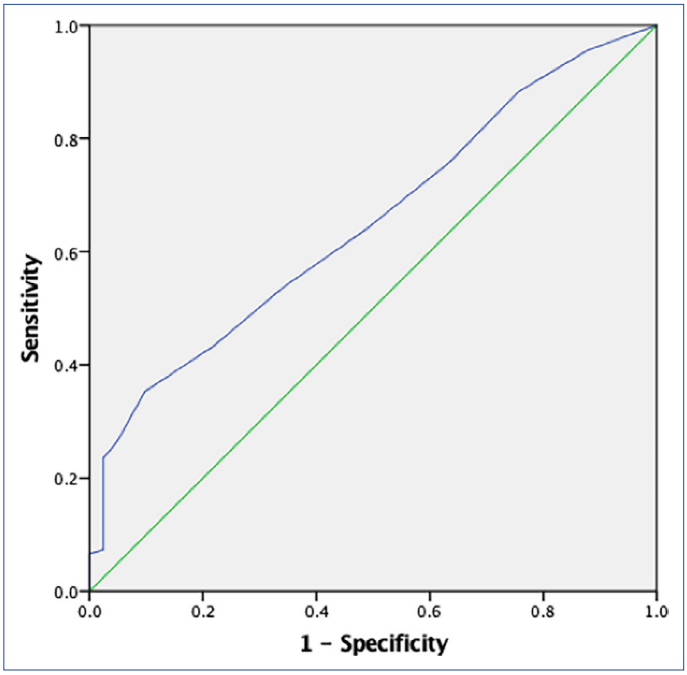

Figure 1. The area under the curve for the duration from ICU admission to the first application of a cytokine filter was 0.65 (95% CI: 0.56–0.74; p=0.004), with 7 days cut-off having a sensitivity of 35.3% and specificity of 90.2%.
ICU: Intensive care unit; CI: Confidence interval.

5 days) in the survivor group, and early application benefits persisted after regression analysis.

This study has some limitations. No specific protocol has been established for cytokine filter indications and application processes due to the retrospective design of the study. It was applied based on the clinician's decision. Since the cytokine removal was dependent on the clinician's decision and the data were collected retrospectively, information about why <3 cycles were performed in six patients who survived and could not be obtained. However, our treatment protocols in ICUs were compatible with the COVID-19 guidelines published by the Ministry of Health of the Republic of Türkiye. Second, this study has no control group without cytokine removal since the primary aim of the study was to investigate the effects of timing in subjects undergoing cytokine filtration. Therefore, we considered it appropriate to include in the study the patients who underwent cytokine filtration at different times.

In conclusion, in a severe population with high mortality, late application of the cytokine filter, besides invasive mechanical ventilation, was found among the risk factors independently associated with mortality. The fact that the treatment was applied in a group with a high mortality rate that did not respond to standard treatment may have affected the results. Different results can be obtained by studying appropriate phenotypes that may benefit from this treatment.

Disclosures

Ethics Committee Approval: The study was approved by The Ankara Bilkent City Hospital No 2 Clinical Research Ethics Committee (Date: 07/09/2022, No: E2-22-2388).

Informed Consent: Due to the retrospective study design, no informed consent was obtained.

Peer-review: Externally peer-reviewed.

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RESEARCH ARTICLE

Prognostic Efficacy of Red Cell Distribution Width and Neutrophil/Lymphocyte in Cardiac Surgery

Ferda Yaman, Tuğba Özyurt, Dilek Çetinkaya

Department of Anesthesiology and Reanimation, Eskisehir Osmangazi University Faculty of Medicine, Eskişehir, Türkiye

ABSTRACT

Objectives: This study aimed to examine the effect of neutrophil-to-lymphocyte ratio (NLR) and red cell distribution width (RDW) values on postoperative mortality and morbidity in patients who underwent off-pump cardiac surgery.

Methods: This study included patients who underwent off-pump coronary artery bypass surgery from January 1, 2018 to January 1, 2020. Correlations between the preoperative NLR and RDW values and postoperative complications, extubation time, length of intensive care unit stay, and length of hospital stay were evaluated.

Results: A total of 68 patients were evaluated. No correlation was found between preoperative RDW and NLR values and age, ejection fraction, extubation time, or length of hospital stay. The length of stay in the intensive care unit did not correlate with the preoperative RDW value but was correlated with the NLR value (p=0.042). In six patients, postoperative complications were observed. No statistically significant difference was found between patients with and without complications in terms of preoperative RDW and NLR values.

Conclusion: In this study, a high preoperative NLR value was associated with a prolonged intensive care unit stay, one of the early complications of cardiac surgery. However, the preoperative RDW value did not have a predictive relationship with early postoperative complications.

Keywords: Neutrophil-to-lymphocyte ratio, off-pump cardiac surgery, red cell distribution width

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Introduction

In the general population, an increased prevalence of coronary heart disease has been observed, which is the leading cause of mortality worldwide. Coronary artery bypass grafting (CABG) remains the standard and optimal treatment for patients with diffuse coronary artery disease. "Off-pump" CABG (OPCABG) is a cardiac surgical technique in which physiological circulation is preserved without the need for aortic or right atrial cannulation or extracorporeal circulation.[1]

Red cell distribution width (RDW) is a measurement of the change in circulating red blood cell (RBC) volume and is traditionally used to differentiate causes of anemia. An increased RDW value indicates greater heterogeneity in circulating RBC size (anisocytosis).[2] The neutrophil-to-lymphocyte ratio (NLR) is a marker of host inflammation, which is calculated by dividing the number of neutrophils by the number of lymphocytes.[3]

RDW and NLR are inexpensive, simple, quantitative parameters routinely measured using automated complete blood count analysis. Both parameters are associated with cardiovascular diseases.[2,3]

In this study, we aimed to explore the effects of NLR and RDW values on postoperative mortality and morbidity in patients undergoing OPCABG.

Methods

The study was initiated after receiving approval from the local ethics committee (approval number: 14.01.2020/13).

This article was presented as an oral presentation at the 26th National Congress of the Thoracic Cardiovascular Anesthesia and Intensive Care Association on 17–18 September 2020.

Address for correspondence: Dilek Çetinkaya, MD. Eskişehir Osmangazi Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, Eskişehir, Türkiye

Phone: +90 222 239 29 79-5007 **E-mail:** dceyhan@ogu.edu.tr

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The study was conducted in line with the 2008 Helsinki Declaration principles. This retrospective study included all patients who underwent OPCABG from January 1, 2018 to January 1, 2020. Patients with anemia (hemoglobin below 13 g/dL), liver or kidney failure, an ejection fraction (EF) value of 30, active infection, and unavailable data were excluded from the study.

In this study, the patients' sex, age, body mass index, comorbidities (diabetes mellitus [DM], hypertension, chronic obstructive pulmonary disease [COPD], and asthma), EF, number of grafted vessels, extubation time, length of intensive care unit (ICU) stay, length of hospital stay, presence of postoperative complications (cerebrovascular event, postoperative new atrial fibrillation [AF], postoperative dialysis requirement, bleeding, surgical revision, and myocardial infarction), and preoperative RDW and NLR values were recorded. Data were obtained from patient files, anesthesia records, and perfusion charts. Patients with missing data were excluded from the study.

In the statistical analyses, variables with continuous values were presented as mean, standard deviation, minimum, and maximum values, and those with categorical values were shown as frequency and percentages. The Shapiro–Wilk test was used to examine the conformity of the data to the normal distribution. The Mann–Whitney U test was conducted to compare groups that did not satisfy the normal distribution in the two groups. To determine the direction and size of the correlation between variables and for variables that did not conform to the normal distribution, Spearman correlation coefficients were calculated. Statistical significance was set at a p value<0.05.

Results

Of the 85 patients who underwent OPCABG, 68 were included in the study. Eighteen (26.5%) patients were female and 50 (73.5%) were male. The mean age was 63.6±10 years. A total of 32 (47.1%) patients had DM, one (1.5%) had COPD, and 44 (47%) patients had hypertension. One vessel graft was employed to 16 (23.5%) patients, two vessel grafts to 43 (64.2%) patients, and three vessel grafts to nine (13.2%) patients. In the study, the mean EF of the patients included was 50.3±10.8. The mean extubation time was 266.0±78.0 min, the mean length of ICU stay was 2.66±0.908 days, and the mean length of hospital stay was 8.40±3.46 days (Table 1).

Correlations between the preoperative RDW and NLR values and age, EF, extubation time, length of ICU stay, and length of hospital stay were evaluated. Neither RDW nor NLR correlated with age (p=0.052 and 0.289, respectively), EF (p=0.967 and 0.286, respectively), extubation time (p=0.648 and 0.347, respectively), or length of hospital stay (p=0.930 and 0.409, respectively). Furthermore, no statistically significant correlation was noted between the preoperative RDW value and the length of ICU stay (p=0.477). However, the preoperative NLR value was significantly correlated with the length of ICU stay (p=0.042) (Table 2). The mean NLR value was 3.68±1.63 for patients who stayed in the ICU for 4 days or longer and 2.96±0.98 for those with a shorter ICU stay, indicating a statistically significant difference (p=0.038). The longer ICU stay was attributed to the hemodynamic instability found in 42% of patients and the requirement for blood product replacement in 34%.

Postoperative complications were observed in six patients (bleeding without revision requirement and need for replacement in two patients, bleeding requiring revision in one patient, one-time dialysis in one patient, and inotropic agent requirement for longer than 12 h in two patients). When the relationship between the preoperative RDW and NLR values and the development of postoperative complications was evaluated, no statistically significant correlation was found (p=0.815 and 0.208, respectively). The mean RDW value was 13.80%±1.568% in patients with complications and 13.46%±1.19% in those without complications, whereas the mean NLR values of these subgroups were determined to be 2.44±0.825 and 3.54±3.37, respectively (Table 3).

Table 1. Demographic data

	n	%
Sex		
Female	18	26.5
Male	50	73.5
Diabetes mellitus		
Absent	36	52.9
Present	32	47.1
COPD		
Absent	67	98.5
Present	1	1.5
Hypertension		
Absent	23	34.3
Present	44	65.7
Number of vessels grafted		
1	16	23.5
2	43	64.2
3	9	13.2
	Mean±SD	**Min-Max**
Age	63.6±10.5	38–82
Ejection fraction	50.3±10.8	24–65
Extubation time (minute)	266±78	60–480
Length of ICU stay (day)	2.66±0.908	2–7
Length of hospital stay (day)	8.40±3.46	4–30

COPD: Chronic obstructive pulmonary disease; SD: Standard deviation; ICU: Intensive care unit.

Table 2. Correlation between preoperative RDW and NLR

r p	Age	EF	Extubation time	Length of ICU stay	Length of hospital stay
RDW	0.237	0.005	0.056	–0.088	–0.011
	0.052	0.967	0.648	0.477	0.930
NLR	0.130	0.131	–0.116	**0.247**	–0.103
	0.289	0.286	0.347	**0.042***	0.409

Spearman's correlation test, *p<0.05. RDW: Red cell distribution width; NLR: Neutrophil-to-lymphocyte ratio; EF: Ejection fraction.

Table 3. Comparison of patients with and without complications

	Patients with complications (n=6)	Patients without complications (n=62)	p
RDW (%)	13.80±1.568	13.46±1.19	0.815
NLR	2.44±0.825	3.54±3.37	0.208

Mann–Whitney U test.

Discussion

In addition to genetic, environmental, and behavioral factors, inflammation plays a role in cardiovascular disease development. Inflammatory cells and signaling pathways are involved in atherosclerosis development.[4] Inflammatory response is a sequelae of chronic exposure to numerous factors that cause endothelial damage, and neutrophils play a major role in this response. Reactive products generated via neutrophil activation both damage the vascular endothelial wall and induce thrombosis with platelet activation. Lymphocytes also accumulate at the site of inflammation and contribute to chronic inflammation.[5] Since the recognition of the effects of inflammatory markers on atherosclerosis, studies have been conducted on the use of these markers as predictive agents in cardiac diseases. A recently published meta-analysis reported that perioperative NLR was an independent predictor of short- and long-term postoperative mortality in CABG surgery involving cardiopulmonary pump use.[6] Similar results were acquired from studies in which OPCABG was used.[7,8]

In this study, the correlation between preoperative NLR values and early complications and mortality in patients who underwent OPCABG was evaluated. However, we found no statistically significant difference in NLR between patients with and without postoperative complications. Previous studies have demonstrated that preoperative NLR values are higher in patients with complications than in those without complications.[9] Conversely, in our study, preoperative NLR values were found to be higher in the group without complications (2.44±0.825 vs. 3.54±3.37). Additionally, a correlation was found between the preoperative NLR value and the length of ICU stay, with the former being statistically significantly higher among patients with a longer ICU stay. High preoperative NLR values prolong the duration of ICU stay in connection with hemodynamic instability and the need for blood product replacement, which are among the early complications. Haran et al.,[10] in their evaluation of 1,694 patients, reported that patients with preoperative NLR values of 3.23 had a longer ICU stay, delayed extubation, and a higher rate of newly diagnosed neurological conditions. In the current study, the preoperative NLR value was above the previously reported value of 3.23 (3.68) in patients with a longer ICU stay.

A high RDW causes microcirculation impairment, although its pathogenesis remains unclear.[11] RDW is an indicator of a patient's physiological reserve or the ability of cells to defend against hypoxic stress. Moreover, an increased RDW value reflects a low physiological reserve.[12]

In a cohort study assessing the role of preoperative RDW in the prediction of acute kidney injury after on-pump cardiac surgery, a high preoperative RDW value might be an independent prognostic factor for acute renal failure, with a 0.1% increase in the RDW value increasing the risk by 1.1%.[13] In another study assessing 150 patients and the role of preoperative RDW in predicting in-hospital mortality in patients undergoing OPCABG, the authors elucidated that a high preoperative RDW value could be used for this purpose. Moreover, among the many factors evaluated, a preoperative RDW value above 14% was the only independent prognostic factor for mortality.[14] Other researchers have also reported that RDW values during admission may be useful for predicting long-term morbidity and mortality, especially in non-anemic patients undergoing off-pump cardiac surgery.[15] In our study, unlike previous research, no statistically significant correlation was found

between the preoperative RDW values and extubation time, length of ICU stay, or length of hospital stay. Of the patients with complications, only two had RDW values above 14%. In our study, only early complications were assessed, and the correlation between major cardiovascular complications and RDW in the long term (after 30 days) was not evaluated. In a study in which 500 patients were evaluated in terms of late complications after on-pump surgery, a significant correlation was found with high RDW values.[16] In another study involving 93 patients who underwent off-pump surgery, the relationship between preoperative RDW and the development of postoperative AF was explored, and the results revealed no statistically significant difference or independent factor.[17] The limitations of our study include the single-center and retrospective design, small sample size, and evaluation of early complications only.

In conclusion, many studies have examined the correlation between RDW and NLR levels with postoperative complications, albeit with different results. Our study findings show that preoperative NLR and RDW levels did not exhibit definite predictive value for early postoperative complications. We think that further studies with many patients are warranted to determine the role of NLR and RDW, which are routinely obtained via a simple and inexpensive complete blood count examination in the preoperative evaluation of high-risk patients for OPCABG in clinical practice.

Disclosures

Ethics Committee Approval: The study was approved by The Eskisehir Osmangazi University Non-Interventional Clinical Research Ethics Committee (Date: 14/01/2020, No: 13).

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

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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Authorship Contributions: Concept – D.Ç., F.Y.; Design – D.Ç., F.Y.; Data collection &/or processing – D.Ç., F.Y.; Analysis and/or interpretation – T.Ö., F.Y.; Literature search – T.Ö., F.Y., D.Ç.; Writing – D.Ç., F.Y.; Critical review – T.Ö., F.Y., D.Ç.

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RESEARCH ARTICLE

Effect of Cold Application on Pain After Chest Tube Removal in Patients Undergoing Bypass Surgery

Ezgi Karalar,[1] Hatice Erdoğan[2]

[1]Department of Cardiovascular Service, Acıbadem Altunizade Hospital, İstanbul, Türkiye
[2]Department of Nursing, Maltepe University, İstanbul, Türkiye

ABSTRACT

Objectives: This study investigated the effect of cold application on pain after chest tube removal in patients undergoing bypass surgery.

Methods: Data of 56 patients who underwent bypass surgery between August 2021 and November 2021 (46 males, 10 females; mean age: 62.8±9.2 years) were analyzed. The patients were divided into two groups: the intervention group (n=28) with cold application and the control group (n=28) without cold application. Demographic characteristics, pain, and vital signs of the patients were compared.

Results: The groups mostly felt pain in the tube site 20 min before cold application, during the procedure, and 20 min after the procedure, and a significant difference in pain quality was observed between the groups ($p<0.05$). No significant differences in pain severity and skin and body temperatures were observed between the two groups 20 min before the procedure. Pain intensity and skin and body temperatures of the intervention group decreased during and 20 min after the procedure. No significant differences in systolic blood pressure, diastolic blood pressure, heart rate, and respiration were observed between the two groups ($p>0.05$). In the control group, systolic and diastolic blood pressures and pulse rate increased during the procedure. The SpO_2 level of the intervention group was higher.

Conclusion: Cold application was effective in managing pain after chest tube removal in patients undergoing bypass surgery.

Keywords: Chest tube, cold application, coronary artery bypass, pain

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Introduction

Coronary artery disease (CAD) has an increasing prevalence among countries. It is one of the most common diseases in Türkiye.[1] Coronary artery bypass graft (CABG) procedures with percutaneous coronary intervention are used in the surgical treatment of CAD. This procedure is among the most commonly performed cardiac surgeries. CABG treats blocked or narrowed vessels using grafting.[2] At the end of cardiac surgery, chest tubes (drain) are placed into the chest of the patient. One is placed in the thorax, and another in the mediastinal cavity. The inserted mediastinal and thoracic drains are used to drain air and blood accumulated in the pleural or mediastinal cavity or fluid accumulated in the pleural cavity, pericardial space, or lungs.[3,4] The inserted drains ensure hemodynamic stability in the postoperative period and prevent complications, such as pleural effusion, chylothorax, hemothorax, and empyema.[2–4]

Anxiety, discomfort, and pain are observed in patients with chest tubes placed after the surgical procedure.[5] It has been observed that postoperative pain in patients undergoing bypass surgery decreases after minimizing sensitivity to pain by stimulating pain receptors using cold application.[6]

Therefore, this study investigated the effects of cold application on pain after chest tube removal in patients undergoing bypass surgery.

Methods

This clinical study included 56 patients who underwent coronary artery bypass surgery at the Cardiovascular Surgery Clinic of Acıbadem Altunizade Hospital between August 2021 and November 2021. In the power analysis, 56 individuals (n=28 in the intervention group and n=28 in the control group) were required to obtain 80% power

Address for correspondence: Hatice Erdoğan, MD. Maltepe Üniversitesi, Hemşirelik Bölümü, İstanbul, Türkiye
Phone: +90 216 626 10 50 **E-mail:** haticeerdogan@maltepe.edu.tr

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at a 0.05 level of significance. Randomization of patient allocation to the groups was performed by drawing lots. The inclusion criteria were as follows: patients who underwent coronary artery bypass graft surgery, those aged between 18 and 80 years, those who could communicate, those who agreed to participate in the study, and those who had no allergy or sensitivity to cold.

The "Patient Information Form," which included the personal information of the patients, the "Short-Form McGill Pain Questionnaire," which assessed the intensity and quality of pain, the Vital Signs Flow Sheet, and the Skin Temperature Evaluation Form were used.

The form developed by the researchers contained information about cold application, its duration and implementation, and patients' consent for the application.

The form, developed by the researcher, comprises nine questions about the patient's demographic characteristics, the name of the surgical procedure, the duration of tube insertion, smoking, alcohol use, and allergy status.

The form provides information on the skin temperature of the chest tube site measured before cold application, during the procedure, and 20 min after tube removal.

A ThermoFlash LX-26 thermometer, which measures skin temperature remotely, was used to assess the temperature of the chest tube entry site. Its suitability was approved by the American Society for Testing and Materials. Skin temperature measurements were performed at the hospital where our study was conducted.

The Short-Form McGill Pain Questionnaire was developed by Melzack in 1987.[7] The validity and reliability of the Turkish version of the questionnaire were assessed by Yakut in 2007.[8] This form provides information on the intensity, effect, and quality of pain. It comprises three parts. The first part measures the quality of pain, the second part measures pain intensity, and the third part measures pain experience.

Data were collected after obtaining the necessary institutional permission and ethics committee approval. Patients who arrived at the center where the study was conducted and met the study criteria were informed about the purpose, process, scope, and duration of the study. Subsequently, written consent was obtained from all 56 patients who voluntarily agreed to participate in the research.

In this study, 27×35 cm ice gel packs were used. Considering the possibility of ice burn or cold allergy, ice covers were used during application. Furthermore, these gel packs were used for patients in the hospital where this study was conducted.

Routine analgesic techniques were used in the study population. In the cardiovascular surgery clinic where this study was conducted, on postoperative days 0 and 1, paracetamol (Flakon) was administered every 6 h as a routine treatment protocol. On postoperative days 2, 3, 4, and 5, paracetamol (500 mg tablet) was administered every 6 h. Analgesics were not administered to all patients as a routine treatment protocol before the procedure. Discharge of the patients was planned to be on the morning of the 5th postoperative day. Patients in the control group received these routine treatments, and those in the intervention group received cold application twice–20 min before and 20 min after the procedure–in addition to the aforementioned routine treatments. A different gel pack was used for each application.

Before chest tube removal on postoperative day 1, the Patient Information Form, the Vital Signs Flow Sheet, the Skin Temperature Evaluation Form, and the Short-Form McGill Pain Questionnaire were administered to the patients in the intervention group, and the data were recorded. Subsequently, a 20-min cold application was applied to an area of approximately 5–15 cm in diameter, with the chest tube entry site in the center. The literature has reported that if the skin temperature drops to 13.6°C or if the procedure lasts for 20 min, cold application can have an analgesic effect and be effective in relieving pain.[9] The cold application was applied during and 20 min after chest tube removal. the same forms and questionnaire were applied, and the data were recorded.

On postoperative day 1, patients in the control group were evaluated using the Patient Information Form, the Vital Signs Flow Sheet, the Skin Temperature Evaluation Form, and the Short-Form McGill Pain Questionnaire, and the data were recorded. The same forms and questionnaire were applied to patients in the intervention group during and 20 min after chest tube removal, and the data were recorded.

Statistical Package for the Social Sciences (version 25; IBM Corp., Armonk, NY, USA) was used in this study. Because the sample size was <30, nonparametric t-tests were applied. Analyses were performed with 95% confidence intervals (95% CIs). Frequency analysis was used in the distribution. The chi-square test was used to analyze the distributions in the intervention and control groups, the Mann–Whitney U test was performed for comparisons of the groups, and the Friedman test was used to determine significant differences between the median values of the dependent groups. P-values <0.05 were used to denote statistical significance.

Results

When the descriptive characteristics of the patients were compared, no statistically significant differences were observed between the groups (p>0.05) (Table 1).

Table 1. Distribution of the patients according to descriptive characteristics

	Groups n=56				x^2	p
	Intervention group (n=28)		Control group (n=28)			
	n	%	n	%		
Age						
≤60	13	46.4	9	32.1	1.20	0.278
>60	15	53.6	19	67.9		
Gender						
Female	3	10.7	7	25.0	1.95	0.163
Male	25	89.3	21	75.0		
Educational level						
Primary school	5	17.9	8	28.6	1.33	0.722
Secondary school	4	14.3	3	10.7		
High school	7	25.0	8	28.6		
University	12	42.9	9	32.1		
Smoking						
Yes	15	53.6	16	57.1	0.72	0.788
No	13	46.4	12	42.9		
Alcohol use						
Yes	12	42.9	7	25.0	1.99	0.158
No	16	57.1	21	75.0		
Allergy						
No	24	85.7	21	75.0	11.20	0.262
Food	1	3.6	7	14.3		
Pollen	2	7.1	0	0.0		
Drug	0	0.0	1	3.6		
Other	1	3.6	1	3.6		
	Mean±SD		Mean±SD		x^2	p
Mean age	61.64±9.39		64.14±9.16		−0.1.34	0.179
BMI (kg/m^2)	28.34±4.09		27.78±4.09		−0.18	0.851
CTD (hours)	26.63±2.28		26.80±2.29		−0.27	0.791

X^2: Chi-square test; SD: Standard deviation; BMI: Body mass index; CTD: Chest tube duration

In the intervention group, 57.1% of the patients had pain in the tube site 20 min before the procedure, 85.7% had pain in the tube site during the procedure, and 82.1% had pain in the tube site 20 min after the procedure. In the control group, 60.7% of the patients had pain in the tube site 20 min before the procedure, 85.7% had pain in the tube site during the procedure, and 71.4% had pain in the tube site 20 min after the procedure (Table 2).

In the intervention group, pain intensity 20 min before cold application was higher than that during and 20 min after the procedure. In the control group, pain intensity during cold application was higher than that 20 min before and after the procedure (Table 3).

A significant difference in the skin temperature scores of the patients during and 20 min after the procedure was observed between the two groups ($p<0.05$). The mean scores of the control group were higher than those of the intervention group (Table 4).

Significant differences in the skin temperature scores obtained by the patients during and 20 min after the procedure were observed between the two groups ($p<0.05$). The control group had higher scores than the intervention group (Table 4).

Moreover, a significant difference in the body temperature values during the procedure ($z=-6.03$; $p<0.01$) and 20 min after the procedure ($z=-4.81$; $p<0.01$) was observed between the two groups, and the control group had higher scores than the intervention group. According to the results of the Mann–Whitney U test, no significant differences in systolic blood pressure, diastolic blood pressure, heart rate,

Table 2. Distribution of patients according to the location of pain before, during, and after the procedure

	Groups n=56				Total	
	Intervention group (n=28)		Control group (n=28)			
	n	%	n	%	n	%
Pain location (20 min befor the procedure)						
Chest	4	14.3	6	21.4	10	17.9
Chest and back	1	3.6	2	7.1	3	5.4
Shoulder and chest	0	0.0	1	3.6	1	1.8
Back	3	10.7	0	0.0	3	5.4
Tube site	16	57.1	17	60.7	33	58.9
Tube site and arm	1	3.6	0	0.0	1	1.8
Tube site and chest	0	0.0	0	0.0	0	0.0
Tube site and shoulder	0	0.0	1	3.6	1	1.8
Tube site and back	3	10.7	1	3.6	4	7.1
Pain location (During the procedure)						
Chest	2	7.1	4	14.3	6	10.7
Chest and back	0	0.0	0	0.0	0	0.0
Shoulder and chest	0	0.0	0	0.0	0	0.0
Back	0	0.0	0	0.0	0	0.0
Tube site	24	85.7	24	85.7	48	85.7
Tube site and arm	0	0.0	0	0.0	0	0.0
Tube site and chest	0	0.0	0	0.0	0	0.0
Tube site and Shoulder	0	0.0	0	0.0	0	0.0
Tube site and back	2	7.1	0	0.0	2	3.6
Pain location (20 minutes after the procedure)						
Chest	3	10.7	1	3.6	4	7.1
Chest and back	0	0.0	0	0.0	0	0.0
Shoulder and chest	0	0.0	0	0.0	0	0.0
Back	0	0.0	0	0.0	0	0.0
Tube site	23	82.1	20	71.4	43	76.8
Tube site and arm	0	0.0	0	0.0	0	0.0
Tube site and chest	0	0.0	6	21.4	6	10.7
Tube site and shoulder	0	0.0	1	3.6	1	1.8
Tube site and back	3	7.2	0	0.0	1	1.8

and respiratory rate were observed between the two groups ($p>0.05$). According to the results of the Friedman test, in the intervention group, the pulse rate during the procedure was higher than that 20 min before the procedure, whereas, in the control group, systolic and diastolic blood pressures and heart rate increased during the procedure. SpO_2 levels were higher in patients who received cold application.

Discussion

CAD is one of the most common diseases in Türkiye.[10] In coronary artery bypass surgery, a midsternotomy is performed. Because of the opening of the sternum during the operation, soft tissues and nerves in the chest wall are damaged, and postoperative discomfort occurs. Surgical intervention and invasive methods cause respiratory complications and pain in the incision area.[11] Pain due to leg incision and retraction of the sternum during surgery and brachial plexus neuropathy may also occur due to saphenous vein grafting.[1]

Nowadays, nonpharmacological methods are also used to control pain in addition to pharmacological methods.[12] Anxiety, discomfort, and pain are observed in patients with chest tube insertion after surgery. Pain receptors are stimulated by stimuli that are too cold or too hot. The number of cold receptors in the body is higher than that of hot receptors.[13] Cold application is a common nursing

Table 3. Distribution of patients according to pain intensity before, during, and after the procedure

	Groups n=56				z	p
	Intervention group (n=28)		Control group (n=28)			
	Mean	SD	Mean	SD		
Pain intensity						
20 minutes before the procedure	2.32	0.61	2.43	0.57	−0.64	0.523
During the procedure	1.53	0.51	3.00	0.00	−6.99	0.000*
20 minutes after the procedure	1.04	0.19	2.43	0.63	−6.41	0.000*
X^2	50.31		13.27			
p	0.000**		0.001**			

*: p<0.05; **: p<0.01.

Table 4. Distribution of patients according to skin temperature before, during, and after the procedure

	Groups n=56				z	p
	Intervention group (n=28)		Control group (n=28)			
	Mean	SD	Mean	SD		
Skin temperature (°C)						
20 min before the procedure	36.65	0.23	36.70	0.32	−0.14	0.888
During the procedure	35.88	0.20	36.81	0.28	−6.46	0.000*
20 min after the procedure	35.72	0.25	36.88	0.32	−6.44	0.000*
X^2	50.31		13.27			
p	0.000**		0.001**			

*: p<0.05; **: p<0.01. z: Mann–Whitney U test, X^2: Friedman test.

intervention. It reduces blood flow in the applied area, slows down the metabolism of the tissues affected, and has a painkiller effect. Therefore, cold application can be applied locally or generally.[14] It is the most frequently encountered nursing intervention in nursing care plans.

Cold application, which is a nonpharmacological method for managing pain, has an important place among nursing practices. One of the most common symptoms after CABG is pain, in addition to pulmonary complications.[15] Poor management of postoperative pain increases the risk of complications in patients, resulting in a reduction in patient comfort.[16] In a systematic review and meta-analysis, Chen et al.[17] (2021) stated that cold application is a safe and easy-to-administer nonpharmacological method for reducing pain, with immediate and lasting effects .

No statistically significant differences in the sociodemographic characteristics were found between the two groups (p>0.05). It can be stated that these variables might have affected the postoperative pain experience of the patients in the intervention and control groups, and the similarities between the variables were important for the homogeneity of the groups.

In our study, it was determined that the patients had the most pain in the tube insertion site. Yılmaz (2017) found that both groups experienced pain in the tube site the most before, during, and after chest tube removal.[16] Ögüt (2018) reported that 94.29% of patients felt pain in the sternum incision area.[18] After chest tube insertion and during the time it remains placed, the endothelium extending into the chest cavity adheres to the tube. Therefore, the rupture of these adhesions with the force applied when pulling the tube causes acute pain.[19] Therefore, we believe that it was normal for patients to feel pain in the tube site.

In our study, in the intervention group, pain intensity 20 min before the procedure was higher than that during and 20 min after the procedure. In the control group, pain intensity during the procedure was higher than that 20 min before and after the procedure.

A study on patients undergoing cardiac surgery found that 20 min of cold application during the removal of the chest tube reduced pain intensity. In the same study, no significant difference in pain intensity was found 15 min after chest tube removal.[9] In another study on the effect of cold application on chest tube removal pain in 140 patients, it was found that patients in the experimental group experienced less pain than those in the control group.[19] Similarly, pain intensity in patients who received cold application before chest tube removal was measured using the visual analog scale and numerical rating scale at different time points, ranging from 5 to 15 min, and it was found that cold application was an effective pain control and relief strategy.[20]

In the literature, several studies have focused on the effect of cold application on pain.[21–23] In addition to thoracic surgery, some studies on cardiovascular surgery have been conducted. In these studies, cold application was performed for 15 or 20 min before tube withdrawal.

Furthermore, in the literature, pain assessment was performed before or during, immediately after, or 5 min after the tube withdrawal procedure. In contrast, in our study, in patients undergoing CABG, cold application was performed 20 min before and after chest tube withdrawal, and the severity of pain was evaluated. We found that cold application 20 min before the chest tube removal procedure reduces the severity of pain; this result supports the literature. Moreover, it can be said that continuing cold application after the thoracic tube removal procedure further reduces the severity of pain.

In our study, no significant difference in the skin temperature 20 min before the procedure was observed between the two groups. However, it decreased during and 20 min after the procedure in the intervention group and increased in the control group. An analgesic effect can be observed if the skin temperature drops to 13°C or if the cold application lasts for 20 min.[13,14] In a literature review, it was observed that a 20-min cold application was performed with ice gel packs before tube removal, and the intensity and location of pain and skin temperature were evaluated before and during the procedure.[6,24,25] In our study, it is believed that the skin temperature decreased due to the cold application applied to the intervention group 20 min before and after the procedure.

In our study, a significant difference in the body temperature values during and 20 min after the procedure was observed between the two groups, and when the averages were compared, the control group had higher body temperature values than the intervention group. No significant differences in systolic blood pressure, diastolic blood pressure, pulse rate, and respiratory rate were observed between the two groups ($p>0.05$). In the control group, systolic and diastolic blood pressures and pulse rate increased during the procedure. SpO_2 levels were higher in patients who received cold application.

In the literature, it has been reported that there is a difference in the indicators related to fever, pulse rate, systolic blood pressure, diastolic blood pressure, SpO_2, and respiratory rate before, during, and after the procedure in patients who received cold application.[26,27]

In line with these results, no difference in body temperature before the procedure was observed between the two groups, and the body temperature of the control group was higher than that of the intervention group during and 20 min after the procedure. We think that this difference is a result of the cold application 20 min before and after the procedure. Cold application, which is a nonpharmacological method, to patients to bring the body temperature to normal levels when they are elevated is among the most common nursing interventions.

Conclusion

A 20-min cold application before chest tube removal reduces pain intensity in patients undergoing bypass surgery. This result supports the literature. Furthermore, it was established that cold application during and after chest tube removal reduced pain severity.

Disclosures

Ethics Committee Approval: The study was approved by The Acıbadem Mehmet Ali Aydınlar Medical Research Ethics Committee (Date: 24/03/2021, No: 2021-06/07).

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

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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RESEARCH ARTICLE

Totally Implantable Venous Access Devices: Study of 1,613 Patients and Complication Management

Nadide Örs Yıldırım

Department of Anesthesiology and Reanimation, Sincan Training and Research Hospital, Ankara, Türkiye

ABSTRACT

Objectives: Totally implantable venous access devices (TIVADs) are crucial for treating patients with malignancy. However, reaching the intravenous route is rendered difficult owing to the consequences of chemotherapy. This retrospective study aimed to investigate the early and late complications associated with percutaneous insertion and TIVAD use.

Methods: A total of 1,647 TIVAD procedures in 1,613 patients between 2010 and 2023 were retrospectively analyzed. All TIVADs were placed in the cardiovascular surgeon operating room under sedation. A C-arm fluoroscopy machine and ultrasound were used during the procedure.

Results: A total of 1,613 patients were included in the study, of which 1,085 were males and 528 were females. The mean age of these patients was 49.8±19.2 (16–86) years. At the right side, 1,403 devices were implanted (791 right subclavian vein and 612 right internal jugular vein), while 210 were implanted at the left side (128 left subclavian vein and 82 left internal jugular vein). During the study period, 285 early and 142 late complications were detected. TIVAD insertions were performed successfully, with no recorded deaths.

Conclusion: This study revealed that TIVADs are relatively safe procedures. Majority of the early complications are related to the implantation technique, whereas late complications are associated with catheter fatigue or the use of inlabrate. These complications can be prevented by adhering to rules of the procedure and employing the appropriate technique. Although C-arm fluoroscopy is crucial for these procedures, a risk of accumulated radiation exposure exists but can be reduced with utmost care.

Keywords: Complication, fluoroscopy, internal jugular vein, subclavian vein, totally implantable venous access devices

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Introduction

Since the introduction of totally implantable venous access device (TIVAD) in 1982, significant progress has been made in its application.[1] Over the years, TIVADs have gained prominence in oncology care, significantly enhancing the quality of life and treatment of patients with cancer. These devices eliminate the need for repetitive venipuncture procedures when administering chemotherapy, parenteral nutrition, antibiotics, fluids, and blood sampling, rendering them particularly valuable for prolonged intravenous (IV) access requirements.[2]

TIVADs comprise of catheters with the distal end positioned at the atriocaval junction and the proximal end connected to a port chamber, usually located in the subcutaneous tissue of the anterior thoracic wall.[3] The choice of entry sites for TIVADs mainly includes the internal jugular and subclavian veins. In certain cases, alternatives such as the cephalic vein, axillary vein in the deltopectoral groove, or lower extremity veins may be considered when the upper venous routes are not feasible.[2]

Although the internal jugular vein can be readily cannulated with the aid of ultrasonography (USG), occasionally, it may not be the preferred option. Despite several disadvantages associated with subclavian vein catheterization, its location in a cosmetically and easily accessible area makes it a viable option. However, in patients with cancer, these sites carry a relatively higher risk of complications, including thrombosis, catheter

Address for correspondence: Nadide Örs Yıldırım, MD. Sincan Eğitim Araştırma Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Ankara, Türkiye

Phone: +90 536 265 01 71 **E-mail:** orsnadide@gmail.com

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fatigue, vein stenosis, and pneumothorax during insertion, leading to a range of early and late complications.[4]

Early complications include introductory sheath kinking, difficult vessel access, arterial puncture, pneumothorax, and cardiac arrhythmia. Late complications include bloodstream infections, catheter malposition, thrombotic occlusion, superior vena cava syndrome (SVCS), "pinch-off" syndrome, extravasation, and pocket and catheter infections.[5] Therefore, understanding and addressing these complications are pivotal in optimizing the use of TIVADs in patient care.

This study aimed to retrospectively analyze 1,613 TIVADs implanted at a single medical center. Both early and late complications associated with device placement are evaluated, providing insights into the challenges posed by TIVAD use and offering recommendations for their prevention and management.

Methods

This study was conducted in accordance with the Declaration of Helsinki guidelines. Local ethics committee approval was obtained from the University of Health Sciences, Scientific Research Ethics Committee (no: 2023/327). This study retrospectively analyzed 1,613 TIVAD procedures performed on 1,647 patients between 2010 and 2023 at a single medical center. These patients were undergoing chemotherapy for the treatment of solid tumors, a clinical indication that enhances the quality of life of these patients.

An experienced anesthesiology team performed all procedures. Two different TIVAD models were utilized: the 9.6-F TIVAD (BardPort Titanium Implantable Port, USA) and the 8.0-F open-ended silicone single-lumen TIVAD (Polysite® 4,008 ISP, adult standard portsilicone catheter, France). The patients received detailed information regarding the procedure prior to TIVAD implantation, and written consent was obtained from the patients.

Preoperative assessments included a thorough medical history and physical examination, underscoring the potential anatomical issues such as chest wall tumors, fractures, cervical or mediastinal adenopathy, rotational flaps, SVCS, and body structure. This evaluation aided in preventing complications and facilitated vascular access. Before surgery, chest radiographs were obtained to assess anatomical structures, and complete blood counts and coagulation tests were performed.

The exclusion criteria included bilateral upper extremity vein stenosis due to prior catheterization or disease, signs of skin infection at the implantation site, fever of unknown origin, and any systemic infection or sepsis. Patients with platelet counts lower than 50,000/mm^3 received platelet transfusion prior to TIVAD placement. Furthermore, patients with International Normalised Ratio (INR) levels exceeding 1.5 received vitamin K or fresh frozen plasma before TIVAD placement.

In the operating room, TIVADs were inserted under strict aseptic conditions with procedural sedation supported by tumescent local anesthesia. Continuous monitoring were performed using electrocardiogram, noninvasive arterial blood pressure, and pulse oximetry. All patients received premedication with IV 0.03 mg/kg midazolam. Procedural sedation was maintained with 0.05–0.15 mcg/kg/min remifentanil infusion. Patients were administered 2 L/min oxygen via a facemask during the procedure, and their sedation level was evaluated using the Ramsay Sedation Scale (RSS), targeting an RSS of 3–4.

Initially, the right subclavian vein entry was the preferred approach until 2017. However, owing to several introductory sheath-kinking incidents, the right lower internal jugular vein was used for cannulation, in line with the widespread adoption of USG and echocardiography guidance, as recommended by the guidelines. In challenging cases with difficult venous access, the left internal jugular or left subclavian vein was used as the primary vein. The subclavian vein was also selected in instances where the jugular vein access was not feasible.

The neck and upper chest vessels were evaluated using USG to confirm patency before patient preparation and draping. Patients were positioned supine with Trendelenburg positioning, and their necks were turned to the opposite side of the procedure. The neck and upper chest were sterilized three times with 10% povidone iodine, and sterile towels were draped over the patient. The operator wore a mask, cap, and lead apron.

Before starting the procedure, all necessary tools were prepared on the process table. Sterility was maintained for the micropuncture sheath, needle, and peel-away sheath, and these were flushed with sterile saline. The wires required for the procedure were placed in an easily accessible location. A sterile drape was applied over the ultrasound probe.

The vein access site was marked using USG guidance, and for subclavian vein attempts, the Seldinger technique was employed without USG. The infraclavicular approach was used when USG was preferred. For internal jugular vein access, the ultrasound transducer was placed just above the collarbone, allowing entry to the vein and lateral puncture to keep the access point low.

Once the needle entered the vein, its position was confirmed by the inflow of blood and USG. A guidewire was then inserted through the needle, and its path is verified using C-arm fluoroscopy. A skin incision was made where the guidewire entered the skin, followed by blunt tissues dissection to create space for the catheter and reduce the risk of catheter bending. Next, a suitable location for the port pocket was determined in the infraclavicular space between the nipple and midline of the clavicle. Tumescent anesthesia

(1% lidocaine with epinephrine 1:100,000, sodium bicarbonate) was administered to this area. A transverse incision was made, and a subcutaneous pocket was created via blunt dissection, with concurrent hemostasis.

A tunnel was prepared, and the catheter was advanced through the tunnel formed between the pocket and guidewire. The intraducer sheath was introduced into the vein over the guidewire. After guidewire removal, the catheter was advanced through the sheath to the atriocaval junction, and its position was confirmed via C-arm fluoroscopy.

To avoid serious complications, proper catheter tip positioning is crucial, including thrombosis and pleural effusion. The catheter tip should ideally be located between the tracheal bifurcation area and the cavoatrial junction, with a distance of approximately 3.5–5 cm between them. Hence, positioning the catheter tip 2–3 cm from the tracheal bifurcation toward the side of the heart was deemed appropriate.

Using an injector, venous return was confirmed through aspirating blood. Following a final assessment, the catheter was connected to the port chamber, which was then implanted and secured to the lower part of the pocket using two anchoring sutures to prevent postoperative displacement. To confirm its functionality, blood aspiration from the port chamber was performed. The catheter lumen was flushed initially with approximately 60 mL of physiological saline, followed by a low-dose solution of 100 U/mL unfractionated heparin.

After completion of the implantation, the subcutaneous and skin incisions were sutured, and sterile gauze was applied for dressing the TIVAD incisions. Patients were transferred to the intensive care unit for recovery, and a chest X-ray was conducted prior to clinic discharge to rule out procedure-related complications.

Visualization of the TIVAD implantation procedure from our clinic is provided in the Appendix section as a video link. It encompassed the entire detailed process of TIVAD placement.

Patient follow-up was conducted throughout their treatment and until catheter removal. Complications and patient demographics were recorded both before and after the procedure, and the data were retrospectively reviewed. These complications were categorized as early (perioperative and up to the first use) and late (occurring after the first catheter use).

Results

During the study period, 1,647 TIVADs were implanted. Among them, 26 patients required TIVAD removal due to various complications and underwent reinsertion for treatment continuation. Data from eight patients were deemed insufficient, resulting in study exclusion. Thus, the study was ultimately completed with 1,613 patients. The mean age of the patients was 49.8±19.2 years (range, 16–86). Of the patients, 1,085 were males and 528 were females. The majority of TIVADs (1,403) were implanted on the right side, whereas 210 were implanted on the left side. Patient demographics and the TIVAD insertion side are summarized in (Table 1). Importantly, no deaths occurred because of TIVAD insertion during the study period.

Table 1. Demographic characteristics

Demographic characteristics	n	%
Sex		
Male	1.085	67
Female	528	33
Median age (years)	49.8±19.2	
Age range (years)	16–86	
Right subclavian vein	791	49
Right jugular vein	612	38
Left subclavian vein	128	8
Left jugular vein	82	5

The most common early complication noted was procedure-related technical difficulties (4.6%). In cases where preferred vascular access was unattainable, the contralateral site was selected for vascular access. Introductory sheath kinking (4.2%) was another frequently encountered early complication, whereas arterial puncture, although common, did not lead to major complications.

In five patients, pinch-off syndrome was identified as a late complication. The broken catheter segments were immediately extracted from the right ventricle via percutaneous intervention, and the TIVADs were repositioned to the contralateral side to ensure continuous treatment.

While platelet infusions were administered to three (0.2%) patients with platelet counts below 50,000/mm^3, minor bleeding occurred in these cases. However, these nonserious bleeding events were successfully managed through conservative measures. Eight cases (0.5%) demonstrated user-related TIVAD pocket infections. Six of these cases responded well to antibiotic treatment, whereas two cases with bacteremia necessitated the removal of port catheters, coupled with surgical intervention alongside antibiotic therapy. Nine patients experienced pocket hematomas that spontaneously resolved without the need for treatment. Skin necrosis occurred in six patients, leading to port catheter removal followed by surgical correction.

Pneumothorax, a significant early complication, was detected in eight patients (0.5%) via chest X-ray. Among these patients, six were managed with 24 h of oxygen

Table 2. Key points for radiation safety

Minimize fluoroscopy time.
Minimize the number of images taken.
Use a C-arm fluoroscopic machine with a laser-aiming line.
Do not take images with an image intensifier (or flat panel detector) underneath.
Use available patient dose reduction technologies (e.g., pulsed mode or low-dose mode).
Use collimation.
Use all available information (e.g., MRI, CT) to plan the interventional procedure.
Position yourself in a low-scatter area.
Use shielding devices.
For a lead apron, wear a wraparound type rather than a front type.
Once a year, lead aprons and thyroid protectors should be assessed for damage.
Wear your dosimeter and know your dose.
Use eye shields to protect the lens.
Obtain appropriate training.
Keep the lead apron and thyroid protector on a hanger, ensuring that they do not get wrinkled.

MRI: Magnetic resonance imaging; CT: Computed tomography.

support without any further procedures. Two patients required closed tube thoracostomy and were treated in the intensive care unit for 48 h before discharge without complications.

SVCS, a severe complication requiring immediate attention, was noted in 12 patients. The port catheters were cautiously removed, and treatment with low-molecular-weight heparin (LMWH) was initiated, resulting in the absence of serious complications in these patients.

In 12 patients, imaging revealed incorrect catheter positioning toward the internal jugular vein. This was promptly corrected under C-arm fluoroscopy guidance (Table 2).

Thrombotic occlusion, the most common late complication, was documented in 97 patients. Of these, 93 were effectively treated with thrombolytic agents, whereas the TIVADs of the remaining four patients were removed.

Notably, no radiation-related complications were observed throughout the study. Table 3 provides a summary of the early and late complications identified in this research.

Table 3. List of port catheter complications

A. Early complications	n	%
a. Introductory sheath kinking	68	4.2
b. Difficult vessel access	75	4.6
1. Access site change	61	4.8
2. Venography	14	0.9
c. Arterial puncture	29	1.8
d. Pocket hematoma	9	0.6
e. Pneumothorax	8	0.5
f. Cardiac arrhythmia	16	1
g. Guidewire bending	5	0.3
h. Post-procedural bleeding	3	0.2
B. Late complications		
1. Catheter malposition	12	0.7
2. Overlying skin erosion	6	0.4
3. Thrombotic occlusions	97	6
4. Pinch-off syndrome	5	0.3
5. Superior vena cava syndrome	12	0.7
6. Infection	8	0.5
7. Twiddler's syndrome	1	0.06
8. Catheter release	1	0.06

As comprehensively stated in the article, careful manipulation of the tissues at the puncture site will prevent kinking of the catheter tubing after placement.

Discussion

TIVADs have become indispensable tools for treating patients with cancer, remarkably improving their quality of life by eliminating the need for repeated venipuncture during chemotherapy and other medical procedures. However, similar to any medical intervention, TIVAD placement is not devoid of complications. In this discussion, we elucidate the various complications encountered in our study and provide insights into their management and prevention.

One of the most common early complications observed in our study was kinking of the introductory sheath, occurring in approximately 4.6% of cases. While Barbetakis et al.[3] reported a lower incidence (0.9%) in their study, our findings suggest a higher prevalence, particularly among patients with subclavian vein access. This issue can impede TIVAD implantation; however, we highlight the utility of fluoroscopy in resolving this complication. In this case, the sheath is slowly withdrawn under fluoroscopy and the catheter is easily passed through the sheath when the fracture disappears.

Extreme caution must be exercised to ensure that the sheath does not exit the vein during this process.

Accidental arterial puncture occurred in 1.8% of our patients, a relatively lower rate than the 6–8% reported in central vein catheterization.[6] Fortunately, these punctures did not result in complications. Pneumothorax, a serious complication, was documented in 0.5% of cases in our series, corroborating with existing data, with a rate of 0.5%–6%. Management of pneumothorax varies according to severity, ranging from observation to tube thoracostomy. Follow-up chest X-rays are crucial in suspected cases even if not initially detected during discharge. Six of our patients were on oxygen support during a 24-h follow-up. Although pneumothorax was not initially detected on the X-ray at the time of discharge, conducting follow-up X-ray examinations in patients with suspected pneumothoraxis is important. In this study, pneumothorax was radiologically observed 10 h after the procedure in one of the two patients who had a strong suspicion of pneumothorax. A precise needle tip placement at the suprasternal notch and angle optimization, along with USG guidance, can help minimize this risk. Aiming the needle tip at the suprasternal notch and ensuring vessel access at an angle of <10° is recommended.

Serious cardiac arrhythmias due to mechanical stimulation of the heart wall during catheterization were noted in 1% of the study group. This complication can be avoided through meticulous catheter tip positioning using C-arm fluoroscopy.

Pocket hematoma, a common early complication, is more likely to occur in patients receiving anticoagulant or antiplatelet therapy. Poor surgical techniques are also responsible for these complications. Although often treated conservatively, in case of an event, it is essential to avoid using the ports to prevent further complications, such as infection.

In our study, late complications, including TIVAD pocket infections, occurred in 0.5% of cases, consistent with rates reported in the literature (0.67–4.1%).[1,3] A strict aseptic technique during insertion and access, along with the use of 2% chlorhexidine for preparation, as recommended in the recent guidelines, can help minimize contamination.[7]

Although rare, SVCS is a life-threatening complication. Early diagnosis is crucial, and immediate catheter removal and anticoagulant therapy with LMWH are essential for management. Patients who develop SVCS have nonspecific symptoms such as chest pain, dyspnea, unilateral pleural effusion, and hemodynamic collapse. Predisposing factors include large-diameter catheters, left-sided placement, and hypercoagulable states, particularly in patients with cancer.[2,8] The catheters should immediately be removed from patients who develop this syndrome, and anticoagulant therapy such as LMWH should be initiated.

Skin necrosis, secondary to port diaphragm pressure on the overlying skin, can be exacerbated by radiation or chemical exposure.[9] Prevention involves avoiding port placement in areas with minimal subcutaneous tissue and fat and considering smaller-sized ports with reduced tissue pressure. Subfascial port placement is an option for patients with limited subcutaneous fat.

Necrosis, defined as tissue death due to insufficient blood supply, can occur if the port diaphragm exerts excessive pressure on the overlying skin.[10] This can also be caused by radiation or chemicals. Reversal of necrosis is not possible. Overlying skin necrosis is more common in situations where there is loss of subcutaneous fat.[10] Thus, port placement should be avoided in areas with minimal subcutaneous tissue and fat to prevent this complication. If ports must be placed, small-sized ones should be preferred, and less pressure should be applied to the tissue. Adhering to this rule during the tunneling process is necessary. Ports can also be placed in the subfascial region for this group of patients.

"Pinch-off" syndrome, caused by compression between the first rib and clavicle, is another important but often overlooked complication.[11,12] This can be induced by swimming and vigorous arm movements. Compression may cause temporary occlusion, complete embolization, or catheter rupture. Regular chest X-ray imaging should be considered in patients experiencing difficulties with drug administration and blood aspiration from TIVADs. Patients with TIVADs should be examined using chest X-rays at regular intervals. If distortion or catheter bending is noted on imaging, the possibility of "pinch-off" syndrome should be considered. In the literature, there is paucity of information regarding "pinch-off" syndrome. We noted five (0.3%) patients with symptoms suggestive of "pinch-off" syndrome. Silicon catheter parts were completely separated from the port housing. Four patients were treated via percutaneous intervention. Owing to further localization of the silicon catheter, one patient underwent surgical intervention.

Thoracic outlet syndrome should be investigated via chest X-ray performed before the procedure. Providing access to the subclavian vein away from the ligament connecting the clavicle and the first rib is considered as the most important factor to prevent this problem.

Another important late complication is catheter malposition. Short catheters left in the subclavian vein or in the upper third of the superior vena cava are the primary causes of migration.[13,14] It can result from excessive arm or shoulder movement, vomiting, coughing, or congestive heart failure.[13] In our study, we detected five malpositions

in the internal jugular vein, and these were corrected via C-arm fluoroscopy imaging. Patients with catheter malposition may present with symptoms of neck, ear, and shoulder area pain or unusual sensations during drug administration.[13,14] Careful examination of patients with pain or unusual sensations during drug administration is therefore essential. In our study, we encountered a catheter in the right ventricle without signs of "pinch-off" syndrome in chest X-ray imaging, likely secondary to forceful flushing or drug administration.

Thrombotic occlusions, which are a frequent occurrence, can often be managed effectively through thrombolytic drug administration. However, in the existing literature, there is a notable dearth of comprehensive information concerning the resolution of occluded catheters via this method. Our study provides a notable contribution to this gap in knowledge. Of the 97 patients in our sample who presented with intraluminal thrombosis, 85 were successfully treated without requiring catheter replacement. We achieved this by employing a combination of a thrombolytic agent and the innovative three-way tap technique. This approach not only offers a viable solution to the problem but also represents a cost-effective means of preserving catheters, which is particularly valuable in resource-constrained healthcare settings.

Additionally, our investigation shed light on an infrequently discussed complication known as Twiddler syndrome, which is primarily associated with cardiac pacemakers but can also manifest in ports.[15] Twiddler syndrome arises from the device rotation within its fibrous capsule. [15] To prevent this issue, ports are typically secured with sutures. However, in our study, we encountered a case in which the sutures had become dislodged, resulting in port rotation. This observation underscores the importance of meticulously securing ports to prevent rotation, thereby averting the risk of inadvertent subcutaneous drug administration. We emphasize the necessity of confirming proper functionality and blood flow from the port prior to drug administration as a precautionary measure.

Wound dehiscence, occurring in 1%–3% of cases, is typically managed via TIVAD removal. Poor suture technique and delayed wound healing due to chemotherapy are common contributing factors. In our practice, we implemented additional support sutures using nonabsorbable materials, which were subsequently removed after a period of 2 weeks. This simple precautionary measure has been proven effective in preventing premature wound dehiscence in our patients.

Over the past 5 years, our clinical practice has witnessed a shift in our approach to vascular access. In our routine practice since 2017, we have leveraged intraoperative USG and venography guidance to reduce the rate of unsuccessful attempts in our clinic. This adjustment aligns with the findings of Silberzweig et al.,[16] who reported the successful use of venography guidance for vascular catheterization procedures. In cases where subclavian vein cannulation proves challenging, we employ venography to evaluate the vein prior to cannulation. This approach minimizes the risk of unnecessary punctures and enhances patient safety.

It is of paramount importance to note that when performing surgical procedures under C-arm fluoroscopy, measures must be taken to mitigate potential biological hazards posed by radiation exposure. All personnel involved in the procedure should be equipped with appropriate personal protective gear, including aprons, thyroid shields, gloves, glasses, and caps, to ensure their safety.

Conclusion

The surgical TIVAD insertion has considerably improved the quality of life of patients requiring long-term IV treatments, with added cosmetic benefits. Although these procedures are generally secure, early and late complications remain a possibility. The use of imaging modalities can facilitate vascular access and reduce the risk of unnecessary punctures.

Overall, a meticulous surgical technique and a cautious approach can help prevent early complications. Thrombosed port catheters can often be effectively treated with thrombolytic therapy, allowing continued treatment without the need for catheter replacement. During catheterization, continuous patient follow-up and expert care can mitigate the risk of later complications.

Notably, Biffi et al.[17] conducted a study involving 403 patients and demonstrated that early and late complication rates remain unaffected by cannulation techniques and sites. Despite the undeniable utility of port catheters, recognizing that they can pose serious and potentially fatal complications is essential. Therefore, a thorough understanding of these devices and vigilant monitoring throughout their use is imperative to ensure patient safety and treatment efficacy.

Disclosures

Online Appendix File: https://drive.google.com/file/d/10HFH2kym75yBCoAe5GSdJwo6lcxx3Q1h/view?usp=sharing

Ethics Committee Approval: The study was approved by The University of Health Sciences Gülhane Scientific Research Ethics Committee (Date: 26/09/2023, No: 2023/327).

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

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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CASE REPORT

Perioperative Desaturation after Onyx (DMSO) Embolization before Surgery

Abdullah Aydın Özcan,[1] Hüseyin Aybar,[1] Alper Uçak[2]

[1]Department of Anesthesiology and Reanimation, Maltepe University Faculty of Medicine, İstanbul, Türkiye
[2]Department of Cardiovascular Surgery, Maltepe University Faculty of Medicine, İstanbul, Türkiye

ABSTRACT

Onyx consists of an ethylene–vinyl alcohol copolymer dissolved in dimethyl sulfoxide, used in blood vessel embolization. Preoperative embolization of some hypervascular tumors is commonly performed to reduce surgical time and blood loss. However, unwanted effects associated with Onyx can raise perioperative anesthetic concerns. A 19-year-old man, weighing 55 kg with an arteriovenous malformation located in the left popliteal region underwent Onyx embolization 1 day before surgery. Because of observed perioperative desaturation, extubation difficulty, and subsequent respiratory distress, the patient's treatment was continued in the intensive care unit. We present the clinical developments and anesthetic concerns experienced during this study. In patients who have undergone Onyx embolization and exhibit preoperative respiratory distress, tachypnea, and desaturation, postponing surgery, except for emergency indications, may be appropriate. For those undergoing surgery, extubation and subsequent intensive care may be required. Steroids, diuretics, antithrombotic drugs, and antibiotics should be considered in the treatment. Oxygen support with a mask and, if necessary, advanced airway support should be provided.

Keywords: Onyx (DMSO), peroperative desaturation, pulmonary edema

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Introduction

Onyx is a commercially available preparation that consists of an ethylene–vinyl alcohol copolymer dissolved in dimethyl sulfoxide (DMSO). Onyx is used for vascular embolization procedures[1] commonly for treating cerebral or spinal arteriovenous malformations (AVMs), highly vascularized tumors, peripheral AVMs, and arteriovenous fistulas. Preoperative embolization of highly vascular tumors is frequently performed with the aim of reducing surgical duration and minimizing blood loss.[2] However, it is worth noting that certain complications associated with Onyx may raise concerns regarding perioperative anesthesia.

Case Report

A 19-year-old man, weighing 55 kg, presented with a long-standing history of pain, visible vein prominence, and edema in the left leg since childhood. Peripheral angiography indicated the presence of AVMs, which were characterized by three niduses in the midsegment of the left superficial artery, two niduses distal to the popliteal artery, and two niduses at the level of the tibioperoneal trunk. The patient underwent coil and Onyx embolization for congenital AVM in the left lower extremity using two vials of Onyx material. AVM-associated lesions were subsequently excised, with a surgical intervention scheduled for the following day. Unremarkable physical examination findings, normal laboratory values, and a typical Posteroanterior chest X-ray image (PA-CXR) were shown on the preoperative assessment. At the time of evaluation, the patient's vital signs were recorded as follows: blood pressure 120/80 mm Hg, heart rate 110 beats/min, oxygen saturation (SpO_2) 92%, temperature 36.8°C, and respiratory rate 16 beats/min. The patient had no known underlying medical conditions or history of previous surgical procedures.

Address for correspondence: Abdullah Aydın Özcan, MD. Maltepe Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İstanbul, Türkiye

Phone: +90 505 575 34 05 **E-mail:** drabdayd@hotmail.com

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Vascular access was established in the operating theater using a 16G cannula on the right hand dorsal, and an infusion of 0.9% NaCl was initiated. Induction of anesthesia was accomplished with 2.5 mg/kg propofol, 1 µg/kg fentanyl, and 0.6 mg/kg rocuronium, leading to orotracheal intubation. Anesthesia maintenance was established with 2.5% sevoflurane inhalation. After surgery conclusion, the patient was extubated with the aid of sugammadex 150 mg but subsequently experienced bronchospasm and desaturation. Immediate intervention involved intravenous administration of 1 mg/kg methylprednisolone, 45.50 mg pheniramine, and 20 mg furosemide. Despite adequate respiratory effort, peripheral oxygen saturation remained at approximately 93%. The patient was consequently transferred to the postanesthesia intensive care unit with nasal cannula oxygen support for further management.

Postoperative PA-CXR image identified a hyperdense region, with particular prominence in the midsegment. The potential occurrence of pulmonary complications such as pulmonary embolism, pulmonary edema, and acute respiratory distress syndrome (ARDS) arising from the application of Onyx was investigated.

Figures 1–6 show the patient's preoperative and postoperative day 1, 2, 3, 4, and 5 PA-CXR image, respectively.

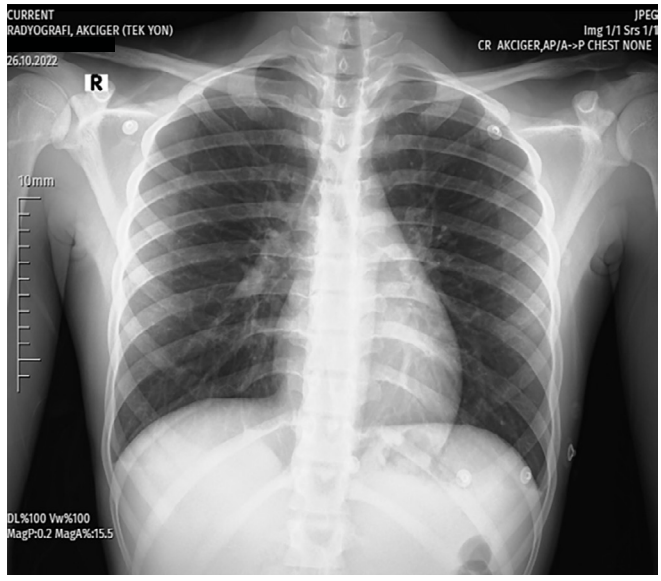

Figure 1. The patient's preoperative history.

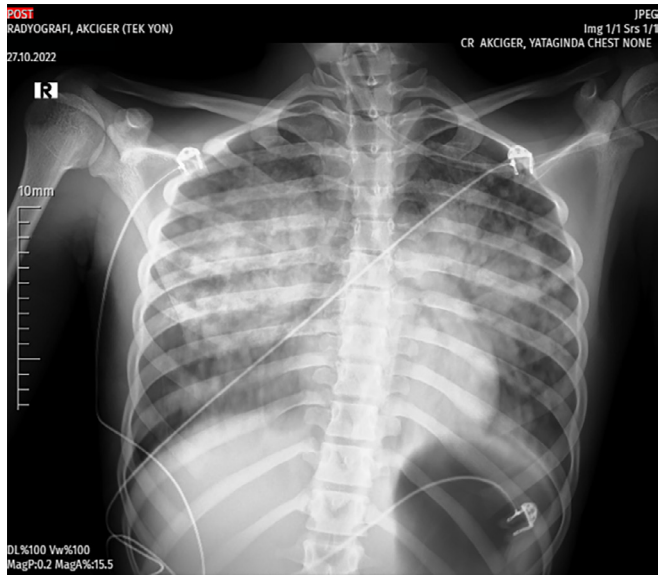

Figure 2. Postoperative day 1 PA-CXR image.
PA-CXR: Posteroanterior chest X-ray image.

Discussion

Onyx is a nonadhesive, liquid embolic material with radiopaque properties that is delivered easily via a microcatheter.[3] However, one notable drawback of Onyx is its solubility in DMSO. Unwanted effects associated with DMSO, including pulmonary edema, bronchospasm, bradycardia, and even cardiac arrest, have been documented.[4]

Asouhidou et al.[5] conducted a retrospective investigation of 69 patients who underwent Onyx embolization for AVMs under general anesthesia with no concurrent cardiac, pulmonary, or significant systemic illnesses. Among these patients, 23 experienced intraoperative desaturation, characterized by a decline in SpO_2 by 1%–8% relative to baseline values. Notably, all episodes of desaturation occurred within 3–7 min after DMSO infusion initiation and exhibited duration of approximately 10 minutes, spontaneously reverting to baseline values without the need for clinical intervention. Furthermore, the authors observed no significant hemodynamic perturbations attributable to DMSO infusion. In a patient with extensive AVM, severe desaturation (SpO_2: 89%, SaO_2: 8.1 kPa) occurred 10 minutes after extubation, necessitating oxygen support for a duration of 20 minutes before the patient met the criteria for discharge from the postanesthesia care unit.

Tolly et al.[6] documented a case involving a healthy 26-year-old man undergoing Onyx embolization for cerebral AVM followed by awake craniotomy for resection. Intraoperative events included tachycardia and profound intraoperative hypoxemia requiring substantial oxygen supplementation. Postoperative chest computed tomography showed hyperattenuating Onyx embolization material within the pulmonary vessels, and electrocardiographic changes supported the possibility of clinically significant embolic events. Thus, anesthesiologists must remain cognizant of the potential for pulmonary migration of Onyx material, which can precipitate substantial perioperative hypoxemia.

In a case detailed by Tawil et al.,[7] a patient who underwent two Onyx embolization procedures for

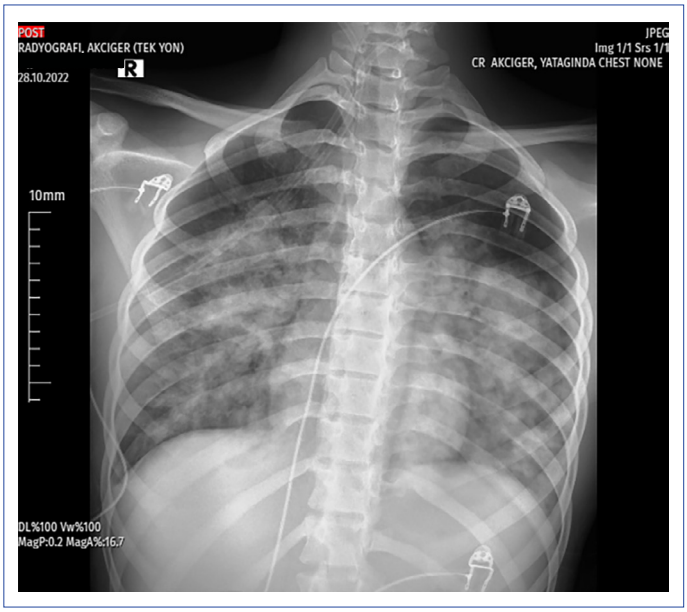

Figure 3. Postoperative day 2 PA-CXR.

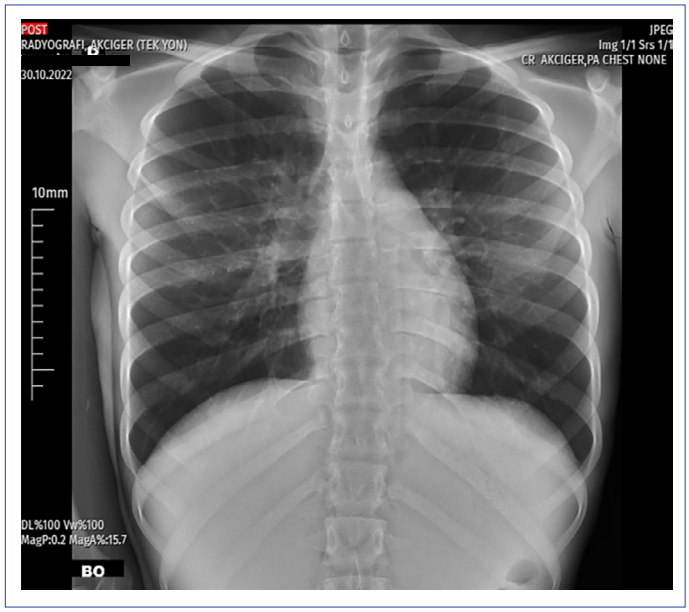

Figure 5. Postoperative day 4 PA-CXR.

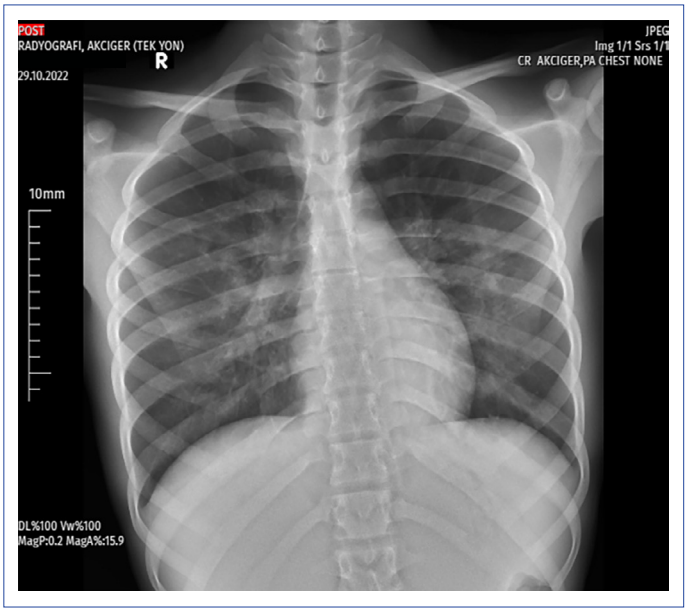

Figure 4. Postoperative day 3 PA-CXR.

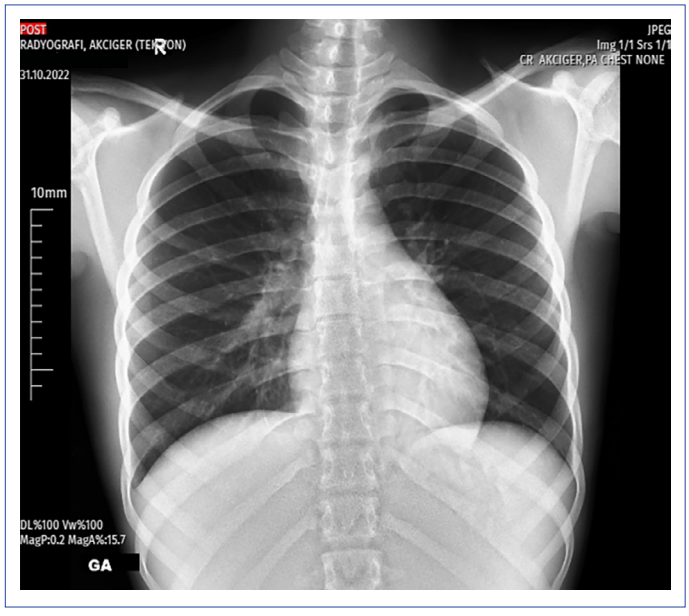

Figure 6. Postoperative day 5 PA-CXR.

cerebral AVMs developed respiratory failure secondary to pulmonary edema shortly after the second embolization. Comprehensive evaluation excluded conditions responsible for pulmonary edema, such as heart failure, kidney failure, iatrogenic fluid overload, negative-pressure pulmonary edema, and infectious etiologies. The patient met the clinical and radiographic criteria indicative of ARDS.

Murugesan et al.[8] reported the occurrence of severe pulmonary edema in a 32-year-old man following Onyx embolization for cerebral AVM. They postulated that ARDS most likely occurred as a result of the pulmonary elimination of DMSO solvent.

In our patient, postoperative laboratory parameters and echocardiographic evaluations yielded unremarkable results. During surgery, 2000 mL of 0.9% NaCl was administered, with a corresponding urine output of 1600 mL. Of note, there was no fluid overload, renal dysfunction, or cardiac insufficiency. The patient's white blood cell count and temperature measurements remained within normal ranges. Bronchospasm occurred during extubation, coupled with challenging positive-pressure ventilation with mask, suggesting negative-pressure pulmonary edema. The quick resolution of symptoms and stability in inflammatory markers strongly suggested a noninfectious

etiology. The severity of clinical manifestations may be attributed to the considerable size of the AVM and the use of two vials of Onyx material. Our patient was categorized as low risk based on the Wells Scoring System for assessing pulmonary embolism risk.[9]

Conclusion

In patients undergoing post-Onyx embolization surgery, perioperative desaturation coupled with respiratory challenges such as dyspnea and diminished peripheral oxygen saturation may be attributable to the development of pulmonary embolism, pulmonary edema, and ARDS associated with DMSO. In patients who have received Onyx, postponing surgery may be a prudent course of action, except in urgent clinical circumstances, if there is evidence of preoperative respiratory distress, tachypnea, and peripheral oxygen desaturation. Adequate measures should be taken to anticipate potential complications and provide timely therapeutic interventions, which may include administering corticosteroids, diuretics, antithrombotic agents, and antibiotics as well as providing oxygen support via mask and, if necessary, advanced airway management during extubation and postoperative care.

Disclosures

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

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LETTER TO THE EDITOR

Rhomboid Intercostal Plane Block After Thoracoscopic Pleurectomy

Mete Manici

Department of Anesthesiology and Reanimation, Koç University Faculty of Medicine, İstanbul, Türkiye

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Dear Editor,

Recurrent pleural effusion can occur during the course of numerous diseases. Various surgical procedures, such as pleural aspiration thoracoscopy, pleurodesis, and decortication, can be performed to treat recurrent pleural effusion. Along with surgical interventions, perioperative analgesia methods have also gained importance. With the increasing use of ultrasound, interfacial plane blocks are being more commonly used in thoracic surgery.[1] These plane blocks are now preferred over epidural anesthesia as they are easier to apply and have less risk of complications. Rhomboid intercostal block (RIB) is one of the most commonly used thoracic wall plane blocks.[2,3] In this report, we will discuss our experience with rhomboid intercostal plane block for perioperative analgesia in a pleurectomy with VATS to treat postoperative recurrent pleural effusion in a patient who underwent surgery for tricuspid atresia. We have obtained approval for this case report from the patient's parents.

Our case involved a 3-year-old boy with ASA III classification (99 cm, 10.3 kg) who underwent surgery for tricuspid atresia. After the surgery, he developed recurrent pleural effusion and underwent pleurectomy and decortication 40 days later. Considering the patient's comorbidities, we chose RIB block with paracetamol and rescue fentanyl as the postoperative analgesia modality. We followed the technique described by Elsharkawy et al.[2] and performed a right-sided RIB with the patient in left lateral position. We used a hockey stick linear ultrasound transducer (6.7–18.0 MHz) placed on the level of the 5th rib, and using an in-plane method, advanced a 22-gauge, 50-mm needle through the trapezius and rhomboid major muscles (Fig. 1). We injected 7 mL of 0.25% bupivacaine into the fascial plane between the rhomboid major and intercostal muscles. During anesthesia induction, patient received intraoperative fentanyl and paracetamol was administered for postoperative pain. We monitored

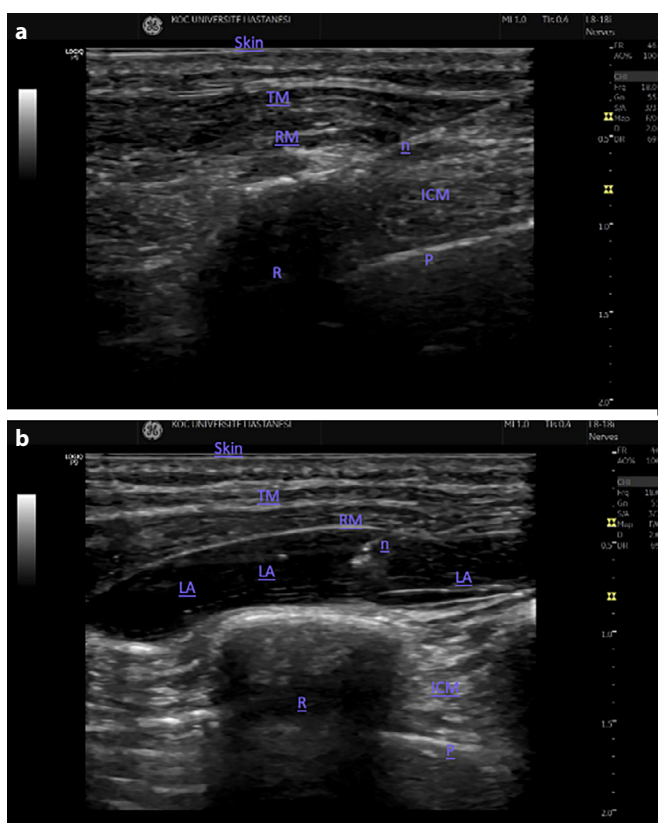

Figure 1. Ultrasound image of rhomboid intercostal plane block. (a) Prelocal anesthesia ultrasound image. (b) Postlocal anesthesia ultrasound image.

TM: Trapezius muscle; RM: Rhomboid muscle; ICM: Intercostal muscle; R: 5th Rib; LA: Local anesthetic solution; P: Pleura; n: Needle trajectory.

Address for correspondence: Mete Manici, MD. Koç Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, İstanbul, Türkiye
Phone: +90 533 474 77 64 **E-mail:** metemanici@yahoo.com

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the patient for 24 hours after the surgery, assessing postoperative pain using CHEOPS scale, with scores above 4 indicating pain. The patient received paracetamol routinely and fentanyl as a rescue analgesic. We are pleased to note that the patient did not require opioid analgesics for the first 12 hours after surgery.

Treating postoperative pain after thoracic surgery is challenging and can adversely affect patient comfort, specifically in pediatric patients. Effectiveness of RIB in VATS procedures has been studied in adults, and it is recommended to reduce opioid use.[4] However, its use in pediatric patients is less common. Literature review found that our case was the youngest known pediatric patient to receive RIB for postoperative pain management after thoracic surgery.

This case demonstrates that RIB can be a successful plane block in pediatric population undergoing thoracic surgery. Incorporating RIB as part of multimodal analgesia may help decrease opioid consumption and potential side effects while improving patient comfort. However, further randomized controlled trials are required to investigate the effects of RIB after thoracic surgery in pediatric population.

Disclosures

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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