JEVTM

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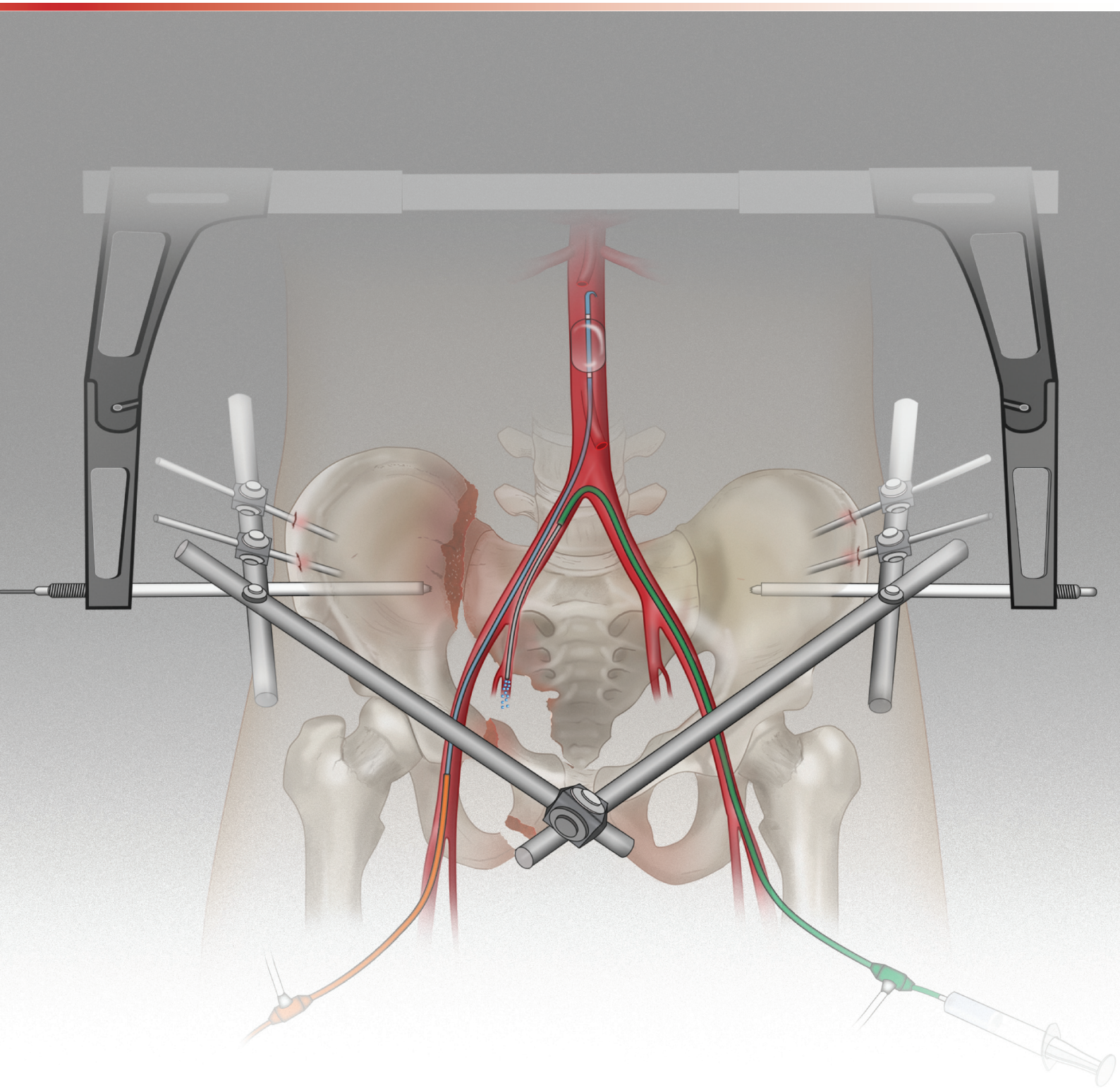

Official publication of the Society of Endovascular Resuscitation and Trauma Management

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Journal of Endovascular Resuscitation and Trauma Management

Volume 8
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This is the *Journal of Endovascular Resuscitation and Trauma Management*. We want to provide a truly Open Access platform for the dissemination of knowledge and peer-reviewed research in the field of endovascular and hybrid hemorrhage control.

To achieve this, we do not wish to be bound by medical discipline, country, resource or even the conventional rules of medical publishing. To achieve this goal, we have assembled an Editorial Board of clinicians and scientists who are experts within the field. This project is generously supported by a grant from the Department of Cardiothoracic and Vascular Surgery, Örebro University Hospital, Sweden.

We are keen to receive manuscript submissions that present new original findings, review important topics or educate our readers on any aspect of hemorrhage control, where an endovascular technique has been employed. This can either be in isolation or in combination with open surgical techniques (hybrid surgery). For further information for authors, please see *https://publicera.kb.se/jevtm*.

As the subject of hemorrhage and resuscitation is a common problem across many medical disciplines, we encourage submissions from all specialties: vascular, trauma, acute care, obstetrics, emergency medicine, to mention a few.

The Journal will publish 3 times a year with additional special issues on specific topics, and will be truly Open Access. There will be no article processing charges or publishing fees. All articles will be published online and indexed using a digital object identifier. The Archives can be found on https://publicera.kb.se/jevtm under journals and are there with no time or access limitations.

The Journal is an EBSCO and CrossRef Member and indexed in SCOPUS, Web Of Science, Clarivate, Sherpa Romeo, Google Scholar, EMBASE, and other indexing services. We are registered with DOAJ (Directory of Open Access Journals) and use Turnitin services.

Official publication of the Society of Endovascular Resuscitation and Trauma Management (EVTM)
In cooperation with Örebro University Hospital and Örebro University, Sweden.

Region Örebro County
Örebro University Hospital

Address:
EVTM Program
Tal Hörer
Dept of Cardiothoracic and Vascular Surgery
Örebro University Hospital and Örebro University
Södra Grev Rosengatan
701 85 Örebro
Sweden

Contact
tal.horer@regionorebrolan.se
jevtm@regionorebrolan.se

The EVTM Office
Mrs Åsa Strandberg
Email: asa.strandberg@regionorebrolan.se

National Library of Sweden

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Author Guidelines

GUIDELINES FOR SUBMISSION

A manuscript submitted to the Journal must constitute a unique piece of work that is not previously published or under consideration for publication, in part or whole, elsewhere.

Submissions should preferably be produced using Microsoft Word, although other formats will be considered. Submissions should be anonymized.

The submission process requires three discreet documents:

1. Cover Letter
2. Title Page
3. Manuscript (including Abstract, Tables and Figures)

Please ensure that the names and contact details of **all** authors are entered on the online submission system.

Cover Letter

This should be written by the corresponding author and must contain the following:

1. The type of manuscript submission (Original Article, Review Article, etc).
2. A sentence or two on the subject of the study.
3. Confirmation that the study is not under consideration for publication by another journal.
4. Confirmation that all of the authors have made a substantial contribution to the manuscript and that they have seen and approved the submission draft.
5. A conflict-of-interest statement regarding the authors. Where there is none, this should be clearly stated. More information about the Journal's publication ethics can be found on the journal webpage https://publicera.kb.se/jevtm/policies.
6. A clear statement that the authors follow the ethical guidelines as stated on the Journal webpage.

Title Page

This should consist of the following:

- Title: This should be concise and reflect the type and purpose of the study.
- Authors: These should be listed in order for publication, with first name, initials and surname.
- Affiliations: The institution(s) that the authors are affiliated with should be listed. Ensure that sufficient information is included to identify the authors (full addresses are not required).
- Corresponding Author: This individual should be clearly identified, along with one full institutional address and email address.
- Presentation: The meeting where any of the submitted data was presented should be listed.
- Disclosure: To disclose any official information.
- Acknowledgements (Optional): Any acknowledgements that you would like to include.
- Conflicts of Interest (Compulsory): A conflict-of-interest statement regarding the authors. Where there is none, this should be clearly stated.
- Funding Declaration (Compulsory): Any grant funding should be listed or it should be noted if no grant funds were used.
- Author Contributions (Optional): All authors are expected to have substantially contributed to the study and manuscript writing (see https://publicera.kb.se/jevtm/policies).

Main Body

This should consist of text in 12 pts, double spaced with a justified margin, written in US English. While each article type has specified headings, the use of sub-headings is encouraged to aid clarity. These should be formatted as follows:

Main Heading **BOLD, FULL CAPITALS**
Sub-Heading ***Bold and Italicized, Title Case***
Sub-sub-heading *Italicized, sentence case*

Abstract
The abstract should be a maximum of 250 words and consist of the following headings (but see specific manuscript types below for exceptions):

- Background
- Methods
- Results
- Conclusions

Keywords
Three to six appropriate keywords should be included.

References

References should follow the Vancouver Style and should be noted in the text numerically in sequence within the text, using square brackets, e.g.: [1] or [1,2] or [1–3].

Example references:

Stannard W, Rutman A, Wallis C, O'Callaghan C. Central microtubular agenesis causing primary ciliary dyskinesia. Am J Respir Crit Care Med. 2004;169:634–7.

Tang AL, Diven C, Zangbar B, et al. The elimination of anastomosis in open trauma vascular reconstruction. J Trauma Acute Care Surg. 2015; *In Press*. doi: XXXXXXXXXX.

Rasmussen TE, Tai NRM. Rich's Vascular Trauma. 3rd ed. Philidelphia: Elsevier; 2015.

Thamm DH. Miscellaneous tumors. In: Withrow S, Vail D, editors. Small Animal Clinical Oncology. 5th ed. St. Louis: Elsevier; 2013. pp. 679–88.

Where there are more than six authors, the first three should be included followed by et al.

Figures/Tables

All figures/tables must be cited within the text, presented as Figure 1, Figure 2*a*,*b*, Figures 1 and 2, and Table 1.

Figure captions should be styled as follows.

Figure 1 Title of figure.
Details of figure described below. (**a**) First sub item. (**b**) Second sub-item.

Table captions are styled similarly.

Supplementary Digital Content

Where manuscripts would benefit from additional content (datasets, images, video) that does not necessarily need to be included in the published article, supplementary digital content (SDC) can be hosted. This includes, but is not limited to, tables, figures, or video. Authors should include in their cover letter a description of this content and its purpose.

TYPES OF ARTICLES

All of the following article types are peer reviewed.

Original Articles

This is a report of a formal basic science or clinical research study. Manuscripts reporting unique scientific studies should be no longer than 5000 words. They should consist of the following sections:

- *Introduction*: This should concisely present the background to the problem that the study hopes to answer. A hypothesis should be clearly stated.
- *Methods*: This section should be suitably detailed to permit replication of the study. The regulatory permissions for the study should also be detailed, e.g. Institutional Review Board, ethical committee etc, including a protocol/registration number. Where animal research has been undertaken, the institutional animal care and use guidelines that have been followed should be clearly stated.
- *Results*: These should involve the reporting of the salient positive and negative findings of the study in clear language. The use of images, figures and tables are encouraged, of which the data should not be duplicated in the prose. There is no maximum number of figures or tables, but these should be appropriate to the study. Numerical results and *P* values should be reported to three decimal places.
- *Discussion*: This should place the reported study findings in the context of the literature. Limitations and future direction should also be discussed. Authors must be careful to ensure that conclusions are not overstated and are supported by data.

They should contain a structured abstract with a maximum of 250 words.

Editorials

Short, focused Editorials on an important aspect of endovascular hemorrhage control are welcomed. These should endeavor to bring attention to an important topic, or accompany an article published within the Journal. The latter will be invited by the Editor. Submitted manuscripts should be no longer than 1500 words. Abstracts are not included.

Narrative Reviews

This style of article can afford the author considerable latitude in examining a pertinent topic in endovascular hemorrhage control. The literature should be examined objectively and presented to the reader in the context of current understanding. The author should be able to synthesize a narrative, which leaves the reader with a good understanding of an emerging or controversial topic. The author is welcome (and encouraged) to express an opinion, but where this is the case, it should be clearly stated.

The submitted manuscript should be no longer than 5000 words. There is no formal structure; however, the use of logical headings/sub-headings is important to enable readers to follow the article easily. The abstract should also be unstructured and be a maximum of 150 words.

Systemic Reviews and Meta-Analyses

Where there is a topic within the subject area of endovascular hemorrhage control that has a substantial evidence base, a Systematic Review with/without a Meta-Analysis is considered more appropriate than a narrative review article. These articles should follow the methodology established by PRISMA. The overall aim is to provide a pooled analysis that enables firm conclusions to be drawn on a particular subject.

Submitted manuscripts should be no longer than 5000 words, and authors should include a PRISMA checklist in their submission. The abstract should be no longer than 250 words.

Tips and Techniques

In the evolving world of endovascular hemorrhage control, the advice and opinion of actively practicing clinicians is of great importance. Both solicited and unsolicited submissions are reviewed, both on major and minor components of endovascular techniques. This can be presented in the context of "evidence" or just as an opinion. The use of quality images and diagrams is encouraged. This type of article permits the author to write from experience, rather than from the published literature. Articles explaining how to approach certain problems or how to accomplish certain maneuvers are welcomed.

The submitted manuscript should be no longer than 1500 words. The abstract should be unstructured and be a maximum of 150 words.

Images of Interest

The Journal accepts images of interest accompanied by a short commentary. The aim of this section is to demonstrate and illustrate an educational message, rather than just to demonstrate dramatic pathology. Images can be submitted as a multi-panel with a series of scans/photographs in order to support the message presented in the narrative.

The submitted manuscript should be no longer than 250 words. Abstracts are not included.

Case Reports

These are short case reports including current literature reviews.

The submitted manuscript should be no longer than 1500 words. An abstract can be included (under 150 words) but is not compulsory.

Letters to the Editor

Letters to the Editor that comment on anything within the Journal can be submitted for publication. Abstracts are not included.

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EVTM-ST Section

The EVTM-ST Section will be a section of each JEVTM edition geared towards residents/fellows and education. The editors will invite one trainee to submit an interesting case report, and invite a reviewer to review and add a brief editorial. The editors should not be authors nor reviewers. The components of the section will include a standard case report presentation with figures of CT or angio or anything interesting and pertinent. The discussion should finish with a "what I learned" summary/bullet points for education purposes. The brief editorial by the reviewer is the final paragraph.

The submissions should be a maximum of 1500 words. An abstract can be included (under 150 words) but is not compulsory.

Conference Proceedings

Where a conference is affiliated to the Journal, the proceedings will be published as agreed by the Editorial Board.

SUPPORT FOR LANGUAGE AND ARTICLE CONTENT

The aim of the Journal, in addition to the dissemination of peer-reviewed evidence, is to support English-second-language authors and early career scientists. Provided that a submitted manuscript has good scientific merit, the Journal is able to provide a free language editing service. Furthermore, where article content would benefit from high-quality figures, artwork can be commissioned to support the publication.

AFTER ACCEPTANCE

Once your article has been accepted and undergone peer review, it will be processed and you will receive the proofs.

COPYRIGHT AND LICENSING

Authors contributing to the JEVTM agree to publish their articles under a Creative Commons CC BY 4.0 License, allowing third parties to read and download, and to copy and disseminate for non-commercial purposes. Articles will be published immediately after the final corrections of the master proof have been made. Authors retain copyright of their work and grant first publication rights to the JEVTM.

PROOFREADING

The purpose of the proof is to check for typesetting or conversion errors and the completeness and accuracy of the text, tables and figures. Substantial changes in content, e.g., new results, corrected values, title, and authorship, are not allowed without the approval of the Editor-in-chief.

After online publication, further changes can only be made in the form of an Erratum, which will be hyperlinked to the article.

ONLINE FIRST

The article will be published online after receipt of the corrected proofs. This is the official first publication citable with the DOI. After release of the printed version, the paper can also be cited by issue and page numbers.

ACCESS

All articles in the JEVTM are open access and upon acceptance are immediately and permanently free for everyone to read and download.

ETHICS AND POLICIES

The JEVTM follows guidelines and best practices published by professional organizations, including Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals by ICMJE, and Principles of Transparency and Best Practice in Scholarly Publishing (joint statement by COPE, DOAJ, WAME, and OASPA). The Journal also follows the guidelines for medical scientific publications (Vancouver, Uniform Requirements for Manuscripts Submitted to Biomedical Journals - URM - and The International Committee of Medical Journal Editors - ICMJE - regulations).

The Journal is committed to maintaining the highest level of integrity in the content published. The Journal has a conflict of interest policy in place and complies with international, national and/or institutional standards on research involving human and animal participants and informed consent. The Journal follows the Committee on Publication Ethics (COPE) regulations and subscribes to its principles on how to deal with acts of misconduct, thereby committing to investigate allegations of misconduct in order to ensure the integrity of research. The Journal is part of Similarity Check, a service that uses software tools to screen submitted manuscripts for text overlap. If plagiarism is identified, the COPE guidelines on plagiarism will be followed.

Content published in the Journal is peer reviewed (double blind review process). Detailed information follows in the text below.

Authorship Criteria

All the authors named as such in the manuscript must have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.

Each author, and any co-authors, must also meet the following criteria:

1. All must have made a significant contribution to the design of the study, the collection of data, or the analysis and interpretation of data and
2. All must, either by writing or by helping to edit the manuscript, have contributed to the design of its intellectual content to a significant degree.

Each author must also be able to take responsibility for part of the article's content and be able to identify which co-authors are responsible for the remaining parts.

The above text comes from the CODEX guidelines for research publications.

Peer Review Policy

- Authors of manuscripts and reviewers of the same manuscript must not be close colleagues, family members, work on the same research project, or otherwise have a close collaboration.
- Reviewers should only accept to assess manuscripts that fall within their own subject area.

- Reviewers should respond to invitations without delay and submit completed reviews within a reasonable time.
- Reviewers' comments must not be influenced by the author's nationality, religious or political beliefs, gender or commercial interests.
- Reviewers' comments must not contain hostile or provocative language and must not include personal attacks, slander or other derogatory comments.

Author Self-Archiving

Article authors have the right to self-archive the submitted ("preprint") version of the manuscript and the published version without any embargo period.

Submitted manuscripts and published versions of articles can, for example, be archived on:

- the author's personal website
- the author's employer's website and/or institutional repository or archive
- non-profit preprint servers or subject-based archives

Preprint Policy

The Journal's editors allow authors to upload earlier drafts of manuscripts/articles on the condition that authors agree to the following:

- Authors retain all rights to any previously published version and are permitted to submit their updated manuscript to the Journal.
- Authors accept that the Journal's editors cannot guarantee full anonymity in the review process, even if the author anonymizes the manuscript when earlier versions of the manuscript are made available.

If the manuscript is published in the Journal, the author is expected to cross-link, with DOI link, the different versions of the manuscript/article.

Orcid

The Journal's editors strongly recommend that authors submitting manuscripts register an "Open Researcher and Contributor Identifier" or ORCID.

This registration provides a unique and stable digital author identity that ensures that the article is attributed to the correct person and improves the searchability of all the author's publications. This helps to ensure that the author receives recognition for their work. As a person's ORCiD remains the same as long as the account exists, any name changes, change of employment, department affiliation or research field do not affect the searchability of previous publications. This facilitates correspondence between research colleagues.

The Journal's editors encourage all authors to include ORCiD along with other author information when the manuscript is registered in the system. If the article is accepted, this will be published with the article.

Open Data

As research funders' and universities' demands for open research data become increasingly common, some authors may be obliged to make their collected empirical material open and available to everyone.

In cases where this applies to the Journal's authors, the Journal's editors encourage that the material be made available according to the FAIR principles (Findable, Accessible, Interoperable, Reusable).

The material thus made available must be linked to within the submitted manuscript under a special heading. Research data should then be made public when the article is published. Empirical material obtained from other researchers must be referenced in the same way as other scientific sources. For further questions about guidelines for handling open data and guidelines about how data should be handled and published, please contact your university.

Archiving Policy

The Journal's current and future content, beginning when the Journal joins Publicera, is made available via Publicera and stored long-term on a secure and central server at the National Library of Sweden.

The Journal's owner and the National Library of Sweden aim for the journal's archive to be transferred and made available via Publicera, and thus the archive will also be stored long-term on a secure and central server at the National Library of Sweden.

In the event that the Journal ceases operations, the Journal's content on Publicera will remain archived at the National Library of Sweden.

Correction And Retraction Policies

The conditions of publication with persistent identifiers such as DOIs include that the object published is final and not changed without readers being clearly informed of such changes.

Articles published in the Journal cannot therefore be changed without a) an erratum or b) a change notice being published and linked to the original article.

If a factual error in an article is discovered, this should be reported to the Editor-in-chief, who decides on possible actions and possible corrections.

The Journal encourages post-publication discussion through Letters to the Editor or on an externally moderated website for review and post-publication discussion of research, such as PubPeer.

In order to maintain the highest scientific standards, the Journal follows strict quality standards:

Upon request, authors should be prepared to send relevant documentation or data in order to verify the validity of the results presented. This could be in the form of raw data, samples, records, etc. Sensitive information in the form of confidential or proprietary data is excluded.

If there is suspicion of misbehavior or alleged fraud, the Journal and/or Publisher will carry out an investigation following COPE guidelines. If, after investigation, there are valid concerns, the author(s) concerned will be contacted via their given email address and given an opportunity to address the issue. Depending on the situation, this may result in the Journal's and/or Publisher's implementation of the following measures, including, but not limited to:

- If the manuscript is still under consideration, it may be rejected and returned to the author.

(*Continued*)

(*Continued*)

- If the article has already been published online, depending on the nature and severity of the infraction:
  an erratum/correction may be placed with the article
  an expression of concern may be placed with the article
  or in severe cases retraction of the article may occur.

The reason will be given in the published erratum/correction, expression of concern, or retraction note. Please note that retraction means that the article is maintained on the platform, watermarked "retracted", and the explanation for the retraction is provided in a note linked to the watermarked article.

Authors have an obligation to correct mistakes once they discover a significant error or inaccuracy in their published article. The author(s) is/are requested to contact the Journal and explain in what sense the error is impacting the article. A decision on how to correct the literature will depend on the nature of the error. This may be a correction or retraction. The retraction note should provide transparency as to which parts of the article are impacted by the error.

Complaints and Appeals Policy

In the case of formal complaints, disputes, or appeals, authors should contact the Editor-in-chief, who is responsible for ensuring that a fair, deliberative, and thorough investigation is conducted.

Policy For Ethical Oversight

The journal follows the ethical guidelines and best practices set forth by the Committee on Publication Ethics (COPE). All cases of ethical misconduct will be dealt with in accordance with COPE's recommendations and guidelines.

Authors' Responsibilities

A submitted manuscript cannot be under consideration for publication in other journals. All authors are obliged to provide retractions or corrections of mistakes after the review process. The final responsibility for the scientific accuracy and validity of published manuscripts rests with the authors, not with the Journal, its editors, or the publisher (Örebro University Hospital).

All published material will include the following Ethics Statement:

Ethics Statement

- All the authors named as such in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
- The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Detailed Ethical Guidelines
Maintaining the integrity of the research and its presentation is helped by following the rules of good scientific practice, which are outlined here:

- The manuscript should not be submitted to more than one journal for simultaneous consideration.
- The submitted work should be an original work. Please provide transparency on the re-use of material to avoid the concerns about text-recycling ("self-plagiarism").
- A single study should not be split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time (i.e. "salami-slicing/publishing").
- Concurrent or secondary publication is sometimes justifiable, provided certain conditions are met. Examples include translations or a manuscript that is intended for a different group of readers.
- Results should be presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation (including image based manipulation). Authors should adhere to discipline-specific rules for acquiring, selecting, and processing data.
- No data, text, or theories by others should be presented as if they were the author's own ("plagiarism"). Proper acknowledgements to other works must be given (this includes material that is closely copied (near verbatim), summarized and/or paraphrased), quotation marks (to indicate words taken from another source) must be used for verbatim copying of material, and permissions secured for material that is copyrighted.
- Authors should avoid untrue statements about an entity (which can be an individual person or a company) or descriptions of their behavior or actions that could potentially be seen as personal attacks or allegations about that person.
- Authors are strongly advised to ensure the author group, the Corresponding Author, and the order of authors are all correct at submission. Adding and/or deleting authors during the revision stages is generally not permitted, but in some cases may be warranted. Reasons for changes in authorship should be explained in detail. Please note that changes to authorship cannot be made after acceptance of a manuscript.

Financial conflicts of interest
Authors need to consistently disclose financial conflicts of interest.

Editors' Responsibilities

The Editors of the JEVTM have responsibilities toward the authors who provide the content of the Journal, the peer reviewers who comment on the suitability of manuscripts for publication, the Journal's readers and the scientific community, the owners/publishers of the Journal, and the public as a whole.

Reviewers' Responsibilities

Peer review assists editors in making editorial decisions and, through editorial communications with authors, may assist authors in improving their manuscripts. Peer review is an essential component of formal scholarly communication and lies at the heart of scientific endeavor.

Any invited referee who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should immediately notify the editors and decline the invitation to review so that alternative reviewers can be contacted.

Any manuscripts received for review are confidential documents and must be treated as such; they must not be shown to or discussed with others except if authorized by the Editor-in-Chief (who would only do so under exceptional and specific circumstances). This applies also to invited reviewers who decline the review invitation.

Reviews should be conducted objectively and observations formulated clearly with supporting arguments so that authors can use them for improving the manuscript. Personal criticism of the authors is inappropriate. Reviewers should identify relevant published work that has not been cited by the authors. Any statement that is an observation, derivation or argument that has been reported in previous publications should be accompanied by the relevant citation. A reviewer should also notify the editors of any substantial similarity or overlap between the manuscript under consideration and any other manuscript (published or unpublished) of which they have personal knowledge.

Any invited referee who has conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies or institutions connected to the manuscript and the work described therein should immediately notify the editors to declare their conflicts of interest and decline the invitation to review so that alternative reviewers can be contacted.

Unpublished material disclosed in a submitted manuscript must not be used in a reviewer's own research without the express written consent of the authors. Privileged information or ideas obtained through peer review must be kept confidential and not used for the reviewer's personal advantage. This applies also to invited reviewers who decline the review invitation.

The scientific editorial technical team has been created in order to support the authors, the editors and the Editorial Board in quality control of all submissions. The team review all submissions and check for scientific problems, errors/bias and quality. Their work is also aimed at checking the ethical issues of all submissions to the JEVTM.

In an effort to standardize the review process for the Journal of Endovascular Resuscitation and Trauma Management, we ask all reviewers to use our checklist when reviewing a manuscript.

Patient Anonymity and Informed Consent Policy

It is the authors' responsibility to ensure that a patient's anonymity is protected, to verify that any experimental investigation with human subjects reported in the manuscript was performed with informed consent and follows all the guidelines for experimental investigation with human subjects required by the institution(s) with which all the authors are affiliated and/or ethical committee processing. Authors are asked to comply with the general guidelines for integrity protection, as listed by the health ministries in the EU, the EU commission, and US Department of Health (see, for example, https://www.hhs.gov/hipaa/for-professionals/special-topics/research/index.html). Authors should mask patient's eyes and as well as genital organs, as far as possible, and always remove patient names from figures.

Protection of Human Subjects and Animals in Research

For original articles in the Journal that report research involving animals, the corresponding author must confirm that all experiments were performed in accordance with relevant guidelines and regulations (i.e. IACUC guidelines and federal regulations, or EU guidelines for animal research). One recommended document for animal studies is the ARRIVE reporting guidelines (PLoS Bio. 2010; 8(6), https://doi.org/10.1371/journal.pbio.1000412). We encourage authors to follow the RRR principles of animal studies in medicine (https://www.feam.eu/wp-content/uploads/FEAM-Forum_Round-table-animals_Report_Final.pdf).

All studies of human subjects must contain a statement within the Methods section indicating approval of the study by an institutional review body (i.e. Institutional Review Board or ethical committee), and, if appropriate, a statement confirming that informed consent was obtained from all subjects if possible. If no legally informed consent can be obtained, such as in research carried out with human subjects receiving emergency treatment, authors should indicate when possible if a waiver of regulatory requirements for obtaining and documenting informed consent applies.

Ethical Approval and Informed Consent

Authors should include information about ethical approval and informed consent, such as "Ethical approval to report these cases was given by XXXXX. Written informed consent was obtained from xxxx."

Or, in cases where approval and consent were not provided, "Ethical approval was not required. Informed consent was not possible because XXXX and the information has been anonymized or informed consent was not required."

All submissions are screened for inappropriate image manipulation, plagiarism, duplicate publication, and other issues that violate research ethics. Depending on the outcome of these investigations, the Journal may decide to publish errata, or, in cases of serious scientific misconduct, ask authors to retract their paper or to impose retraction on them.

General Statement

Patients have a right to privacy that should not be infringed without informed consent. Identifying information, including patients' names, initials, or hospital numbers, should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication. Informed consent for this purpose requires that a patient who is identifiable be shown the manuscript to be published.

Identifying details should be omitted if they are not essential. Complete anonymity is difficult to achieve, however, and informed consent should be obtained if there is any doubt. For example, masking the eye region in photographs of patients is inadequate protection of anonymity. If identifying characteristics are altered to protect anonymity, such as in genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

EVTM Society

Join the Endovascular Resuscitation Platform

The EVTM Society is a non profit organization that aims to share information on advanced methods for bleeding control and endovascular resuscitation, exchange of data, and cooperation and education. It is also designed to serve as a professional platform for the multidisciplinary approach.

By joining the EVTM Society you will be part of this global development.

To join, please visit jevtm.com/evtm-society.

The Membership fee is 50 USD biannually (25 USD per year).
Contact information for payment: lotta@mkon.se

Vision and Mission:
Our mission is to promote optimal treatment and new methods for bleeding control in trauma and non-trauma patients, and state-of-the-art endovascular resuscitation. This will be achieved by a joint international body that will support the following:

- A web-based free platform for EVTM issues (jevtm.com).
- JEVTM – the Journal of Endoascular Resuscitation and Trauma Management, an open access peer-reviewed journal.
- The EVTM round table symposium, a platform for continuous debate and data exchange.
- Educational opportunities in the form of manuals (Top Stent), courses, workshops, and web seminars.
- Promoting open dialogue and cooperation between societies, organizations and the industry.
- Promoting new guidelines and recommendations for EVTM-related issues and protocols.
- Promoting research in EVTM-related areas, both human and animal.
- Promoting PR for EVTM issues, grants, and collaboration with industry.
- Encouraging residents and young colleagues to carry out research on EVTM issues.
- Promoting cooperation and data exchange with other medical instances.

Structure:
The EVTM council, led by the society chair, will change membership periodically (i.e., after two years). The council aims to have one or two representatives from each participating country and discipline.

The EVTM Society is supported at this stage by Örebro University Hospital in all financial respects (as part of EVTM research group support). This support has been granted for the forthcoming five years.

The main task of the council is to pave the way for the EVTM venture, and promote the JEVTM/EVTM symposium, EVTM-related courses, cooperation, and free exchange of information.

Members will obtain free access to all JEVTM information and discussions as well as regular updates on EVTM-related activities, education, and developments. Members will also be offered a reduced fee for the EVTM round table symposium.

The EVTM Society is registered in Sweden, and is managed in collaboration with the EVTM program at Örebro University Hospital, the JEVTM journal and web platform, and other institutes.

Since the society is registered in Sweden, it will follow the rules and guidelines of the Swedish government and the EU. Expansion to other countries is welcome, but should follow our ethical guidelines and the EVTM Society should be named in all documents appropriately.

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ENDOVASCULAR RESUSCITATION and TRAUMA MANAGEMENT

Contents

Narrative Review Article

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Orthopedic Management of Pelvic Trauma

L De Luca, A Maurizio and L Branca Vergano

Ospedale Santa Chiara – APSS Trento, Italy

Patients with a suspected pelvic fracture should be managed according to the principles of Advanced Trauma Life Support. The mechanism of trauma determines the pattern of pelvic lesions and the likelihood of associated injuries. The most common classification to describe pelvic lesions is the Young–Burgess system. This classification describes the radiographic images by analyzing the mechanism of injury that leads to predictable patterns of injury and displacement. It is useful in describing injuries and in helping guide both initial treatment and definitive fixation. The initial treatment in case of pelvic lesion is the application of a pelvic binder. An external fixator is recommended in hemodynamically unstable patients with unstable pelvic lesions to prevent further bleeding and to support measures of hemorrhage control. Definitive treatment of pelvic ring lesions requires anterior stabilization or a posterior fixation, or both, depending on the type of injury.

Keywords: *Pelvic Trauma; Hemorrhagic Shock; Pelvic Fracture; Pelvic External Fixator; Pelvic Osteosynthesis*

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INTRODUCTION

Patients with a suspected pelvic fracture should be managed according to the principles of Advanced Trauma Life Support (ATLS) [1].

The mechanism of trauma determines the pattern of pelvic lesions and the likelihood of associated injuries. In the case of pelvic fractures, it is crucial to ascertain the mechanism of trauma as it drives the assessment and management of the patient concerned [2].

For low-energy injuries, they usually occur in elderly osteoporotic patients as a result of falls from a standing height.

In contrast, the most common mechanisms of high-energy injuries are motor vehicle accidents, motorcycle accidents, pedestrian versus vehicle incidents, or falls from height. Associated injuries are very common. There is a high probability of concomitant hemorrhage and hypovolemic shock. Management of these lesions requires prompt evaluation and treatment [1,3].

Corresponding author:

Dr. Lapo De Luca, Ospedale Santa Chiara – APSS Trento, Largo Medaglie d'oro 9, 38122 Trento, Italy.

Email: lapo.deluca@apss.tn.it

PHYSICAL EXAMINATION AND IMAGING

Primary inspection of the undressed patient should focus on pelvic asymmetry, differences in leg length, injured soft tissue around the pelvis to detect open wounds, swelling, contusions, or degloving (Morel–Levallè lesion), including the perineum to rule out urethral or vaginal bleeding, as well as the observation of potential differences in the color of the feet, which might be due to vascular impairments [2].

A significant leg length discrepancy in the absence of an obvious long bone fracture may indicate a vertically unstable and displaced pelvic fracture. In addition to identifying the regions of pain, pelvic instability should be assessed by clinical examination. The pelvic ring may be quite stable at the initial examination in lateral compression injuries [2,4].

In open book injuries, more severe rotational instability in the horizontal plane may occur with or without additional instability in the craniocaudal direction. The combination of rotational instability in the lateral and anterior posterior directions, as well as craniocaudal instability, is the most serious instability. Physical examination without fluoroscopy is not sensitive enough to detect minor instability, the presence of gross instability suspected for a severely unstable fracture may also be associated with significant bleeding. The stability of the pelvis is assessed by firmly grasping the iliac wings, pushing and pulling them apart and then back together [2]. Repeated maneuvers of stability testing should be avoided as these could increase or cause potential bleeding [4].

While the above-mentioned signs allow the examiner to detect mechanical pelvic instability, it remains

difficult to determine the severity of additional hemorrhage and blood loss and the extent of soft-tissue injuries. Immediate analysis of the primary hemoglobin concentration can be performed using capillary, venous, and arterial whole blood by bedside hemoglobinometry (photometry) [5,6]. Results are then available within 40 seconds. Our observations have shown that vital hemorrhage is possible at a primary hemoglobin concentration of 8 g/dL [7].

The inspection of capillary refill and palpation of peripheral pulses of lower extremities allow assessment of the vascular status. An abnormal capillary refill is defined as more than three seconds. A doppler examination of foot pulses should be performed in all suspected cases.

Neurological assessment of the lower extremities is mandatory and consists of an accurate sensory examination, testing of toe and foot extension, plantar flexion of the foot and knee extension, and patellar and Achilles tendon reflexes in the awake patient.

A connective patient warming system can be used to avoid hypotermina during the diagnostic phase [8,9].

An anteroposterior pelvic X-ray, without pelvic binder if the patient's condition allows it, is the first radiological assessment. As long as the patient is stable, an additional spiral computed tomography (CT) scan should be performed as early as possible, depending on the patient's general condition. This consists of a cranial CT, neck CT, chest, abdominal, and pelvis CT ("trauma scan") with 50 mL iodine contrast medium (Isovist) given 15 minutes before scanning. Inlet and outlet views are no longer taken as they can be reconstructed from the CT data set [10].

CLASSIFICATION

Imaging can be used to classify pelvic fractures and can be achieved using the Arbeitsgemeinschaft für Osteosynthesefragen (AO), Tile or Young–Burgess classification systems [11].

The most common classification to describe pelvic lesions is the Young–Burgess system [12]. This classification describes the radiographic images by analyzing the mechanism of injury that leads to predictable patterns of injury and displacement [12,13]. It is useful in describing injuries and in helping guide both initial treatment and definitive fixation (Figure 1).

Antero posterior compression (APC) injuries are more frequently defined as "open book" injuries. APC pelvic lesions are classified as more instable on a scale from 1 to 3. Symphysis disruption of more than 2.5 cm indicates disruption of the pelvic floor and the anterior sacroiliac ligaments. It is important to differentiate APC-1 injuries from APC-2 injuries; sometimes this is only possible by testing the patient's pelvis under fluoroscopy while they are under anesthesia (examination under anesthesia (EUA)). Stability is defined as more than 2.5 cm of horizontal displacement and 1 cm of vertical displacement under stress. If the pelvis is stable on EUA, the injuries are treated non-operatively and the patient is allowed to weight-bear as tolerated. If, on the contrary, the pelvis is unstable on EUA, it needs anterior and posterior fixations with protected weight-bearing on the posteriorly injured side for up to 8–12 weeks [14]. Significant bleeding is frequently the most common cause of death in patients affected by displaced APC-2 and APC-3 lesions [13].

In lateral compression (LC) injuries, significant bleeding is likely, although less common, and it is typically the result of an arterial injury. The associated visceral lesions are the most frequent causes of death in patients with LC-type injury patterns. LC injuries are classified from 1 to 3 with each designation representing increasing instability. It is challenging for surgeons to predict which non-operatively managed LC fractures will result in symptomatic malunion based on static imaging [15].

Sagi et al. applied EUA to LC fractures. The authors developed a protocol consisting of surgical treatment of posterior pelvic ring injuries in the case of >1 cm of displacement for LC-1 lesions or any pelvic displacement for LC-2 and LC-3 injuries. After posterior fixation, further EUA is performed and anterior pelvic fixation is carried out in the case of anterior displacement of >1 cm [16].

In vertical shear (VS) lesions, the injury can involve ligaments, bone, or a combination of both; consequently proximal migration of one hemipelvis is the main characteristic of these lesions. Vertical shear fractures are typically very unstable.

In some cases, acetabular fractures can be associated. Here the treatment is tailored to the specific pattern of injury and displacement.

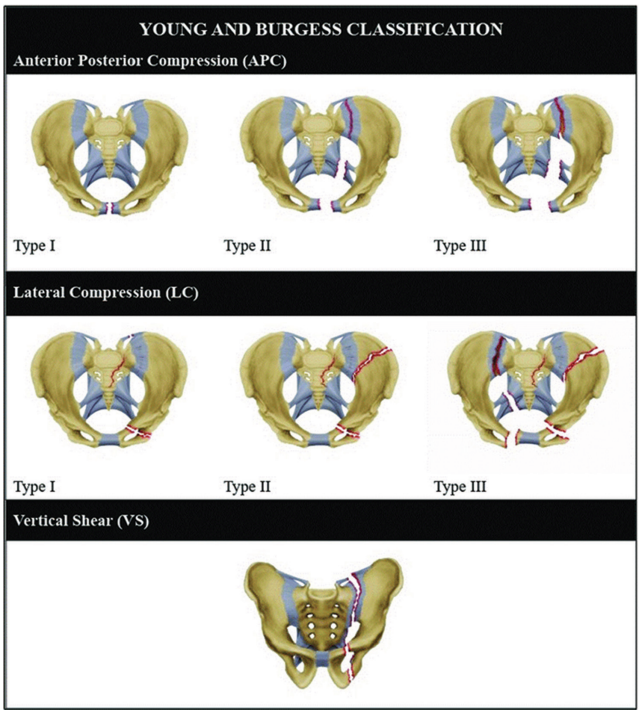

Figure 1 Young–Burgess classification.

TREATMENT

The initial treatment in the case of pelvic lesion is the application of a pelvic binder [17]. which should be tightened over the greater trochanters. This device stabilizes the pelvic ring, reducing bleeding from the fracture sites and preventing disruption of formed clots [3]. The contraindication to the use of a pelvic binder is a hypothetical risk of over-intrarotation of the hemi pelvis with consequent visceral injury (the bladder) in LC pelvic fractures, but no clinical evidence on this topic exists. The pelvic binder should be removed in the case of confirmation of a mechanically stable pelvic fracture [18]. All binders should be removed within 24–48 hours to prevent pressure sores (Figure 2); this should be managed and arranged with the orthopedic pelvic surgeon in the case of mechanically unstable fractures [18].

Figure 2 Pelvic binder skin lesion.

Recently, use of external fixation and C-clamp application as life saving procedures in acute bleeding control has been re-considered.

External fixation can be applied to the pelvis (depending on the fracture pattern) if the patient is taken to the operating room for surgical treatment of extra-pelvic injuries and/or if definitive fixation of the pelvis is expected to be delayed by more than 24–48 hours [18]. External fixation is recommended by many authors (with grade 1a evidence) in hemodynamically unstable patients with unstable pelvic lesions to prevent further bleeding and to support measures of hemorrhage control, including angiography and pelvic packing (Figure 3) [19,20].

External pelvic fixation aims to reduce the intrapelvic volume in "open book" injuries, so as to decrease the retroperitoneal bleeding space and to provide stable counterpressure to the "packed" lap sponges in the case of preperitoneal pelvic packing. In fact, preperitoneal pelvic packing alone is not effective without adequate counterpressure by posterior pelvic elements, obtained by a pelvic binder or by surgical devices (C-clamp or external fixator) [21]. The pins of the external fixator can be placed in the iliac crest or in the supracetabular region. Contraindications to anterior external fixator are fractures that involve the acetabular region or the iliac ala.

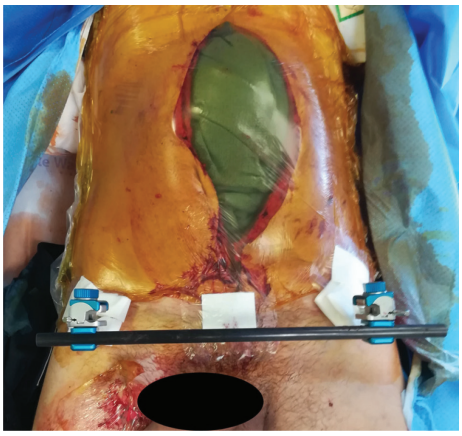

Figure 3 Anterior external fixator and pelvic packing for unstable pelvic lesion.

Otherwise, a posterior C-clamp is indicated in "vertical shear" injuries with sacroiliac joint disruptions for hemorrhage control, but malposition and pin migration are a real concern [22,23]. Absolute contraindications are posterior iliac wing fractures, while relative contraindications are comminuted sacral fractures (in the case of strong compression, a C-clamp may cause lesions of sacral nerve roots) [24,25]. Furthermore, the area of pin insertion of the C-clamp is the same as the percutaneous definitive internal fixation (ileosacral screws) and the device itself can impede log-rolling of the patient during care nursing [18]. For these reasons, a C-clamp is rarely used today.

Some authors have agreed on the effectiveness of an emergency technique to address posterior pelvic ring instability, with the insertion of a percutaneous iliosacral screw, called a "resuscitation screw". This can be associated with external fixation, using a C-clamp or binders, with the aim of effectively reducing pelvic volume. This technique is effective but very risky, and should only be used in selected cases and performed by experienced surgeons [26,27].

Definitive treatment of pelvic ring lesions requires anterior stabilization and/or a posterior fixation, depending on the type of injury [2].

The British Orthopaedics Association recommends definitive fixation of pelvic ring injuries within 72 hours if the general status of the patient allows for major surgery procedures [28].

Current indications for surgical stabilization of pelvic ring injuries include pain and mechanical instability.

Anterior fixation can be achieved with open reduction and internal fixation (ORIF) using plate and screws by different surgical approaches (Pfannenstiel, ilioinguinal, intrapelvic) or with screws alone (pubic rami

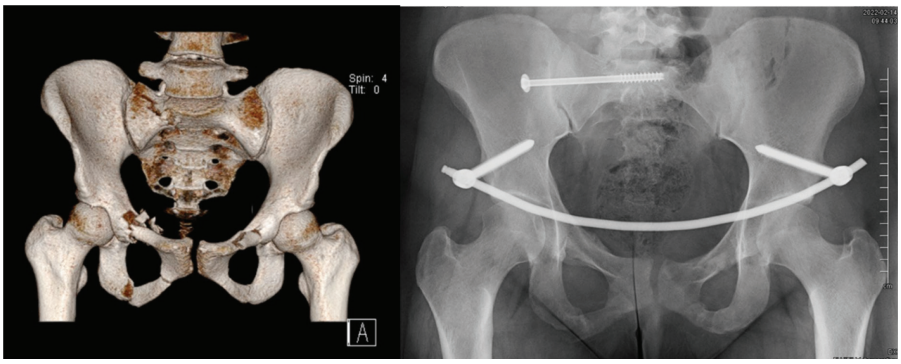

Figure 4 Pelvic lesion with instability treated with a posterior sacroiliac screw and anterior INFIX.

screws). Anterior fixation may also be achieved percutaneously using an external fixator as the definitive treatment or an anterior subcutaneous internal pelvic fixator (INFIX) [29,30]. There are some particular indications for INFIX, especially in patients with concomitant skin or soft tissue lesions, or in the case of bladder injury or abdominal infection [26].

Most lesions of the posterior pelvic ring (sacroiliac joint fracture, and dislocation and sacral fractures) can be indirectly reduced with closed or minimally invasive techniques. When indirect reduction is insufficient to obtain anatomic reduction, it is mandatory to reduce the lesion with a formal open procedure, i.e. with an anterior (first window of the ilioinguinal approach) or a posterior approach (midline or parasacral approaches). Posterior fixation is normally obtained with sacroiliac or trans-sacral screws. However, this procedure may put some key structures at risk, such as L5, S1 and upper sacral nerve roots, presacral venous plexus, cauda equina, etc [2]. Alternative methods of fixation are posterior plating (tension band plating), posterior INFIX, or lumbopelvic instrumentation, especially in the presence of sacral dysmorphism or in specific situations (obesity, lumbopelvic dissociation, etc.) (Figure 4).

Ethical Approval and Informed Consent

Ethical approval was not required. Informed consent was not required.

CONCLUSION

High-energy traumas causing pelvic displaced lesions are a relevant cause of morbidity and mortality. Acute stabilization of a mechanically unstable pelvis is crucial for patient resuscitation in the presence of active bleeding and hemodynamic instability.

The correct understanding of the complexity of pelvic injuries can guide the surgeon to follow the right steps to address the lesion and thus reduce the probability of complications and death.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

All authors have no conflicts of interest.

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Author Contributions

All authors have made substantial contributions to the study and manuscript writing.

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Narrative Review Article

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Endovascular Management of Pelvic Trauma: The Interventional Radiology Point of View

Velio Ascenti[1], Carolina Lanza[2], Pierpaolo Biondetti[2], Jean Marc Pernes[3], Matteo Renzulli[4], Costantino Del Giudice[3], Gianpaolo Carrafiello[2,5] and Anna Maria Ierardi[2]

[1]Post-Graduate School of Radiology, University of Milan, Milan, Italy
[2]Radiology Department, Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Milan, Italy
[3]Radiology Department, Institut Mutualiste Montsouris, 75014 Paris, France
[4]Department of Radiology, IRCSS Azienda Ospedaliero-Universitaria di Bologna, 40138, Bologna, Italy
[5]Department of Oncology and Haemato-Oncology, University of Milan, 20122 Milan, Italy

Background: Traumatic pelvic injuries are associated with high injury severity scores and significant morbidity and mortality. Active bleeding is the most common cause of death among those patients. Due to limitations of surgery for pelvic hematomas, angiographic treatment is at the forefront of pelvic trauma management.
Objective: The present article aims to discuss the available endovascular treatment modalities, and common angiographic treatment strategies and techniques.
Conclusion: Interventional radiologists plays a key role in the management of patients with pelvic trauma. New standardized protocols are needed to minimize the time spent on deciding the correct treatment for each patient.

Keywords: *Pelvic Trauma; Hemorrhage; Interventional Radiology; Endovascular Treatment*

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INTRODUCTION

Worldwide, deaths resulting from trauma are still among the most frequent, especially in the under-45 population [1].

Pelvic trauma (PT) is an umbrella term that encompasses several types of injury, such as pelvic ring fractures, acetabular fractures, and avulsion injuries. The majority of pelvic fractures in younger individuals are caused by high-energy blunt trauma such as a car/motorcycle accident (43–58%), a fall from height (5–30%), and a pedestrian struck by a vehicle (about 20%) [2,3]. Fragile and elderly adults may incur such injuries from a low-energy mechanism (e.g., a fall from a standing posture). Concomitant injuries, most commonly involving the abdominal and pelvic viscera, are more frequent with high-energy trauma [4].

Corresponding author:
Anna Maria Ierardi, Radiology Department, Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Via Francesco Sforza 35, Milan, Italy.
Email: amierardi@yahoo.it

Pelvic fractures account for around 3% of all bone injuries [5]. These injuries are seen in patients who are often young, with a high overall injury severity score (ISS) [6]. Because of the quick exsanguination, difficulties in achieving hemostasis, and concomitant injuries, mortality rates remain high, with rates reported to be between 5 and 15%, and in patients with hemodynamic instability mortality rates can be up to 50% [5,7].

The therapy of patients with PT is difficult, necessitating multidisciplinary efforts to comprehend and manage patients with PT at all its severity levels. It is also critical to have treatment standardization governed by protocols that measure mechanical and hemodynamic stability. Interventional radiology is complementary to rather than a substitute for surgery, and plays a critical role in the management of these patients. Here a systematic review of the literature was performed, to highlight the actual role of interventional radiology in PT. The methodological quality and certainty of evidence were evaluated using PRISMA.

Physiopathology of Pelvic Trauma

Severe hemorrhage is a life-threatening condition. Fractured trabecular bones and ruptured pelvic veins constitute the majority of bleeding sources, while arterial bleeding is reported in about 20% of cases [8]. Different fracture types, including lateral compression, anteroposterior compression, vertical shear, and combined

mechanisms, can cause varying degrees of bleeding. Usually, the last three cause the most severe damage and require angiography in 20% of cases [1]. For unstable patients, early fracture stabilization is crucial to stabilize the pelvic ring and reduce hemorrhage [5]. The type of fracture underlying the bleeding has a large impact on hemorrhage control: in cases of lateral compression injury, bleeding stops in 99% of cases, whereas the intrinsic instability of posterior compression, vertical shear, and combined mechanism fractures results in ineffective bleeding control after compressive maneuvers in 18% to 22% of cases, especially if arterial involvement is present [1]. Another critical factor to consider is trauma-induced coagulopathy (TIC), which is caused mostly by hypothermia and repeated transfusions. Wherever possible, the presence of coagulopathy should guide the interventional radiologist in choosing the embolic material. In fact, it is widely known that because their methods of action are essentially dependent on clot formation, coagulopathy limits the effectiveness of embolization performed with gelatin sponges and coils [9–12]. Many authors have advocated for the use of non-adhesive liquid embolic agents (NALEA) and *n*-butyl cyanoacrylate (NBCA) in patients with coagulopathy because their embolization mechanisms are based on mechanical actions of polymerization (NBCA) and solidification (NALEA) rather than thrombus formation [9,13].

Pelvic Anatomy

Before performing vascular embolization, it is imperative to have a comprehensive understanding of the vascular anatomy of the pelvis and any potential variations. The primary arterial vascular supply of the pelvis is given by the dividing branches of the internal iliac arteries and, to a lesser extent, by the branches of the external iliac artery [14]. The internal iliac arteries are typically divided into anterior and posterior branches. The anterior trunk serves the majority of the pelvis organs through the obturator, umbilical, inferior vesical, gonadal, internal pudendal, and inferior gluteal branches. The posterior trunk serves the posterior abdominal wall and pelvis through the iliolumbar, lateral sacral, and superior rectal branches [4].

About 30% of patients also have middle rectal arteries. These arteries usually originate together with prostatic arteries in the prostate-rectal trunk [14]. Both non-targeted embolization and recurrent hemorrhage can result from anastomoses with the superior and inferior rectal arteries, which are frequently seen [15].

A relatively high risk of hemodynamically significant bleeding, death, and morbidity is also associated with injuries to the external iliac artery, which have been reported to occur in 3.5–17% of cases of PT [16,17]. For effective endovascular therapy, a complete evaluation of the external iliac arteries is therefore mandatory. One particularly significant anatomic variant is the Corona Mortis, which is a vascular anastomosis between the external iliac artery and the obturatory artery. It is reported to be present in a third of patients on routine CT examination [18].

Ethical Approval and Informed Consent

Ethical approval was not required. Informed consent was not required.

MANAGEMENT OF PELVIC TRAUMA

The two most important variables in PT are hemodynamic stability and mechanical stability of the fracture; the subsequent diagnostic and therapeutic workflow will depend on these variables, and hemodynamic stability is particularly important. Regarding hemodynamics, Advanced Trauma Life Support (ATLS), considers patients hemodynamically unstable when they present with blood pressure <90mmHg and heart rate >120 bpm with signs of cutaneous vasoconstriction, altered level of consciousness, and shortness of breath [19].

The anatomical description of pelvic ring lesions (mechanical stability–instability) is not definitive in the management of pelvic-related hemorrhage since there is not a clear correlation between the type of fracture and the bleeding risk, even if some fractures such as anterior-posterior compression are related with a requirement for a greater number of transfusions [5,20].

The most recent and used classification for the management of PT patients is the one provided by the World Society for Emergency Surgery (WSES) [5].

According to this classification, patients are classified following the severity of injury, which is evaluated by the Young–Burgees classification for pelvic ring fractures, and, most importantly, the hemodynamic status according to the ATLS. The primary objectives of effective PT management include stabilizing hemodynamic status, addressing coagulation disorders, ensuring the mechanical integrity and stability of the pelvic ring, and preventing various complications such as septic, urogenital, intestinal, vascular, sexual, and walking-related issues. Subsequently, the goal is to achieve definitive stabilization of the pelvis.

The WSES classification divides traumatic pelvic ring injuries into three grades:

- *minor* (stable hemodynamics and mechanics);
- *moderate* (stable hemodynamics, unstable mechanics);
- *severe* (hemodynamic impairment regardless of mechanical stability).

If patients have hemodynamic stability, they should always have a multiphasic CT scan with contrast medium injection that will be used to guide further therapeutic procedures.

On the other hand, in the hemodynamically unstable setting, immediate intervention is necessary.

Patients with a *minor* degree of injury usually undergo a CT scan and then are referred to non-operative management (NOM).

Patients with a *moderate* degree of injury receive pelvic binder fixation as soon as possible, then a CT scan is performed and if necessary (signs of bleeding on the CT scan) embolization carried out.

The most threatening scenario is obviously when the patient is not hemodynamically stable.

Resuscitation, mechanical stabilization, pre-peritoneal pelvic packing (PPP), resuscitative endovascular balloon occlusion of the aorta (REBOA), and embolization are commonly used treatments for severe pelvic injuries. However, it seems that the order in which these techniques are used varies greatly depending on the local expertise and experience. Currently, there are no clear recommendations, and opinions on how to treat hemodynamically unstable pelvic fractures are divided [21].

According to the First Italian Consensus Conference on Pelvic Trauma [7] the management of hemodynamically unstable patients should rely on the results of Focused Sonography for Trauma (FAST) ultrasound. If there is free fluid in the abdomen (positive FAST) the patient will be transferred immediately to the operating room, where they will be prepared for an exploratory laparotomy and treated with pelvic stabilization and PPP. Patients who do not have free fluid will only require external pelvic fixation and a PPP. If the patient regains hemodynamic stability following surgery, a contrast-enhanced CT scan will be conducted. The patient will receive embolization if active blushing is seen, since it has a strong correlation with bleeding on angiography. If, on the other hand, the patient's instability persists following surgery, embolization will be performed without a CT scan since there is a high probability that the bleeding has an arterial origin [22].

It should be acknowledged that the time necessary for an on-call interventional radiologist (IR) to show up to the hospital and find/embolize vascular injuries during angiography might cause procedural delays. In addition, venous injuries (80% of cases as previously said) will persist after embolization. Because of this, endovascular treatment should be taken into consideration for unstable patients when there will not be an undue delay in care or when other measures, such as PPP, aortic balloon occlusion, and/or blood transfusions, have already been performed [4,21,23].

ENDOVASCULAR TREATMENT

When Should Angiography be Performed?

The undisputed indications for performing angiography are active extravasation of contrast medium on CT, the presence of pseudoaneurysms, and the presence of arteriovenous fistulas [1]. Nevertheless, the sensitivity of a CT scan in detecting active bleeding after trauma is known to be between 60 and 90% [24,25]. There are several cases in which angiography may be necessary even in the absence of evidence of arterial injury on CT examination, such as, for example, in patients with persistent hemodynamic instability after PPP or in the presence of a large (>500 cm^3) pelvic hematoma even in the absence of active blush on CT examination [26].

Embolization Technique

The common femoral artery is punctured at the level of the femoral head, generally on the opposite side to the hematoma, to facilitate pelvic vessel catheterization. Two femoral accesses could be obtained in some elderly individuals or in patients with especially convoluted arteries to shorten the amount of time needed for the procedure. Puncture on palpatory guidance is not always possible given the hypotension these patients might have. In addition, pelvic binders may hide the artery. In these cases, the use of ultrasound guidance for a puncture may help.

As regards the upper limb arteries approach, these arteries have historically been punctured in situations of significant pelvic soft-tissue injury or when pelvic devices prevent transfemoral access. Nevertheless, radial artery access is becoming more and more popular in trauma patients, with technical success rates comparable to those of femoral access [27,28].

If there are no obvious sources of bleeding on the CT scan, non-selective as well as selective angiographies in various projections should be performed to search for sources of bleeding.

Selective angiographies should always be performed and are of the utmost importance to rule out or confirm bleeding spots [29].

The primary goal of embolization is to quickly stop blood flow to the injured vessels to restore hemodynamic stability. Whenever feasible, super-selective embolization is preferable; however, it should be considered that the time required to manipulate a microcatheter into smaller pelvic visceral arteries might cause the treatment to take longer than necessary.

If, for instance, the patient is hemodynamically unstable or has deteriorating vital parameters, a quick embolization of the entire anterior or posterior division branch of the internal iliac artery is preferable to a time-consuming super-selective embolization of the single vessel responsible for the bleeding. Moreover, the increased risk of ischemia given by non-selective embolization is mitigated by the rich collateral network present in this anatomical region [1]. Other authors, however, assert that selective embolization may be carried out as quickly as proximal embolization without reducing the survival rate of trauma patients [30].

The hemodynamic status of the patient should also guide the IR to choose between multiple embolic agents and devices that can be used in the management of PT. The choice of the embolic agent depends on the physician's experience and the vascular injuries on a case-by-case basis. Generally, temporary embolic agents such as gel foam should be used in the case of large territory embolization or empiric embolization, while definitive embolic material, liquids or solids, should be preferred for super-selective embolization. In addition, as previously mentioned, it is important to access the coagulation profile of the patient prior to embolization. If coagulation is altered, as is frequently seen in trauma patients, some embolic materials (i.e. coils, gel foam) will not achieve hemostasis easily.

A borderline case is when there are no signs of bleeding on angiography in a hemodynamically unstable patient who has not had a CT scan and there is free fluid in the abdomen on FAST ultrasound. In these cases, prophylactic embolization with resorbable material (i.e. gel foam) is recommended for temporary occlusion [31,32]. In addition, no significant differences in survival, complications, and days of hospitalization are reported in patients who underwent this procedure.

Complications related to embolization are not frequent and are mostly related to access site points, including bleeding, hematoma, pseudoaneurysms, and arteriovenous fistulae. Other complications associated with arterial embolization itself arise either accidentally from non-target embolization or as an inevitable consequence of big vessel or bilateral embolization. The femoral head, lower leg, pelvic viscera, and gluteal muscles can all be affected by ischemia or necrosis [33].

REBOA

REBOA is a relatively new temporary measure to control hemodynamically unstable trauma patients in the early resuscitative phase. It consists of the inflation of an endovascular aortic balloon through a femoral introducer sheath.

In short, REBOA is an alternative to emergent resuscitative thoracotomy (RT) in hemodynamically unstable trauma patients [34,35], whose only requirement is a femoral arterial access. It enables the reestablishment of a systolic blood pressure >90 mmHg, which allows for further diagnostic investigations (CT scan with contrast medium injection) or interventions such as pelvic packing or embolization.

Due to the potential for visceral organ ischemia, REBOA should ideally not be positioned in Zone 2 (para-renal), but rather in Zone 1 (supra-celiac or descending aorta) or Zone 3 (infra-renal).

Zone 3 REBOA may be the best option for pelvic bleeding since it allows for a prolonged occlusion period of 4–6 hours and prevents ischemic/reperfusion injury to visceral organs [36].

REBOA complications can be severe and bring the resuscitative effort to a premature end due to arterial disruption or dissection [37,38].

International registries on the use of REBOA in trauma have yielded positive results, but there are still open questions regarding its application, such as the best location and timing for access, the best zone for inflation, and which medical specialist should oversee the procedure [5].

OUTCOME AND FUTURE PERSPECTIVES

Endovascular procedures in the management of PT injuries are safe procedures with a high success rate ranging from 74% to 100% of cases [39].

Most reports in the literature on the subject are retrospective, for obvious ethical reasons.

The application of embolization and pre-peritoneal packing in hemodynamically unstable PT patients varies greatly around the world. Historically, PPP has been more extensively utilized in Europe, while embolization has more commonly been employed in the United States [40,41].

More recently, PPP was adopted in North America too, given the assumption that delays in embolization due to a lack of staff availability or the need for trips to the angiography suite have shown an increase in patient mortality. In the early 2000s, Verbeek et al. in a large multicentric study showed improved outcomes and a faster time to intervention with pre-peritoneal packing, but they also revealed that embolization was consistently required for the most critically ill patients to achieve hemorrhage control [23].

On the other hand, in a recent review and meta-analysis on the comparison of pre-peritoneal packing and embolization in unstable PT patients, McDonogh et al. showed that analysis of dual-arm studies showed no significant difference in mortality between PPP and embolization, with 27% of patients treated with PPP requiring subsequent embolization for inadequate hemorrhage control. The authors believe that a definitive comparison between modalities is unachievable due to bias, heterogeneity, and insufficient reporting of physiological data, underscoring the necessity of standardized reporting in this high-risk subset of trauma patients [42].

To overcome the gap in published guidelines, Renzulli et al. proposed a possible standardization of the angiographic procedure in the setting of PT, concerning how and when to perform the procedure, the interventional technique, and embolization materials used [29].

A new standardization protocol was proposed in Hong Kong in order to minimize the time required for the intervention needed by the PT patient. It consists of performing sequentially in the same room the three pillars of therapy of hemodynamically unstable PT patients: external fixation, PPP, and embolization. In a recent multicenter analysis, this protocol was identified

as the single most independent predictive factor for 30-day, 7-day, and 24-hour mortality rates [43,44].

However, a large workforce comprising a multidisciplinary team of anesthetists, orthopedic surgeons, general surgeons, and IRs would need to be available around the clock in trauma care centers to accomplish this one-step resuscitation and therapeutic action.

CONCLUSIONS

PT is a life-threatening condition with a very high rate of variability in presentation and outcomes. The management of such pathology involves medical specialists from multiple fields and, among them, the IR plays a key role. New standardized protocols for the management of these patients must be implemented to minimize the time spent on deciding the correct treatment for each patient.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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Narrative Review Article

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Anatomy and Classification of Pelvic Trauma

Jacopo Giuliani, Riccardo Guelfi, Camilla Cremonini, Dario Tartaglia, Giuseppe Zocco, Massimo Chiarugi and Federico Coccolini

General, Emergency and Trauma Surgery Department, Pisa University Hospital, Pisa, Italy

Pelvic fracture is one of the most complex injuries in trauma treatment. Bleeding continues to be one of the primary causes of death from pelvic fracture, and the severity of bleeding is not necessarily correlated with the fracture pattern. The priorities in managing pelvic fractures include controlling bleeding. Historically, classification systems only consider the anatomical fracture pattern, which does not correlate with the outcomes. The World Society of Emergency Surgery (WSES) classification considers both the pelvic fracture pattern and the hemodynamic condition of the patient. Vascular injuries caused by pelvic fractures are potentially lethal because they often manifest as non-compressible multifocal venous bleeding (80–85% of pelvic bleeding) and less frequently as arterial bleeding (15–20% of pelvic bleeding). The presence of vascular injury and open pelvic fractures are independent factors contributing to mortality. Another fundamental factor in the management of pelvic vascular trauma is time [1]. In this context, the assessment of potentially significant vascular injury and timely hemorrhage control should be the highest priorities in the acute management of these injuries. Classification of pelvic injuries that considers both the fracture pattern and the hemodynamic status of the patient, such as the WSES classification, appears to have greater utility in clinical practice compared to the diffused anatomical classification.

Keywords: *Pelvic Fracture; Blunt Trauma; Hemodynamic Status; Bleeding; Vascular Injuries*

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INTRODUCTION

Pelvic fracture is one of the most complex injuries in trauma treatment and is often the result of high-energy blunt trauma, accounting for approximately 3% of all skeletal injuries [2–4]. Patients are typically young and exhibit a high Injury Severity Score (ISS). Mortality rates remain elevated, ranging from 5 to 16%, particularly in patients with hemodynamic instability and severe associated injuries [5–7].

Bleeding continues to be one of the primary causes of death from pelvic fracture, and the severity of bleeding is not necessarily correlated with the fracture pattern. In patients with pelvic trauma, the prognosis is more closely linked to the severity of pelvic vascular injury than to pelvic ring fractures [8]. The initial management of pelvic trauma primarily focuses on physiological alterations and associated injuries, placing less emphasis on fracture patterns. The priorities in managing pelvic fractures include controlling bleeding, stabilizing hemodynamics, correcting coagulopathy and physiology, followed by achieving definitive mechanical stabilization of the pelvic ring.

Historically, the Young–Burgess [9] and Tile [10] classifications are the two most commonly recognized in the literature. These two classification systems only consider the anatomical fracture pattern, which does not correlate with the outcomes of patients with pelvic trauma. Rommens et al. [11] recently developed a radiographic classification (anatomical fracture pattern) for managing fragility fractures of the pelvis (FFPs) [11,12].

In 2017, the World Society of Emergency Surgery (WSES) published its guidelines for the classification and management of pelvic trauma. The WSES classification categorizes pelvic trauma injuries into mild, moderate, and severe, taking into consideration both the pelvic fracture pattern and the hemodynamic condition of the patient [13]. Pelvic fractures may be open or closed. Open pelvic fractures are relatively rare but more complex due to concurrent internal and external bleeding [14]. They are also usually associated with the onset of infection that may progress to sepsis, contributing to mortality [4,15–18]. Sepsis is associated with only 2–4% of all pelvic fractures but carries a mortality rate of up to 45% [19–21]. Therefore, an open pelvic fracture can be regarded as a specific pattern of disease with distinct injury severity and treatment strategies [22].

Corresponding author:
Federico Coccolini MD, General, Emergency and Trauma Surgery, Pisa University Hospital, Via Paradisia 1, 56100, Pisa, Italy.
Email: federico.coccolini@gmail.com

Ethical Approval and Informed Consent

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YOUNG–BURGESS CLASSIFICATION

The Young–Burgess classification (Figure 1) categorizes pelvic fractures according to the mechanism of injury [9]:

- Antero-Posterior Compression (APC):
  - APC I: less than 2.5 cm of widening of the pubic symphysis with no posterior instability, both clinically and radiographically;
  - APC II: widening of the pubic symphysis and posterior pelvic instability due to the rupture of the anterior sacroiliac complex;
  - APC III: associated with complete posterior ligamentous disruption.
- Lateral Compression (LC): LC injuries occur when a force, applied laterally and directed medially, is exerted on the pelvis. Fractures are more common with LC injuries compared to APC injuries.
  - LC I: lateral force applied to the back of the pelvis, representing a spectrum of injuries. The severity of sacral injury varies from an incomplete anterior iliac wing fracture to a complete sacral fracture, depending on the amount of energy applied to the pelvis at the time of injury. The degree of pelvic instability correlates with the severity of the injury, and there might be a role for stress radiographs in classifying this instability;
  - LC II: sacral fracture, rupture of the sacroiliac ligament and joint, or a crescent-shaped fracture dislocation of the ilium;
  - LC III: injuries result from a greater force. Ipsilateral internal rotation of the hemipelvis causes injuries to the contralateral hemipelvis in the form of anterior sacroiliac ligament rupture and injury to the sacrospinous and sacrotuberous ligaments.
- Vertical Shear (VS): These injuries result from an axial force applied to one or both hemipelvis lateral to the midline. The sacrum is pushed downward, causing complete ligamentous injury. Pelvic ring fracture may be present instead of ligamentous injury.
- Complex: A combination of the three primary patterns (APC, LC, or VS). Most of them result from combined LC injuries with APC or VS patterns.

TILE CLASSIFICATION

The Tile Classification (1980) is based on the type of mechanical instability of the pelvic ring [10].

- Type A: does not involve the pelvic ring itself and it is mechanically stable;
- Type B: rotational instability;
- Type C: vertical instability.

ROMMENS CLASSIFICATION FOR FFPS

The Rommens Classification is a classification for managing FFPs resulting from low-energy impacts (typically in elderly patients). It is based on morphological criteria

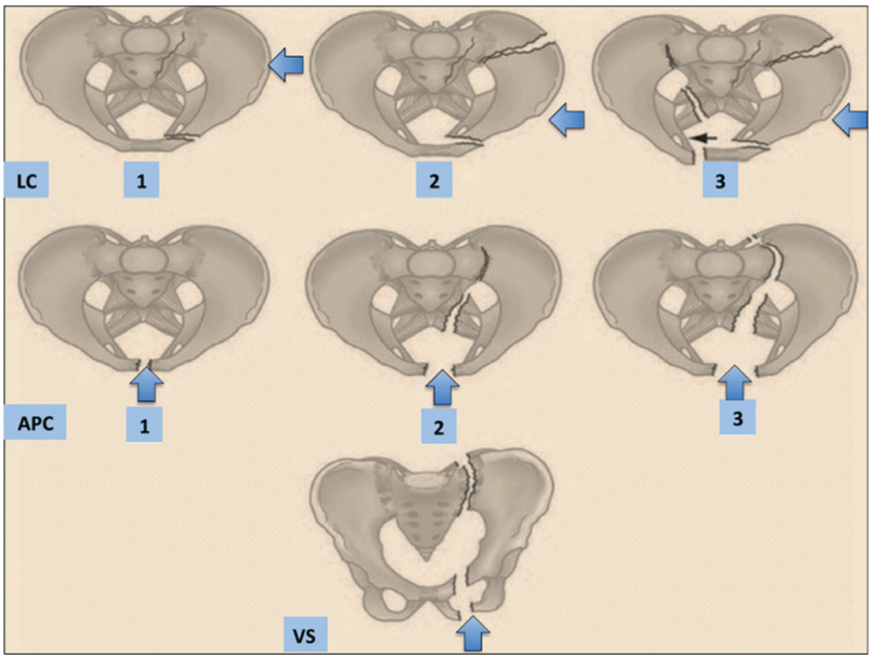

Figure 1 Young–Burgess classification for skeletal pelvic lesions.

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and corresponds to the degree of instability of the pelvis [11,12].

- FFP type I:
  - a: unilateral anterior pelvic ring disruption;
  - b: bilateral anterior pelvic ring disruption;
- FFP type II:
  - a: dorsal non-displaced posterior injury;
  - b: only sacral crush with anterior disruption;
  - c: non-displaced sacral, sacroiliac, or iliac fracture with anterior disruption;
- FFP type III:
  - a: displaced unilateral ilium fracture and anterior disruption;
  - b: displaced unilateral sacroiliac disruption and anterior disruption;
  - c: displaced unilateral sacral fracture together with anterior disruption;
- FFP type IV:
  - a: bilateral iliac fractures or bilateral sacroiliac disruptions together with anterior disruption;
  - b: spinopelvic dissociation together with anterior disruption;
  - c: a combination of various posterior instabilities together with anterior disruption.

WSES CLASSIFICATION

The WSES classification takes into account both the anatomical pattern of pelvic fracture and physiological changes in the patient (hemodynamic stability or instability). The WSES Classification divides pelvic ring injuries into three classes (Table 1):

- Minor (WSES Grade I): hemodynamically and mechanically stable injuries (APC 1 and LC 1);
- Moderate (WSES Grades II and III): hemodynamically stable and mechanically unstable injuries (APC 2–3 and LC 2–3);
- Severe (WSES Grade IV): hemodynamically unstable injuries regardless of mechanical status.

As previously mentioned, the ATLS definition considers a patient "hemodynamically unstable" when blood pressure <90 mmHg and heart rate >120 bpm, with evidence of cutaneous vasoconstriction (cold, moist, reduced capillary refill), an altered level of consciousness and/or dyspnea [23].

Based on this classification, WSES has provided a management algorithm for patients with pelvic trauma [13].

DISCUSSION

The management of pelvic trauma continues to be a challenge. Pelvic fractures are often the result of high-energy impact and are generally associated with multisystem injuries and catastrophic bleeding. Most deaths related to pelvic fractures have been caused by associated injuries (i.e., brain trauma) [24–26]. Vascular injuries caused by pelvic fractures are potentially lethal because they often manifest as non-compressible multifocal venous bleeding (80–85% of pelvic bleeding) and less frequently arterial bleeding (15–20% of pelvic bleeding). In pelvic trauma, hemorrhage is indeed the most common cause of preventable death [8]. However, the Young–Burgess and Tile classification models do not correlate with the number of transfusions and do not show a consistent correlation with the need for urgent embolization.

The WSES classification of pelvic trauma, in addition to pelvic fracture stability, takes into consideration the hemodynamic conditions of the patient, allowing for an approach that directly targets the stabilization of hemodynamics and the control of pelvic bleeding.

Wang et al. [27], in line with the WSES classification, confirm that in patients with pelvic trauma mortality rates increase significantly with the severity of the injury class (from minor to severe injuries). They also note that the stability/instability of the pelvic ring does not have a significant impact on mortality. Furthermore, Wang et al. highlight the presence of vascular injury and open pelvic fractures as independent factors contributing to mortality [27]. Pelvic vascular injuries have been identified in 7–10% of stable pelvic fractures, often considered minor injuries and typically managed conservatively. Some of these fractures may even require angiographic embolization. Not only should the mechanical stability be assessed, but the associated vascular injury should also be considered in the management algorithm. The impact of mechanical pelvic stability on pelvic fracture mortality was statistically non-significant. However, the associated vascular injury served as an independent risk factor

Table 1 WSES Classification.

WSES Classification	*WSES Grade*	*Young–Burgess Classification*	*Hemodynamics*	*Mechanic*
Minor	WSES grade I	APC I – LC I	Stable	Stable
Moderate	WSES grade II	LC II/III – APC II/III	Stable	Unstable
	WSES grade III	VS – CM	Stable	Unstable
Severe	WSES grade IV	Any	Unstable	Any

for mortality. Unlike closed fractures, open pelvic fractures can lead to concurrent external bleeding, internal hemorrhage, associated injuries to the ano-rectal or urogenital regions, infections related to contaminated wounds, and other complications (sepsis and multi-organ dysfunction). Patients with open pelvic fractures exhibit significantly worse outcomes (higher mortality rate, increased infection rate, longer hospitalization time, and extended stay in the intensive care unit) compared to patients with closed pelvic fractures of the same WSES class (minor, moderate, and severe) [27].

Li et al. [22] evaluated the application of the WSES classification to patients with open pelvic fractures. In their study, they highlight that even in the case of open pelvic fractures, mortality, duration of intensive care unit admission, and hospitalization duration increase with the rising WSES grade of pelvic trauma. Furthermore, there is a correlation between open pelvic fractures and the development of sepsis. Sepsis proves to be an independent risk factor for mortality in patients with open pelvic fractures. Additionally, patients with sepsis exhibit significantly higher percentages of pelvic instability and associated vascular injuries compared to patients without septicemia. Besides hemorrhage control, the management of wound infection and the potential development of sepsis are crucial in the management of open pelvic fractures (broad-spectrum antibiotics for gram-positive and gram-negative bacteria, surgical debridement, and creation of a diverting colostomy). According to Li et al., the WSES classification is applicable when managing patients with open pelvic fractures; however, they emphasize that by adding the onset of sepsis as an additional variable (WSES classification + sepsis), a better prediction of mortality is achieved in cases of open pelvic fractures [22].

Another fundamental factor in the management of pelvic vascular trauma is time [1]. In this context, the assessment of potentially significant vascular injury and timely hemorrhage control should be the highest priorities in acute management [8].

In a retrospective cohort study, Spering et al. proposed a score to detect pelvic vascular injury in patients with severe pelvic fractures in pre-hospital trauma management. They identified nine predictive factors incorporated into a clinical score to identify patients with pelvic fractures at risk of significant vascular injury (P-VIS) [1].

- Patient condition:
  - Age ≥70 years;
  - High-energy trauma;
  - Penetrating trauma/open pelvic injury;
  - Shock index ≥1;
- Pre-hospital interventions:
  - Cardiopulmonary Resuscitation;
  - Replacement of >1 liter of fluid;
  - Intubation;
- Compensation:
  - Need for vasoactive drug therapy;
  - Residual shock (systolic blood pressure SBP ≤90 mmHg) under therapy.

A score of 0–2 points represents almost no risk of vascular injury, 3–5 points indicate a probable pelvic vascular injury, 6–8 points identify a very probable pelvic vascular injury, and 9 points represent an apparent vascular injury. This score is easy to apply and would suggest early pelvic stabilization through pelvic binding, as well as immediate transfer to a Level I Trauma Center and the subsequent early activation of an extended trauma team with vascular repair capabilities and high transfusion availability.

CONCLUSIONS

The severity of hemodynamic and physio-metabolic derangement represents a fundamental issue in the early management of patients with pelvic trauma.

Therefore, a classification of pelvic injuries that considers both the fracture pattern and the hemodynamic status of the patient, such as the WSES classification, appears to have greater utility in clinical practice compared to the diffused anatomical classification.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

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Commentary

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REBOA in Severe Brain Injury: Fatal Combination or Another Treatment Alternative?

Khan–Kessel Corner

Mansoor Khan[1] and Boris Kessel[2]

[1]*Department of Trauma Surgery, Hull Royal Infirmary, Hull, UK*
[2]*Division of General Surgery and Trauma, Hillel Yaffe Medical Center, affiliated with Rappaport Medical School, Technion, Haifa, Israel*

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Resuscitate thoracotomy (RT) is considered as a last resort to save lives of massively bleeding patients in Class IV hemorrhagic shock. Aortic cross-clamping of the descending thoracic aorta redistributes the patient's limited blood volume to the vital organs: myocardium and brain. The outcome of this procedure is arterial hypertension above the clamp and hypotension below the clamp. This dramatic intervention in patient physiology has multiple consequences, including significant increased cerebral blood flow. During the last decade, a new technique – resuscitate endovascular balloon occlusion (REBOA) – has emerged as a viable alternative to open aortic clamping. The most significant advantage of this technique is that, in selected patients, its minimally invasive nature allows it to be proactively employed prior to critical hemodynamic deterioration. Due to increasing experience and the spread of the learning curve, multiple studies have already been published, but mortality data on REBOA use is conflicting. Actually, the rationale for both techniques is the same, with the only difference being in the way aortic control is obtained – extra or intraluminally. Interestingly, in the era of open thoracotomy and aortic clamping, suspected or proven severe traumatic brain injury (TBI) was not considered as an absolute contraindication for this procedure. However, the use of REBOA in these patients is severely criticized, most probably due to the potential significant impact on brain physiology. The first expert opinion study on REBOA use in 2019 did not reach consensus on whether TBI patients may experience any benefit on REBOA use [1]. However, the accumulative data from recent years demonstrate that the issue is still under active investigation and answers are yet to be determined. Elkbuli et al., in a study on patients suffering TBI who underwent REBOA, showed that inpatient mortality with REBOA does not differ between patients with or without concomitant TBI [2]. Furthermore, in a large study spanning 8 years, Brenner et al., found that Zone 1 REBOA had better outcomes compared with RT in all patterns of injury, including TBI patients [3].

We raise several questions that should be addressed, and we will be happy to open discussion on our journal pages. Theoretically, supra-physiological blood pressure and increased carotid blood flow induced by aortic occlusion may worsen cerebral edema, increase intracranial pressure, or exacerbate intracranial hemorrhage. The question we need to ask is how dangerous is it to occlude the aorta in TBI patients? Will increasing cerebral blood flow (CBF) exacerbate the bleeding? Will increased CBF result in intra-cranial pressure (ICP) elevation and affect neurologic outcomes? Does this increase the risk of potential brain herniation?

The true effect of aortic occlusion on the injured brain is unclear. Only a few investigations have been performed in this area, all of which have been conducted on animals. In 1990, Shackford et al., in a study on four groups of animals, found that aortic clamping improved perfusion to the injured brain without a significant increase in ICP. In addition, this study demonstrated that aortic occlusion elevated mean arterial pressure and appeared to have no detrimental effect on ICP, CBF and cerebral blood pressure [4]. One may claim that an increase in CBF may exacerbate existing intracranial hemorrhage. Currently, in our opinion,

Corresponding author:
Mansoor Khan, Department of Trauma Surgery, Hull Royal Infirmary, Hull, UK.
Email: manskhan@doctors.org.uk

such statements cannot be proved or excluded. In a single-animal study, Cralley et al. demonstrated that REBOA does not worsen brain injury [5]. Similar results were demonstrated in Johnson et al.'s study, which did not demonstrate any differences in the percentage of animals with hemorrhage progression on CT after REBOA. Another very interesting finding of this study was that in the animal model, rapid blood resuscitation, and not REBOA, resulted in the largest increase in ICP [6]. In addition, the impact of multiple brain autoregulation mechanisms in "artificially" changed brain physiology is completely unclear. In summary, we feel that, as clear conclusions regarding REBOA are unlikely to be established in animal models, larger randomized investigations utilizing human subjects are urgently needed.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Case Report

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REBOA to the Rescue: Successful Endovascular Resuscitation of Methemoglobinemia-Induced Cardiac Arrest

Lucas P Bowen, Nakia U Armendariz, Jadeyn M King, Laura J Moore and Anna K Mydlowska

Department of General Surgery, University of Texas Health Science Center, Houston, TX, USA

REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta) is an endovascular occlusion device commonly used to temporize bleeding due to traumatic non-compressible torso hemorrhage. This case report presents the successful utilization of REBOA in the resuscitation of a critically ill trauma patient that presented to the emergency department status post motor vehicle collision, later found to have methemoglobinemia. The REBOA was placed as part of a catch-all trauma workup following cardiac arrest after intubation. The timely placement of the REBOA resulted in a return of spontaneous circulation within 30 seconds of balloon inflation. While it is not a definitive treatment of methemoglobinemia, REBOA allowed us to successfully resuscitate the patient until final diagnosis and treatment of the underlying methemoglobinemia could be made. The patient would go on to regain full neurologic function. We believe that this is the first reported resuscitation of a patient with methemoglobinemia utilizing the REBOA device.

Keywords: *REBOA; Methemoglobinemia; Non-Traumatic Cardiac Arrest; Resuscitation; Shock*

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INTRODUCTION

REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta) is a minimally invasive large vessel occlusion device used as a substitute for resuscitative thoracotomy with aortic clamping [1,2]. Its application results in an increase in coronary blood flow, cardiac output, mean arterial pressure, carotid blood flow, and partial pressure of oxygen to the brain [3–5]. While REBOA has begun to carve a niche in managing hemorrhagic shock, its use in the broader treatment of hypoperfusion is in its infancy. Currently, limited data exists demonstrating its feasibility in the management of non-trauma cardiac arrest in humans [6–12]. Building on this, we present a unique case of successful REBOA deployment in a case of dissociative shock secondary to methemoglobinemia poisoning. The early initiation of REBOA led to the prompt restoration of circulation and facilitated the stabilization of the patient until definitive diagnosis and treatment.

CASE PRESENTATION

A 60-year-old male with no known previous medical history presented to the emergency department as a level one trauma activation. His car reportedly collided into a tree at between forty and fifty miles per hour. According to the emergency medical services, the patient ingested an "energy drink" immediately preceding the accident. On arrival at the emergency department, the patient's Glasgow Coma Score (GCS) was 11. He was notably diaphoretic and hypoxic at a maximum O_2 saturation of 88% on a non-rebreather. Additionally, he was notably hypotensive with an initial blood pressure of 82/50. On primary examination, the patient demonstrated no external signs of trauma.

Corresponding author:

Lucas Bowen, Department of General Surgery, University of Texas Health Science Center, 6431 Fannin St, Houston, TX 77030, USA.

Email: Lucas.P.Bowen@uth.tmc.edu

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The patient was immediately started on high-flow oxygen, and two large-bore peripheral intravenous access points were established. A workup including chest X-ray, pelvic X-ray, and Electrocardiogram (EKG), and focused assessment with sonography for trauma (FAST) exam was notably negative for pathology. Due to the severity of hypotension, he received a blood transfusion using the 1:1:1 strategy (packed red blood cells, platelets, and plasma) which improved his systolic blood pressure to 90 mmHg. However, the patient remained hypoxic, at below 90% oxygen saturation. Endotracheal intubation was then performed to secure the airway and provide ventilatory support.

Within seconds of intubation, the patient experienced a sudden loss of pulses. One round of immediate cardiopulmonary resuscitation and epinephrine administration was initiated, and a COBRA-OS REBOA was placed via the right common femoral artery. The catheter was inserted into Zone 1 via the 4 French sheath, and placement was confirmed via chest X-ray (Figure 1). Balloon inflation was then initiated at full occlusion of 13 cc at a time of 14:34. Within 30 seconds of balloon inflation, the patient achieved return of spontaneous circulation (ROSC). The balloon was then partially deflated at 14:48, and the patient was taken for an emergent computed tomography scan, which was negative for an acute process. Although intubated, the patient remained hypoxic with a maximum oxygen saturation of 88% and notable perioral cyanosis.

A radial arterial line was then placed, yielding brown "chocolate" blood which made the clinical team suspicious for methemoglobinemia. Subsequent labs were notable for an elevated methemoglobin level of 28.7%. The REBOA balloon was then completely deflated and removed at 15:07 and supportive care was initiated. After the administration of methylene blue, the patient remained hemodynamically stable and was transferred to the intensive care unit for further management. Within 24 hours, the patient was extubated and weaned to room air. He exhibited neurological recovery and a GCS score of 15. The patient was eventually discharged following a short hospital course.

Ethical Approval and Informed Consent

As a de-identified case report, no ethical approval or written informed consent was required for this study.

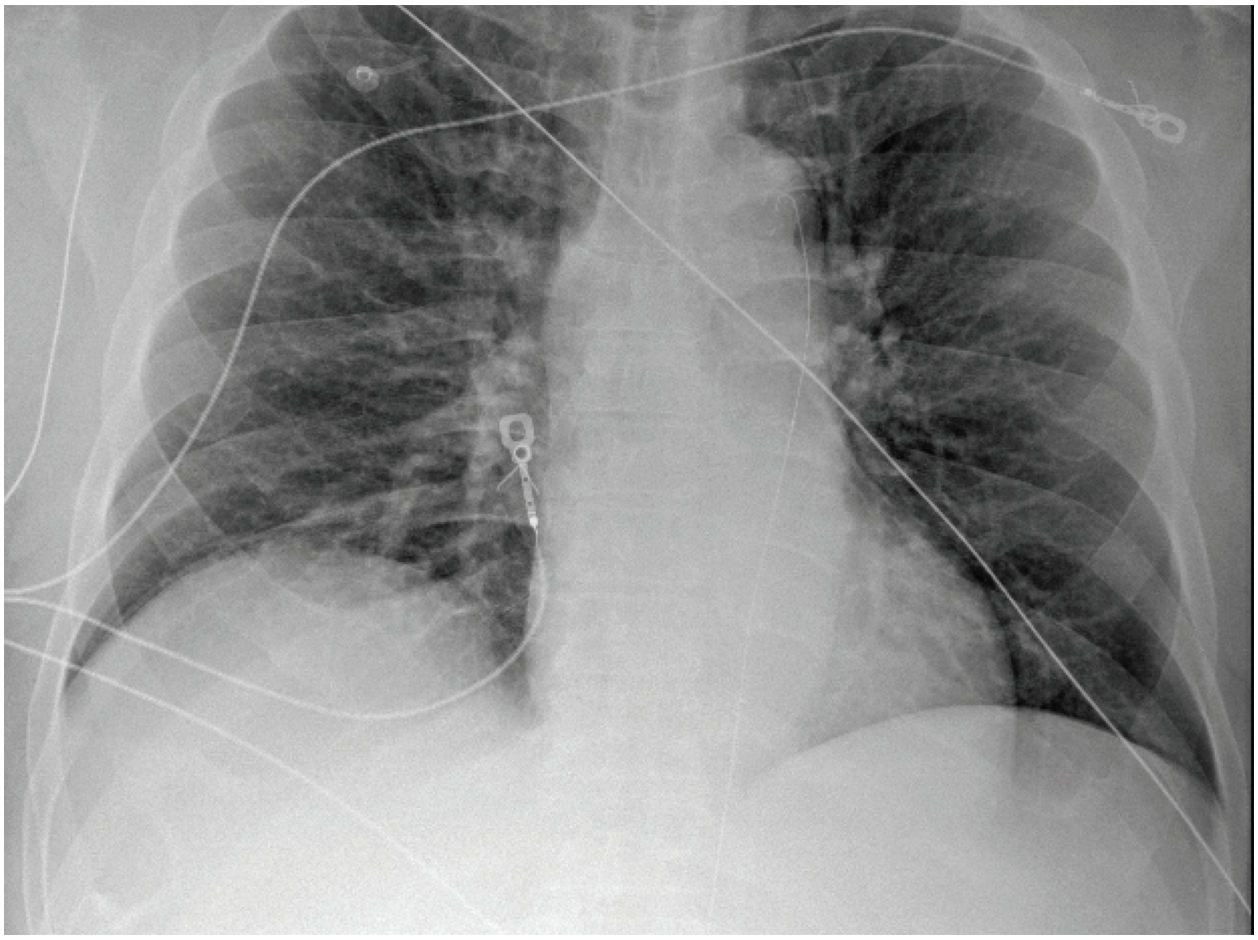

Figure 1 Chest X-ray confirming Zone 1 REBOA placement.

DISCUSSION

This case demonstrates the potential life-saving impact of REBOA in a patient suffering cardiac arrest secondary to hemoglobinopathy. While it is not a definitive treatment for methemoglobinemia, REBOA enabled us to successfully resuscitate the patient until final diagnosis and treatment of the underlying pathology could be made. Several keys to the successful use of REBOA included early placement of common femoral artery access for monitoring of hypotension, and clinician competency with the REBOA procedure. While data on the use of REBOA in non-trauma cardiac arrest is limited, the improvement in coronary and cerebral perfusion previously demonstrated in animal studies is likely responsible for ROSC with balloon inflation [6–12]. While REBOA use has been widely adopted by many trauma surgeons, its use in other populations remains limited. Emergency medicine physicians can be successfully trained in the use of REBOA through established, validated training courses [13].

Factors such as pre-existing medical conditions and anatomical considerations must be diligently evaluated prior to REBOA utilization [14]. Furthermore, vascular injuries, thromboembolism, and lower-extremity amputation due to unrecognized vascular access complications are a potential reality of REBOA treatment [15]. Many of these access site complications were associated with the use of large 12 French sheaths required for the first-generation REBOA device. However, with the recent introduction of smaller sheaths, the rate of these adverse events has been shown to lower dramatically [16].

As a retrospective case report, our study bears limitations establishing causation and generalizability, and is susceptible to human error in the electronic medical record. To our knowledge, this case report is the first to document the management of methemoglobin-induced cardiac arrest. The profound impact of REBOA on managing dissociative shockz demonstrated through this patient's trajectory, merits further investigation.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflict of Interest

Laura Moore is Chair of the Scientific Advisory board, has an equity stake, and receives consulting fees from the developer of COBRA-OS REBOA, Front Line Medical Technologies Inc.

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Case Report

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A Rare Cause of Abdominal Pain: Splenic Artery Aneurysm and Endovascular Treatment

Halil Oktay Usluer[1], Akif Yarkaç[2], Çağrı Safa Buyurgan[2], Buğrahan Güldür[2], Ataman Köse[2], Seyran Bozkurt[2] and Engin Kara[3]

[1]Siverek State Hospital, Emergency Medicine Department, Sanliurfa, Turkey
[2]Mersin University Medical Faculty, Emergency Medicine Department, Mersin, Turkey
[3]Mersin University Medical Faculty, Radiology Department, Mersin, Turkey

Keywords: *Abdominal Pain; Coil Embolization; Emergency; Rupture; Splenic Artery*

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INTRODUCTION

Splenic artery aneurysm (SAA) and splenic artery rupture are rarely seen in the emergency department. The most common visceral artery aneurysm is a SAA, which accounts for about 60–80% of all visceral artery aneurysms. Other common sites include the hepatic artery, the superior mesenteric artery, and the celiac artery [1]. However, SAAs are more prevalent, especially among women and individuals with certain risk factors such as pregnancy, portal hypertension, or connective tissue disorders [2,3]. SAA rupture has been reported to occur between 2% and 10% of SAA cases [4]. A ruptured SAA is an emergency condition and can be fatal if not treated early. Here, we aim to present a case of syncope after abdominal pain due to a ruptured SAA.

CASE REPORT

A 51-year-old male patient presented to the emergency department with abdominal pain and diarrhea, both of which he had been experiencing for 10 days, and dizziness, which had started on the day he arrived at the emergency department, followed by syncope. He had no known comorbidities. There was no history of previous operations, pancreatitis, or abdominal trauma. Vital signs were blood pressure 65/42 mmHg, pulse rate 72 per minute, and respiratory rate 20 per minute. Physical examination was normal except for diffuse abdominal tenderness. The laboratory findings were as follows: Hgb: 9.4 g/dL, pH: 7.36, HCO_3: 22.0 mmol/L, Beb-ecf: –2.7 mmol/L.

A 64-slice contrast-enhanced computed tomography (Toshiba Activion 16-Toshiba Medical Systems Corporation, Tochigi, Japan) revealed diffuse, dense free-fluid densities in the perigastric, peripancreatic, and perisplenic areas; faint density increases in the mesenteric adipose tissue that may be compatible with hematoma; and an aneurysm in the splenic artery. The presence of fluid and fat stranding around the aneurysm and around the spleen suggested the diagnosis of aneurysm rupture (Figures 1–3). Aortic aneurysms and dissections were excluded.

An SAA rupture was considered, and intravenous fluid support was administered. The patient underwent emergency surgery by the general surgery department. On exploration, there was diffuse hemorrhagic fluid and coagulum in the abdomen. Approximately 500 cc of hemorrhagic fluid was aspirated. No active bleeding focus could be detected during the operation, and the operation was terminated by placing a drain. The patient underwent an interventional procedure by the Department of Interventional Radiology.

After the placement of a 6F introducer in the right common femoral artery, images were obtained from the celiac superior mesenteric arteries. Subsequently, an attempt was made to reach the splenic artery using 4F and 5F cobra catheters with microcatheter wire complications, but it could not be successfully reached.

Corresponding author:
Halil Oktay Usluer, Siverek State Hospital, Emergency Medicine Department, Sanliurfa, Turkey.
Email: hoktayusluer@gmail.com

Figure 1 The appearance of an SAA is shown with a black arrow (sagittal plan) (the presence of fluid and fat stranding around the aneurysm and around the spleen suggests SAA rupture).

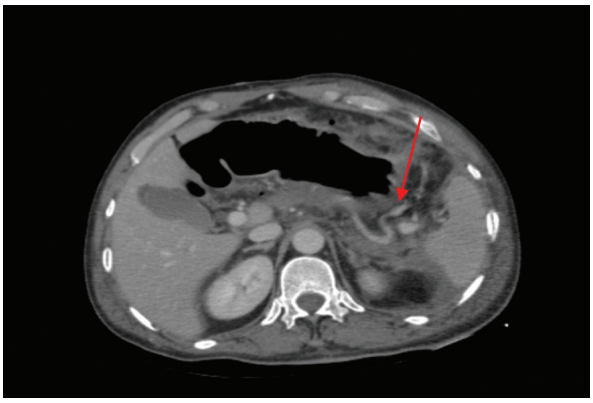

Figure 2 The appearance of an SAA is shown with a red arrow (axial plane) (the presence of fluid and fat stranding around the aneurysm and around the spleen suggests SAA rupture).

Figure 3 The appearance of an SAA is shown with a red arrow (coronal plane) (the presence of fluid and fat stranding around the aneurysm and around the spleen suggests SAA rupture).

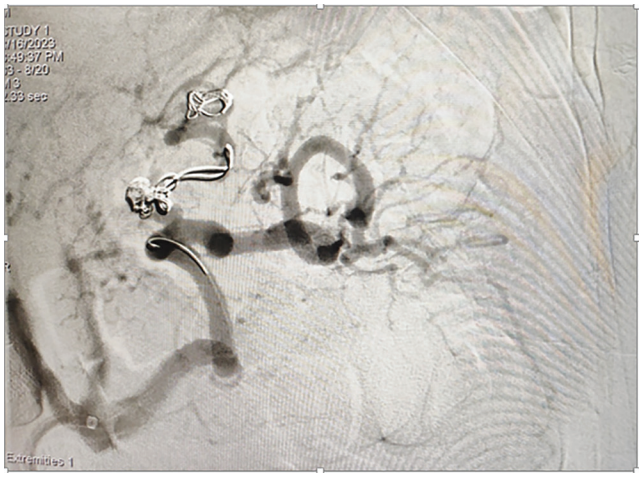

Figure 4 Coil embolization in the interventional procedure performed on the patient.

The aneurysm was then localized with a combination of microcatheter wires placed proximal to the celiac artery using a long introducer with a steerable tip, and the aneurysm and the adjacent splenic segment artery were embolized with coils of 7 × 150 mm, 5 × 150 mm, 5 × 8 mm, 6 × 11 mm, 4 × 10 mm, 3.5 × 8 mm, 3 × 10 mm, and 3 × 8 mm (Balt Extrusion, Montmorency, France). There were no complications, and splenic artery flow improved after the procedure (Figure 4). The patient, who underwent open surgery and subsequent interventional procedures, was followed in terms of fluid therapy, antibiotic therapy, and hemodynamic observation. The patient remained stable throughout the follow-up. After 14 days of hospitalization, outpatient follow-up was recommended and the patient was discharged.

Ethical Approval and Informed Consent

Ethics committee approval was not required for our case. Informed consent was obtained from the patient.

DISCUSSION

Although the exact etiology of SAAs is unknown, the most common pathologic finding is a defect of elastic fiber and smooth muscle loss in the tunica media.

Increased blood flow in the splenic artery seems to be a factor related to aneurysm development; therefore, these aneurysms are more common in fibromuscular dysplasia, portal hypertension, infection, congenital anomalies, liver transplant patients, and patients with pancreatic malignancy [3]. Especially during pregnancy, weakening of the vessel wall due to hormonal changes and increased splenic blood flow may predispose to aneurysm development [5]. It may be secondary to the above-mentioned causes or congenital. According to the International Registry of Acute Aortic Dissection (IRAD), women with vasculopathy are at risk of pregnancy-related vascular dissection. The presence of concomitant hypertension in pregnant patients with vasculopathy is seen as a risk factor for aneurysm development [6]. Our patient was diagnosed with SAA at a young age despite the absence of any predisposition and was subsequently investigated, but no risk factor was found. In a published case report, a 53-year-old woman who died of SAA without any risk factor was found to have possible atherosclerosis and fibromuscular dysplasia findings on histologic examination performed during an autopsy. It is also thought that α-1 antitrypsin deficiency may play a role in the etiology [7].

Patients with SAAs are frequently asymptomatic, but in 20% of cases, there are vague symptoms such as left upper quadrant pain, nausea, epigastric discomfort, and sometimes back pain [8,9]. In our case, the aneurysm manifested itself only with mild abdominal pain, which was present for 10 days, but after rupture, it led to hospitalization with hypotension and syncope.

Generally, aneurysms larger than 3 cm are rare. However, aneurysms larger than 10 cm have been reported in the literature. In aneurysms larger than 5 cm, the risk of rupture increases [9]. In our case, the aneurysm diameter was approximately 9 mm, and although the risk of rupture was low, the patient presented with a rupture clinic. In rupture, the sudden onset of severe abdominal pain, hypotension, or hypovolemic shock is observed and may lead to life-threatening outcomes. Rupture is the most fatal clinical condition in SAA, occurring in 3–9% of cases, and the mortality rate associated with rupture is reported to be up to 36%. Our patient was hypotensive on admission, and although rupture was detected, the patient, with a high amount of intra-abdominal hemorrhage, required prolonged follow-up (14 days). He was discharged from the hospital in good health after successful treatment.

Radiologic imaging methods are essential for the diagnosis. Calcifications can be seen in the left upper quadrant on direct abdominal radiographs. It may not always be possible to visualize the splenic artery with ultrasonography. Computed tomography and magnetic resonance imaging methods can be used to determine the localization, morphology, and other pathological findings that may accompany the aneurysm. In the literature, it has been reported that aneurysms are most commonly seen in the middle 1/3 of the splenic artery [3]. In our case, the aneurysm was located in the middle 1/3 of the splenic artery, and computed tomography helped us in the diagnosis.

Although SAA is usually asymptomatic, it should be treated early as it can lead to complications such as rupture, which can result in mortality. Treatment is recommended when the aneurysm diameter is greater than 2 cm [10]. As pseudoaneurysms have a higher risk of rupture, they should be treated as soon as they are detected, regardless of their diameter. The ideal treatment modality is to maintain flow in the splenic artery and disable the aneurysm by protecting the spleen [3,5], although there are studies reporting that beta blocker agents may reduce the risk of rupture. In the treatment of SAA, depending on the localization of the aneurysm, splenic artery ligation by open surgery or laparoscopic method, ligation of the aneurysm, arterial reconstruction after partial or total aneurysmectomy, and/or splenectomy are planned [7,10].

In our case, these techniques were not applied because active bleeding was not detected at laparotomy. There are opinions advocating that treatment can be performed with percutaneous interventional techniques such as transcatheter embolization, drug-coated stent graft application, or percutaneous coil or thrombin injection after aneurysms are detected on CT angiography. In patients with high operative risk, and especially in patients with bleeding, effective results can be obtained in a short time with arterial embolization using a coil [5]. McDermott et al. reported a success rate of 85% with transcatheter arterial embolization in patients with SAA [11]. Similarly, Guillon et al. reported a 92% technical success rate in endovascular treatment with embolization and stenting in patients with SAA [12]. In practical applications, coil embolization should be the first endovascular method of choice in SAAs.

CONCLUSION

SAA and associated aneurysm rupture are rare yet fatal clinical conditions. Open surgery, laparoscopic surgery, and endovascular treatments are viable options for managing these patients. However, the mortality and morbidity rates associated with surgical interventions are notably high. Conversely, endovascular therapies are increasingly favored due to their less invasive nature, ease of performance, lower complication rates during the procedure, and higher success rates.

Endovascular methods should be prioritized, especially when the patient is within reach of a tertiary care center, when the primary care hospital lacks appropriate surgical expertise, or when transportation of the patient is challenging.

Acknowledgements

The study was performed at Mersin University Faculty of Medicine Hospital. The study has not been previously presented at any forum or meeting.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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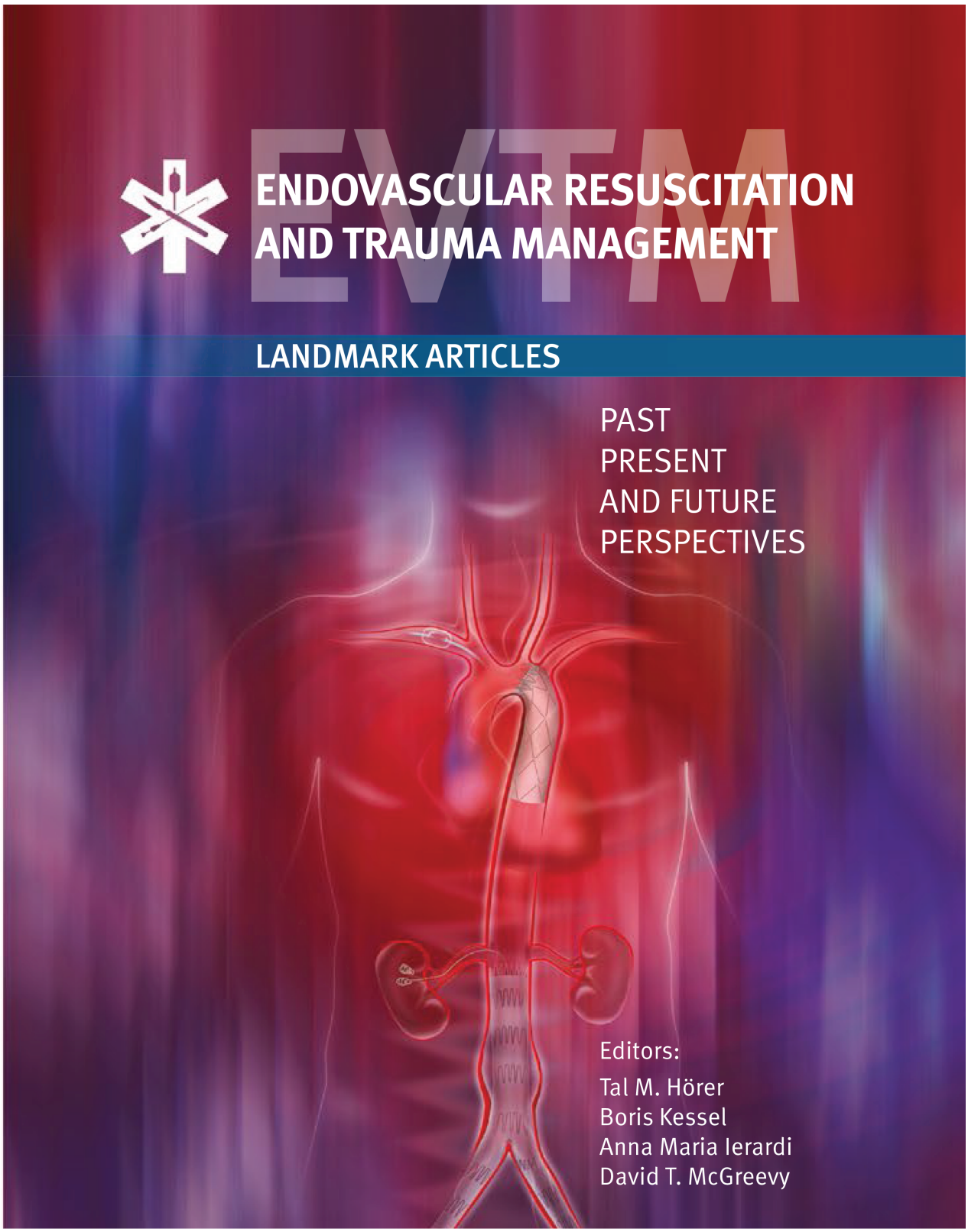
EVTM Landmark Articles



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Education

EndoVascular resuscitation and Trauma Management – Specialists in Training (EVTM-ST) is a newly formed group within the EVTM Society and EVTM Council who represent the interests of trainees, especially with regards to training, education, research and exchange programmes.

One of the main EVTM-ST events is the monthly multidisciplinary international case discussions on Zoom. An appreciated concept with focus on allowing the participating trainees to discuss a presented EVTM case, with only one consultant present for guidance. Participants are from all around the world, from various disciplines and with different levels of experience. We have great discussions, exchange of knowledge and hear about different local experiences that everyone can learn from.

If you are interested in joining the EVTM-ST case discussions,

please email: david.mcgreevy@regionorebrolan.se

Coming Meetings

11th World Society of Emergency Surgery Congress, 25–28 June 2024, Rhodes Island, Greece
https://www.wses.org.uk/news/wses-congress-2024-rhodes-save-the-date-25-28-june-2024

ESVS 38th Annual Meeting 2024, 24–27 September 2024, Kraków, Poland
https://esvs.org/events/annual-meeting/annual-meeting-2024/

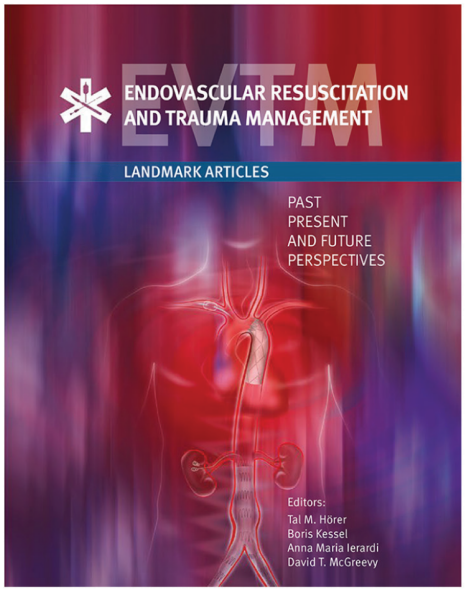
9th EVTM Symposium 17–19 October 2024, Örebro University Hospital, Sweden
https://jevtm.com/evtm-symposium/

EVTM Workshop 16th October 2024, Örebro, Sweden
https://jevtm.com/workshop/

VEITH Symposium, 19–23rd November 2024, New York
https://www.veithsymposium.org/index.php

25th Congress of the Asian Society for Vascular Surgery (ASVS 2024), December 3–6 2024, Bangkok, Thailand
https://asvs2024.com/

Books



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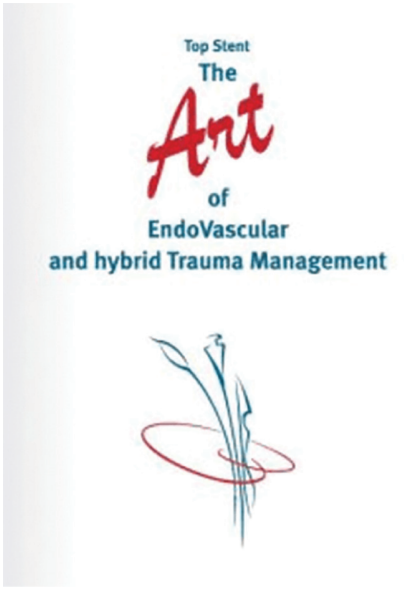

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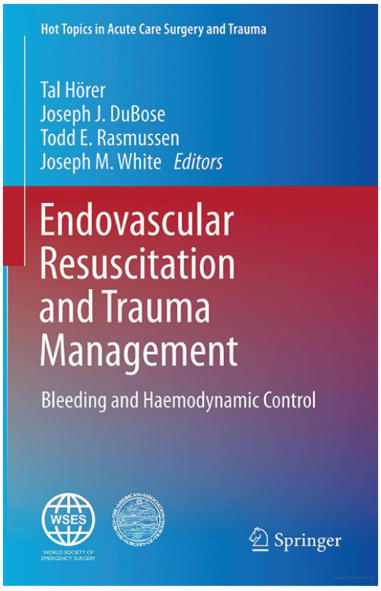

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EndoVascular resuscitation *and* Trauma Management (EVTM)

Hands-on Workshop

Örebro University Hospital, Sweden

EndoVascular Resuscitation and Trauma Management

EVTM instructors TBA

Local team: Tal Hörer, David McGreevy, Kristofer Nilsson, Artai Pirouzram

Target: Surgeons, Vascular, IR, ED, Intensivists, Trauma, civilians and Military with interest in trauma/bleeding/resuscitation, emergency & pre-hospital teams

Date: 16th October 2024

Workshop Directors: Tal Hörer and David McGreevy

Workshop Registration: Lotta Ahlbertz lotta@mkon.se

Cost (cover expenses only): 500Eu. 400Eu for EVTM Society members

Place: Facility for experimental studies and surgical training, Örebro University Hospital.

Partners: TBA

The aim of this two day workshop is to train, stimulate discussion, **mutual learning and sharing** of experiences while practicing EndoVascular resuscitation *and* Trauma Management (EVTM) using a multidisciplinary team approach with emphasis on local resources. "No ego, just good science, care and collaboration" is the main motion of the event. We are all here to share, learn and develop, for our patients.

The workshop is built on an individual, professional level and we will together explore different methods for resuscitation, bleeding control, hemostasis, trauma management and bail-outs. Some methods are used clinically world-wide, while some are under development and have been used on selected patients. This workshop concentrates on basic and advanced aspects

of *open and endovascular* bleeding control techniques. We will combine open hemostasis and endo aspects with vascular access, angiography, embolization, endografts, shunts and other endo/hybrid solutions for the unstable patient. Hemodynamic instability with a focus on trauma, non-trauma, bleeders and non-bleeders. From ruptures to gastrointestinal and gynecological bleeders with a wide range of hemodynamic instabilities in focus. We will explore how methods used by some disciplines can be used by others.

We will focus on clinical data and lessons learned from more than 20 years use of these methods in clinical practice.

- Vascular access:
  - Different methods (blind, doppler, ultrasound, fluoroscopy and cut down)
  - Its use in hemodynamic unstable patients
- Aortic Balloon Occlusion (REBOA) basic and advanced methods and SAAP
- Basic/advanced angiography principles and practical tips
- Damage control EVTM and bailout methods – open, endo and hybrid
- Maintaining and closing a vascular access
- Basic and advanced postoperative considerations
- Up-to-date research and clinical experience
- Cases/discussions
- Knowledge of basic/advanced material and new technologies on the market
- Endografts, embolization material on the market, and what to use and when
- Open and endo/hybrid hemostasis. From junctional bleeding to rAAA
- Intensive training on live tissue
- ICU and post-operative aspects (such as IAH and ACS and its treatment)
- Basics for building an “EVTM service”; tools needed
- Advanced experimental methods in resuscitation using REBOA and ECMO with CPR on live tissue models.
- When should we choose open surgery and stop playing with endo?

The workshop is individually tailored during the practical parts (advanced and basic as needed). Participants will get basic training and knowledge of vascular access, angiography, endografts, embolization and REBOA placement and other basic catheters and hybrid tools as part of the EVTM concept. This will be combined with open techniques and bleeding control maneuvers. The workshop has been certificated by the EACCME and acknowledged by collaboration with societies such as the European Society for Trauma and Acute Care Surgery, the European Vascular Society and others.

Tal Hörer, Örebro University Hospital, tal.horer@regionorebrolan.se
+46196024632 (direct) / +46702383495 / +46196021111 (switchboard)

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Program at the live tissue lab training and dry lab/cadaver lab.

Day 1:

The day starts at 12:00 with <u>Lunch at the training facilities</u> at Örebro University Hospital, Sweden.

Bleeding control issues; hemostasis; the hemodynamic unstable patients. Short presentations on vascular access, how to, complications, indications for REBOA (pREBOA, iREBOA), Abdominal compartment and complications. Endografts, embolization, choosing correct products etc. Data regarding EVTM will be presented. Different hemodynamic instabilities will be discussed as GI bleeding, trauma, Gyn, rAAA and others. Basic and advanced techniques for diagnostic and treatment of hemodynamic instability. Methods to use endografts, embolization agents, balloons and other tools will be presented and discussed. When open surgery is the best option and when not to play endo. Tips and tricks, bailouts.

Day 2:

07:00 Gathering/changing at the Training Center

07:15–08:40 "EVTM hands-on review – what can we do?" (Cadaver)
(Preliminary – if available, to be announced the day before)

08:40–09:30 Breakfast with the industry.

Hands-on animal lab including:

Every station is led by a highly experienced instructor with one-to-one training on live tissue as well as group scenario discussions (lunch and coffee will be served in the lab). Changing stations according to interest is encouraged. Dedicated stations per discipline/area according to the groups.

Practical training points in the animal lab:

1. Material usage in bleeding patients, general considerations and management scenarios
2. Open techniques for bleeding control/hemostasis and combinations with endo/hybrid.
3. Vascular access
    - Basic principles/advanced methods
    - Cut-down techniques
    - Endoshunts and shunts
    - Hybrid procedures
    - Puncture methods
    - Seldinger technique
    - The failing access – alternatives
    - Venous access and ultrasound
    - Basic and advanced methods
4. Upgrading/introducers/guide wires
5. REBOA

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+46196024632 (direct) / +46702383495 / +46196021111 (switchboard)

- Material and REBOA kit
- Deflation and re-positioning
- Intermittent/partial inflation (MAP as target – iREBOA/pREBOA)
- Ongoing bleeding practice
- CPR procedures and pending arrest

6. Balloon in alternate locations (Iliac, Subclavian, Brachiocephalic trunk/Zone 1 neck)
7. Hybrid procedures for hemostasis – junctional bleedings, balloons/xchange
8. Aortography and angiography considerations (type, volume, etc.)
9. Endografts/embolization advanced as needed – what, when, how
10. Junctional bleedings- solutions
11. Bailouts in endovascular and hybrid surgery

All training aspects will be modified to the participants' level and interest.

15:00 End of workshop and evaluation/feedback; Diploma

Email us for interest and follow www.jevtm.com and social media for details

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More info at www.jevtm.com/workshop and social media #EVTM

9th EVTM Symposium

HOT TOPICS in EndoVascular resuscitation and Trauma Management

Symposium chairs:
Charles Fox (US), Boris Kessel (IL), Anna Maria Ierardi (IT)

Scientific committee:
Boris Kessel (IL), Frank Plani (ZA), Eugene Moore (US), Artai Pirouzram (SE)
David McGreevy (SE), Kristofer Nilsson (SE), Chuck Fox (US), Anna Maria Ierardi (IT), Federico Coccolini (IT),
Maria Antonella Ruffino (CH), Pirkka Vikatmaa (FI),
Stacy Plotkin (US), Alon Schwartz (IL)

Local organizing committee:
Tal Hörer, David McGreevy

Thursday October 17th	
07.00	**Registration opens / Coffee and industry exhibition**
Opening session: EVTM in modern bleeding care Current international trends and developments 6 min talk + 4 min discussions **Chairs**: Anna Maria Ierardi (IT) and Chuck Fox (US) **Panelists:** Anahita Dua (US), Hayato Kurihara (IT), Eugene Moore (US), Rebecka Hultgren (SE), Lionel Lamhaut (FR)	
07.45	Opening remarks – Boris Kessel (IL) and Chuck Fox (US) Greeting from the local committee: David McGreevy (SE)
08.00	**Keynote lecture** – Decreasing Time to Hemostasis in a Trauma Hybrid OR – Laura Moore (US)
08.20	EVTM – Worldwide practice updates in trauma and non-trauma – Where are we now and future aspects Tal Hörer (SE)
08.30	EVTM – Endovascular and hybrid management in trauma USA today – Pedro Teixeira (US)
08.40	Endovascular resuscitation in Japan. Experience and Current trends – Yosuke Matsumura (JP)
08.50	Can we do better with bleeding care in Europe? – Hayato Kurihara (IT)
09.00	South African experience and trends in bleeding care. Where do we stand? Can endo help us? – Frank Plani (ZA)
09.10	Current trends in interventional radiology for bleeding control, what's new and what's coming? – Anna Maria Ierardi (IT)
09.20	Current developments in emergent vascular surgery. Where do we stand? – Greg Magee (US)
Session 2: Endo and hybrid tools and techniques for bleeding trauma patients What to use, when and how 6 min talk + 4 min discussion **Chairs**: Greg Magee (US), Erica Mitchell (US) **Panelists:** Pirkka Vikatmaa (FI), Artai Pirouzram (SE), Junichi Matsumoto (JP), Mansoor Khan (UK/UEA), Elina Quiroga (US)	
09.40	Past, present and future techniques for open, endo and hybrid hemorrhage control. How, when and what to use? – Eugene Moore (US)
09.50	Extremity trauma: Is it still only open surgery? When endo? Examples – Chuck Fox (US)
10.00	Visceral bleeding: When to choose endo or hybrid surgery? Endografts/Colis and more – Erica Mitchell (US)
10.10	Embolization in trauma – When and how to do it? How to choose and use? – Maria Antonella Ruffino (IT)
10.20	Hybrid techniques in trauma, the Baltimore Shock Trauma experience of EVTM – KJ Nagarsheth (US)
10.30	Endografts for visceral and peripheral bleeders – How to choose, how to use and what to know? – Greg Magee (US)
10.40	Best Current Management Of Pediatric Vascular Injuries: When Conservative; When Open; When Endo? – Elina Quiroga (US)
10.50	**Coffee and industry exhibition**
Session 3: Advancements for bleeding patients (trauma and non-trauma) and technological developments 6 min talk + 4 min discussion **Chairs**: E Moore (US), Rishi Kundi (US), Anna Romagnoli (US) **Panelists:** Mario D'oria (IT), Alon Schwartz (IL), Rishi Kundi (US), Elina Quiroga (US), Joakim Jorgensen (NR), Pedro Teixera (US)	
11.10	What is new and different in bleeding care 2024? From pre-hospital to the ICU in Shock&Trauma Baltimore – Jonny Morrison (US)
11.20	What is new in imaging for bleeding patients? CT, Hybrid suites and more – Anna Maria Ierardi (IT)
11.30	Hybrid / Semi-hybrid rooms: Where and who should have them, what to invest in and how to use them? – Rishi Kundi (US)
11.40	REBOVC (Vena Cava Balloon) in Juxtahepatic Venous bleeding. Experimental data and can it be used? – Maria Wikström (SE)
11.50	Non-traumatic visceral bleeding and endo management (coils? Endografts?) – When and how? – Anahita Dua (US)
12.00	OB-GYN bleeding and endo tools – what, when and how? What to use? – Maria Antonella Ruffino (IT)
12.10	When to take a bleeding patient to CT (or CT to the patient) and when not? Semi and unstable patients? – Erica Mitchell (US)
12.20	CT-first resuscitation protocol for severe trauma in hybrid ER – Satomi Seno (JP)

Session 4: Education of the future trauma and vascular surgeon
Joint session with the European Society for Trauma & Emergency Surgery (ESTES)

6 min talk + 4 min discussion

Chairs: Hayato Kurihara (IT), Joakim Jorgensen (NR), Carl Montan (SE)

Panelists: Anna Romagnoli (US), Paul Puchwein (AT), Anahita Dua (US), Joao Sahagoff (BR), Rebecka Hultgren (SE)

12.30	What have we learnt in trauma and education? Team up with the vascular people? My view – Joakim Jorgensen (NR)
12.40	Do we need vascular surgeons for traumatic bleeders? How to team up and educate? – Carl Montán (SE)
12.50	Vascular surgeons should be educated in trauma and vice versa? How to build good collaboration? – Carl Wahlgren (SE)
13.00	Abdominal compartment syndrome? How not to miss it? How to follow, treat and educate? – Boris Kessel (IL)
13.10	Local Anesthesia in bleeders? We do it in ruptures Educational/team issues – Sofia Strömberg (SE)
13.20	Vascular trauma open and endo aspects in modern times – how do we educate future surgeons? – Juan Duchesne (US)
13.30	Beyond blood – Mansoor Khan (UK)
13.40	Specialists in Training corner – Intersociety collaboration to promote education Y-ESTES and EVTM-ST – Gabriele Bellio (IT)
13.50	**Lunch**

Session 5: Debate session: Endo vs. Open

6 min talk + 4 min discussion

Chairs: Stacy Plotkin (US) and David McGreevy (SE)

Panelists: Sofia Strömberg (SE), Joakim Jorgensen (NR), Joao Sahagoff (BR), Juan Duchesne (US), Zoran Rancic (CH)

14.30	Debate: The bleeding femoral access – You should always OPEN IT! (Call Anesthesia!) – Stacy Plotkin (US)
14.40	Debate: The bleeding femoral access – We'll fix it with ENDO (Local Anesthesia!) – Artai Pirouzram (SE)
14.50	Debate: Revascularization Should PRECEDE External Bone Fixation – Erica Mitchell (US)
15.00	Debate: Revascularization Should FOLLOW External Bone Fixation – Paul Puchwein (AT)
15.10	Debate: REBOA is an IMPORTANT tool for unstable bleeding patients – David McGreevy (SE)
15.20	Debate: No REBOA, OPEN SURGERY is the way to go! – Daniel Shefer (IL)

Session 6: Hot topics in thoracic endovascular resuscitation
From imaging to treatment

6 min talk + 4 min discussion

Chairs: Pedro Teixeira (US), Manuel Garcia-Toca (US) and Zoran Rancic (AT)

Panelists: Ozcan Gur (TR), Erica Mitchell (US), Magnus Jonsson (SE), Giuseppe Asciutto (SE)

15.30	SVS Blunt Thoracic Aortic Injury Guidelines – how should we treat these patients? – Pedro Teixeira (US)
15.40	Endografts for thoracic aortic bleeders (dissection, rupture, trauma) – What to use and when? – Zoran Rancic (CH)
15.50	Blunt thoracic aortic injury trends, how to treat and data from the Aorta Trauma Foundation – David McGreevy (SE)
16.00	Axillo-subclavian trauma and iatrogenic injuries – is endo the solution? World collected data – Mario D'oria (IT)
16.10	BTAI In Pediatric Patients: When Should They Undergo Invasive Treatment: When Endo, When Open? – Elina Quiroga (US)
16.20	Prediction of mortality in Blunt Thoracic Aortic Injury – Mario D'oria (IT)
16.30	Acute Thoracic Aortic Pseudocoarctation after Blunt Thoracic Aortic Injury – Erica Mitchell (US)
16.40	**Coffee and industry exhibition**

Session 7: The non-trauma patient; tools, techniques, and results
From Pre-hospital to ICU

6 min talk + 4 min discussion

Chairs: Lionel Lamhaut (FR), Paul Puchwein (AT) and Marius Rehn (NR)

Panelists: Sam Sadek (UK) TBA

17.00	eCPR – current status and future aspects – Marius Rehn (NO)
17.10	VA ECMO in the management of trauma associated cardiogenic shock– Chris Bishop (UK)
17.20	Pre-Hospital ECMO cannulation – practical aspects and limitations – Lionel Lamhaut (FR)
17.30	REBOA/balloons in OncoVascular Surgery? – Joao Sahagoff (BR)
17.40	Pre-hospital REBOA in cardiac arrest/eCPR? Value, limitations and future aspects – Lionel Lamhaut (FR)
17.50	Intestinal ischemia after endovascular resuscitation – Bjørn Farbu (NO)
18.00	Cardiac arrest and REBOA? Experimental data and future aspects – Emanuel Dogan (SE)
18.15	**Get Together Party – With light meal, local culture and more…**

Friday October 18th	
07.15	**Coffee / Industry Exhibitors**
Session 8: Hot topics in acute vascular surgery – Endografts and more **Joint session with the European Society for Vascular Surgery (ESVS)** 6 min talk + 4 min discussion **Chairs**: Pirkka Vikatmaa (FI), Rebecka Hultgren (SE) **Panelists:** Zoran Rancic (CH), Magnus Jonsson (SE), Sofia Strömberg (SE) TBA	
08.00	Is EVAR/TEVAR taking over ruptures? Should it? – Rebecka Hultgren (SE)
08.10	100% EVAR in all infrarenal rAAA – a single center 15 year experience – David McGreevy (SE)
08.20	Thoracoabdominal ruptures, what can be done and when? – Artai Pirouzram (SE)
08.30	Acute vascular access: How to do it and how to avoid complications? – Magnus Jonsson (SE)
08.40	Technical and post-op aspects in ruptures, what can we learn for other bleeding patients? – Pirkka Vikatmaa (FI)
08.50	Endografts for iatrogenic access bleeding – how to deal with access complications? – Shahram Aarabi (US)
09.00	Endovascular treatment or open surgery in thoracic aortic trauma. Overview, what to do and when? – Ozcan Gur (TR)
09.10	EVTM-Specialists in Training corner: Late rupture after EVAR, single center data – Rami Hammadi (SE)
Session 9: The great debate on REBOA/Endo in trauma and non-trauma **Joint session with the World Society of Emergency Surgery (WSES)** 6 min talk + 4 min discussion **Chair**: Ernest Moore (US) and Boris Kessel (IL) **Panelists:** Federico Coccolini (IT), Fausto Catena (IT) & TBA	
09.20	Liver trauma – Endo/open/hybrid aspects – Ernest Moore (US)
09.30	Splenic trauma – Endo/open/hybrid aspects – Fausto Catena (IT)
09.40	Pelvic trauma – Endo/open/hybrid aspects – Federico Coccolini (IT)
09.50	Pancreatic trauma – Endo/open/hybrid aspects – TBA
10.00	Kidney and ureter trauma – Frank Plani (ZA)
10.10	Liver and pelvic trauma – Damage control surgery? – Kristina Doklestić Vasiljev (SR)
10.20	Critical analysis of the UK REBOA Trial – What can we conclude about REBOA in trauma? Martinez-Hernandez (SP)
10.30	**Coffee and industry exhibition**
Session 10: Modern trauma care including EVTM methods and mass casualties' issues **Joint session with the Israeli Trauma Society** 6 min talk + 4 min discussion **Chairs**: Alon Schwartz (IL) and Gad Shaked (IL) **Panelists:** Juan Duchesne (US), Chuck Fox (US), Joao Sahagoff (BR), Frank Plani (ZA) TBA	
10.40	Hybrid approach for ileac artery stab wound – Ori Yaslowitz (IL)
10.50	Surgical Department experience on October 7th attack in Israel – Morris Batumsky (IL)
11.00	Balloon occlusion of inferior vena cava – Where we are? – Nimrod Aviran (IL)
11.10	We sure could use REBOA – Itay Zoarets (IL)
11.20	A single trauma center experience with Mega Multiple Casualties Incident – Yulia Elobra (IL)
11.30	Vascular injuries in Mega Multiple Casualties Incident Oct 7th – Dimitry Shapovalov (IL)
11.40	REBOA in severe brain injury: fatal combination or treatment alternative? – Ron Daskal (IL)
11.50	Rare complications in abdominal trauma – case and discussion – Guy Golani (IL)
12.00	Surgical education during armed conflict – educational aspects and more – Daniel Shefer (IL)
Session 11: Registry data, experimental studies and developments within EVTM 6 min talk + 4 min discussion **Charis**: Kristofer Nilsson (SE), Carl Wahlgren (SE) **Panelists:** Sam Sadek (UK), Maria Wikström (SE), Jostein Brede (NO), Marius Rehn, TBA	
12.10	ESVS new Vascular Trauma Guidelines – Carl M Wahlgren (SE)
12.20	Details from the UK-REBOA Trial – what does it actually show? What can we learn? – Sam Sadek (UK)
12.30	PROOVIT trauma vascular registry – what does the data from USA say? More endo? – Rishi Kundi (US)
12.40	Time to (endo) bleeding control is important. Data – Anna Romagnoli (US)
12.50	ERICA ARREST study – Hutchinson Halden (UK)
13.00	Specialists in Training corner – Nitric Oxide (NO)-donator in ischemia – Anna Stene Hurtsén (SE)
13.10	**Lunch**

Session 12: Hot topics in anesthesia and critical care with EVTM aspects **New developments** 6 min talk + 4 min discussion **Chairs**: Peter Hilbert-Carius (DE), Marius Rehn (NR), Juan Duchesne (US) **Panelists:** Lars Helsten, TBA	
14.00	A trauma surgeons view of an unstable patient, decision making and the anesthetic team collaboration – Juan Duchesne (US)
14.10	An anesthesiologist's view of an unstable patient – Physiology aspects and strategies – Kristofer Nilsson (SE)
14.20	RIBCAP-HEMS project – Axel Großstück (DE)
14.30	ECMO in trauma patients – latest experience from the conflict in Israel – Gad Shaked (IL)
14.40	REBOA ARREST trial – Jostein Brede (NO)
14.50	Pre-clinical hypovolemia research – Lars Øyvind Høiseth (NO)
Session 13: EVTM rising technologies: imaging, devices, endografts and more 6 min talk + 4 min discussion **Chairs**: Yosuke Matsumura (JP), Junichi Matsumoto (JP) and Rebecka Hultgren (SE) **Panelists:** Shahram Aarabi (US), Anna Romagnoli (US), Anahita Dua (US), Giuseppe Asciutto (SE), Chance Spalding (US)	
15.00	CTA – what is out there and what is new? Hybrid suite, ER and more – Junichi Matsumoto (JP)
15.10	Ultrasound – Can we see better, when to use it and for what? – Maria Antonella Ruffino (IT)
15.20	New endografts on the market and coming soon (US and EU) – Greg McGee (US)
15.30	New Embolization agents – what is on the market and what is coming? – Anna Maria Ierardi (IT)
15.40	REBOA – what is on the market? Future? – Rishi Kundi (US)
15:50	Hybrid ER, RAPTOR and implementing these technologies – experience, what about the limitations? – Pirkka Vikatmaa (FI)
16:00	Endovascular shunt-what is it, experimental data and WHEN to use? Johan Millinger (SE)
16.10	**Coffee and industry exhibition**
Session 14: EVTM and interventional radiology: bleeding control, embolization agents, new technologies **What to use and when for bleeding control?** **Chairs:** Anna Maria Ierardi (IT) and Maria Antonella Ruffino (IT) **Panelists**: Mario D'Oria (IT), Giuseppe Asciutto (SE), Pierpaolo Biondetti (IT)	
16.30	Surgeon, anesthesiologist, radiologist, emergency doctor: who does what – Hayato Kurihara (IT)
16.40	IR team: The prompt activation in the management of emergency bleeding – Jan Raupach (CZ)
16.50	Hybrid room: what has changed in endovascular approach for bleeding control? – Giuseppe Asciutto (SE)
17.00	Endovascular thrombectomy tools and what can we do, when? – Tal Hörer (SE)
17.10	Post Partum Hemorrhage – how to save the uterus – Pierpaolo Biondetti (IT)
17.20	Evidence – Where do we stand with guidelines? When to embolize and when other methods in trauma? Federico Coccolini (IT)
17.30 – 18.45	**Session 15: EVTM Society meeting (open to all)** Hosted by Boris Kessel (IL), Chuck Fox (US) Agenda: latest activities, economic summary, elections results, future plans TBA
19.30	**Symposium Dinner – Place TBA**

Saturday October 19th	
08.00	**Coffee and Industry Exhibition**
Session 16: Ruptures: endo, open and hybrid aspects 6 min talk + 4 min discussion **Chairs:** Sofia Strömberg (SE), Magnus Jonsson (SE) **Panelists:** Anahita Dua (US), Anna Romagnoli (US), Joao Sahagoff (BR)	
08.30	What graft to use in ruptures AAA? Options? Technical aspects – Zoran Rancic (AT)
08.40	What graft to use in ruptured Thoracic AA? Options? Technical aspects – Magnus Jonsson (SE)
08.50	Adjunct techniques in ruptures: Viceral endografts and Technical aspects – Greg Mcgee (US)
09.00	Adjunct techniques in ruptures: Coils and embolization agents, what can be used to prevent endoleaks? – Artai Pirouzram (SE)
09.10	Post-operative aspects of the ruptured patient and ICU care (both for Open and endo) – Erika Mitchell (US)
09.20	Local anesthesia in rAAA? Hemodynamic unstable? When? How? – Carl Wahlgren (SE)
09.30	Abdominal compartment in the ICU – what, when and how to decompress? – Khatereh Djavani Gidlund (SE)

Session 17: Trauma and vascular controversies
New civilian and military developments in bleeding control

6 min talk + 4 min discussion

Chairs: Kristina Doklestić Vasiljev (SR), Mansoor Khan (UK)

Panelists: Laura Moore (UK), Shahram Aarabi (US), Carl Wahlgren (SE), Johan Millinger (SE)

09.40	New developments in bleeding care in the pre hospital and emergency room settings – Mansoor Khan (UK)
09.50	EVTM integrated in trauma service reduces time to hemostasis? – Jonny Morrison (US)
10.00	Integrating Endo and hybrid for trauma patients in Shock and Trauma Baltimore – Anna Romagnoli (US)
10.10	Endovascular management of Non-traumatic bleeding: how to do it, how to think in place with low resources? Adenauer Goez (BR)
10.20	Vascular trauma and use of shunts – data and cases from Ukraine – Yulia Nahaliuk (UA)
10.30	Vascular injuries in the current conflict Israel; data; what do we know? – Viktor Bilman (IL)
10.40	Open and endo in recent war injuries; lessons and how would we do in the future? – Dimitry Shapovalov (IL)
10.50	**Coffee and Industry Exhibition**

Session 18: From prehospital and austere environment to the ICU

6 min talk + 4 min discussion

Chairs: Frank Plani (ZA), Chuck Fox (US), Chance Spalding (US)

Panelists: Adenauer Goes (BR), TBA

11.10	Developing a Helipad to THOR Process – Laura Moore (US)
11.20	How to do vascular access in pre hospital settings? – Hutch/ Chris Bishop (UK)
11.30	Current use of REBOA in Pre hospital and military settings – Chance Spalding (US)
11.40	Vascular damage control in limited resources environment: reports from Amazon – Adenauer Goes (BR)
11.50	Tips and tricks , shunts and more in vascular trauma – Shahram A (US)
12.00	Tips and tricks in bleeding patients and what to think of in the ICU – Juan Duchesne (US)
12.10	Endovascular management of high grade TBAI and Axilosubclavian injuries – practical tips and tricks – Manuel Garcia-Toca (US)
12.20	Low-cost FAA/REBOA simulators for training and training experience in Spain – TBA
12.30	Closing remarks, from EVTM to JEVTM and more – Tal Hörer (SE)

12.40 Grab and go lunch

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Jan Andersen
+46 708 95 65 35
jan@limedic.se

Gustav Friberg
+46 70 141 61 36
gustav@limedic.se

Odysseas Zacharopolos
+46 76 277 63 21
odysseas@limedic.se

Limedic AB
Hägernäsvägen 10
183 60 Täby
Sweden
www.limedic.se