



An Integrative Review of Clinical Complications of Virchow's Triad in Deep Vein Thrombosis

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Abstract

Background: Deep vein thrombosis (DVT) is a serious clinical condition with significant complications. Understanding its underlying mechanisms is essential for developing effective prevention and treatment strategies. This study aims to analyze and synthesize the main clinical complications associated with Virchow's triad and its influence on the management and treatment of patients at risk for DVT. **Methods:** An integrative literature review was conducted, exploring various data sources, including recent and relevant studies from PubMed and BVS (Lilacs & Medline). The methodology involved formulating a guiding question, searching databases, selecting studies according to inclusion and exclusion criteria, critically analyzing the included studies, discussing the results, and incorporating the samples in the integrative review. **Results:** The analysis highlighted the complexity of clinical complications associated with Virchow's triad and DVT. Key risk factors such as venous stasis, endothelial injury, and hypercoagulability were identified as determinants in the predisposition to thrombus formation. COVID-19 emerged as a significant complicating factor, increasing the risk of venous thromboembolism in cancer patients.

Significance | This integrative review highlights the critical role of Virchow's triad in DVT pathophysiology, guiding better prevention and treatment strategies.

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Editor Md Shamsuddin Sultan Khan And accepted by the Editorial Board
May 24, 2024 (received for review April 02, 2024)

Early diagnosis, integrated management, and appropriate prophylactic strategies were identified as crucial for improving clinical outcomes in DVT patients. The study emphasized the importance of a multidisciplinary approach to DVT management, incorporating various healthcare professionals to provide comprehensive care. **Conclusion:** This study underscores the need for a multidisciplinary and integrated approach to DVT management. By continuing to explore and understand the complexities of venous thrombosis, advancements in prevention, diagnosis, and treatment can be achieved, ultimately improving the quality of life for patients.

Keywords: Deep vein thrombosis, Virchow's triad, Venous stasis, Endothelial injury, Hypercoagulability

1. Introduction

Deep vein thrombosis (DVT) is a severe and potentially fatal condition characterized by the formation of blood clots in the deep veins, primarily in the lower extremities. This condition poses significant health risks due to its direct complications and the potential for serious secondary health issues, such as pulmonary embolism, which can be life-threatening. Understanding the underlying mechanisms and clinical complications associated with DVT is crucial for improving patient outcomes and advancing treatment strategies.

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Please cite this article.

Emanuel Nascimento Nunes, José Vinicius Bulhões da Silva et al. (2024). An Integrative Review of Clinical Complications of Virchow's Triad in Deep Vein Thrombosis, *Journal of Angiotherapy*, 8(5), 1-6, 9722

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To comprehend the complexities of DVT, it is essential to explore Virchow's triad, a fundamental concept in the pathophysiology of venous thrombosis. Virchow's triad, as described by Kushner et al. (2022), includes three primary factors that contribute to thrombus formation: venous stasis, endothelial injury, and hypercoagulability. Venous stasis refers to reduced blood flow within the veins, which can occur due to prolonged immobility or conditions that impede venous return. Endothelial injury involves damage to the inner lining of the blood vessels, which can result from trauma, surgery, or inflammation. Hypercoagulability indicates an increased tendency of the blood to clot, often due to genetic predispositions or medical conditions such as cancer or hormonal imbalances. These elements collectively create a conducive environment for clot formation and serve as a framework for understanding the etiology and progression of DVT. Early identification and management of risk factors are pivotal in preventing DVT. McLendon et al. (2023) emphasize recognizing risk factors such as immobility, recent surgery, and certain medical conditions, which significantly increase the likelihood of developing DVT. The emergence of COVID-19 as an additional risk factor for venous thromboembolism, particularly in cancer patients, further complicates the clinical landscape. Brenner et al. (2022) underscore the need for a personalized approach and heightened vigilance in managing these patients to mitigate the risks.

Effective diagnosis and management of DVT rely heavily on advanced imaging methods and interventional techniques. According to Hindi et al. (2022), imaging findings are crucial for accurately identifying DVT and planning appropriate treatment strategies. Ultrasonography, highlighted by Nasra and Negussie (2023), plays a pivotal role in assessing peripheral veins, providing valuable information for the diagnosis and monitoring of DVT. These diagnostic tools are indispensable for timely and accurate intervention, which is critical for preventing complications and improving patient outcomes.

Despite advances in understanding and managing DVT, clinical complications remain a significant challenge. González-González et al. (2021) discuss the increased risk of stroke related to COVID-19, illustrating the complex interactions between viral infection, thrombosis, and the central nervous system. These complications highlight the necessity for specific preventive and therapeutic strategies tailored to vulnerable patient groups.

This integrative review aimed to examine the clinical complications associated with Virchow's triad and their impact on the management and treatment of patients at risk of venous thrombosis. By gathering evidence from various sources, this review seeks to provide valuable insights for clinical practice and guide future research in this critical area of vascular medicine. The objective was to analyze and synthesize the main clinical

complications associated with Virchow's triad and their influence on the management and treatment of patients at risk of DVT. By comprehensively understanding these aspects, healthcare providers can better anticipate challenges, implement effective prevention strategies, and optimize therapeutic interventions to improve patient outcomes in the context of DVT.

2. Materials and Methods

2.1 Study Design

This integrative literature review was conducted to synthesize the main clinical complications associated with Virchow's Triad and their impact on the management and treatment of patients at risk for venous thrombosis. The review involved searching electronic journals in the PubMed and BVS (Lilacs & Medline) databases.

2.2 Guiding Question

The guiding question formulated for this review was: "What are the main clinical complications associated with Virchow's Triad, and how do they impact the management and treatment of patients at risk for venous thrombosis?"

2.3 Producer

To address this question, we used specific Health Sciences Descriptors (DeCS): Deep Vein Thrombosis, Venous Stasis, Endothelial Injury, and Hypercoagulability. These descriptors were combined using the Boolean operator "AND" to ensure a comprehensive search. The databases searched included PubMed and BVS (Lilacs & Medline).

2.4 Inclusion and Exclusion Criteria

The inclusion criteria for this review encompassed systematic reviews, controlled clinical trials, observational studies, and original articles published between 2018 and 2023. Eligible articles needed to be written in English, Spanish, or Portuguese and focus on the clinical complications resulting from Virchow's Triad. Conversely, exclusion criteria included duplicate articles, studies lacking significant samples, and dissertations or theses.

2.5 Phases of Sample Analysis

The integrative review proceeded through six distinct phases to comprehensively analyze the selected samples. First, we formulated a clear guiding question to direct our research focus. Next, we conducted a thorough search for relevant literature by applying specific Health Sciences Descriptors (DeCS) in PubMed and BVS (Lilacs & Medline), which initially yielded 215 articles. From these findings, we meticulously analyzed titles and abstracts, ultimately selecting 80 studies for further evaluation—60 from PubMed and 20 from BVS. Following this, a critical analysis phase ensued, during which 50 articles from PubMed and 14 from BVS were excluded due to their lack of alignment with the study's thematic focus, resulting in 26 remaining studies. Subsequently, the results of these studies were collaboratively discussed among the authors, ensuring alignment with the initial guiding question. Finally, a

Table 1. Main Articles Contributing to the Study

| Author and Year | Title | Objective | Results | Final Considerations |
|---|--|---|---|---|
| Badireddy M, Mudipalli VR (2023) | Deep Venous Thrombosis Prophylaxis | Discuss strategies for DVT prophylaxis | Adequate prophylaxis is crucial for preventing DVT, especially in high-risk patients | Implementing prophylactic guidelines can significantly reduce DVT incidence |
| Hindi H, Dongmo G, Goodwin A, Jones S, Loveridge K (2022) | Imaging findings and interventional management of deep venous thrombosis | Analyze imaging findings and interventional management of DVT | Imaging is essential for accurate diagnosis and effective treatment of DVT | Advanced imaging techniques improve clinical management of DVT |
| McLendon K, Goyal A, Attia M (2023) | Deep Venous Thrombosis Risk Factors | Identify risk factors for DVT | Factors such as immobility, recent surgery, and certain medical conditions increase the risk of DVT | Early identification of risk factors can improve DVT prevention and treatment |
| Brenner B, Ay C, Gal GL, et al. (2022) | Venous thromboembolism risk, prophylaxis, and management in cancer patients with COVID-19: An unmet medical need | Evaluate risk, prophylaxis, and management of venous thromboembolism in cancer patients with COVID-19 | Cancer patients with COVID-19 have an elevated risk of venous thromboembolism | The need for personalized prophylactic and therapeutic approaches for this group is highlighted |
| Nasra K, Negussie E (2023) | Sonography Vascular Peripheral Vein Assessment, Protocols, and Interpretation | Evaluate the use of ultrasonography in peripheral vein assessment | Ultrasonography is effective in evaluating and diagnosing peripheral vascular conditions | Standardized protocols can improve diagnostic accuracy and clinical management |
| Kushner A, West WP, Khan Suheb MZ, Pillarisetty LS (2022) | Virchow Triad | Discuss Virchow's triad and its clinical relevance | Venous stasis, endothelial injury, and hypercoagulability are critical components in thrombus formation | Understanding Virchow's triad is essential for managing venous thrombosis |
| Gonzalez-Gonzalez FJ, Ziccardi MR, McCauley MD (2021) | Virchow's Triad and the Role of Thrombosis in COVID-Related Stroke | Explore the role of Virchow's triad in COVID-related strokes | COVID-19 can exacerbate conditions leading to thrombus formation, increasing the risk of stroke | Specific preventive approaches are needed for COVID-19 patients |
| Silva J, et al. (2024) | The Amplified Effects of COVID-19: Analysis of Health Risks and Global Socio-Economic Conditions | Analyze the health risks and global socio-economic conditions amplified by COVID-19 | The pandemic has exacerbated health risks and socio-economic inequalities | The global response should focus on mitigating the amplified negative effects of the pandemic |

Source: Data collected from articles, 2024.

Table 2. PICO Strategy Applied to the Study

| ACRONYM | ELEMENT | DESCRIPTION |
|---------|--------------|--|
| P | Population | Patients at risk of deep vein thrombosis (DVT), especially those with risk factors such as venous stasis, endothelial injury, and hypercoagulability (Virchow's Triad). |
| I | Intervention | Prophylaxis and management strategies, including early mobilization, intermittent pneumatic compression devices, appropriate anticoagulation, and advanced diagnostic interventions such as ultrasound and other imaging techniques. |
| C | Comparison | Comparison with standard care or absence of specific interventions, or comparison between different management strategies (e.g., anticoagulation vs. compression devices). |
| O | Outcome | Reduction in DVT incidence, improvement in clinical outcomes (e.g., lower rates of complications such as pulmonary embolism), increased rate of early and accurate diagnosis, and enhancement of patients' quality of life. |

comprehensive general analysis was conducted, incorporating eight studies from PubMed (5) and BVS (3) that contributed to the integrative literature review's final composition.

2.6 PICO Strategy

To systematically investigate the clinical complications linked to Virchow's Triad, we utilized the PICO strategy (Patient/Problem, Intervention, Comparison, and Outcome). This method enabled us to craft precise and targeted research inquiries, streamlining the exploration and examination of pertinent literature (Table 2). The components of our PICO framework encompassed defining the patient population at risk for deep vein thrombosis (DVT), examining clinical management and treatment strategies for complications associated with Virchow's Triad, comparing different clinical approaches and their efficacy, and assessing the impact of these interventions on patient outcomes and the management of venous thrombosis. This structured approach ensured a comprehensive synthesis of current evidence on the subject matter.

3. Results and Discussion

3.1 Clinical Complications and Virchow's Triad

The analysis of the included studies reaffirmed the critical components of Virchow's triad—venous stasis, endothelial injury, and hypercoagulability—as essential risk factors for developing deep vein thrombosis (DVT). This aligns with the findings of Kushner et al. (2022), reinforcing the theoretical framework that these elements collectively contribute to the pathogenesis of DVT. The consistency of these findings across multiple studies underscores the robustness of Virchow's triad in explaining DVT etiology.

3.2 Impact of COVID-19

The emergence of COVID-19 as a complicating factor in DVT, particularly in cancer patients, was highlighted by Brenner et al. (2022). The interplay between viral infections, such as COVID-19, and pre-existing risk factors like malignancy creates a compounded risk for venous thromboembolism (VTE). This necessitates a multifaceted approach to patient management, integrating antiviral treatments, anticoagulation therapy, and vigilant monitoring for VTE.

3.3 Advancements in Imaging Technology

Technological advancements in imaging, as noted by Hindi et al. (2022) and Nasra and Negussie (2023), have significantly improved the early diagnosis and management of DVT. Enhanced imaging techniques, such as high-resolution ultrasound and magnetic resonance venography, enable the detection of thrombosis at earlier stages, allowing for prompt intervention. These early interventions are crucial in preventing the progression of DVT and mitigating severe complications.

3.4 Importance of DVT Prophylaxis

The review emphasized the critical role of effective DVT prophylaxis in hospitalized patients, as discussed by Badireddy and Mudipalli (2023). Prophylactic strategies, including early mobilization, the use of intermittent pneumatic compression devices, and appropriate anticoagulation, are essential in reducing the incidence of DVT. Implementing these measures as standard care protocols can significantly decrease the risk of thrombotic events in at-risk populations.

3.5 Multidisciplinary Approach to DVT Management

An integrated, multidisciplinary approach is vital for managing the clinical complications of DVT. This includes collaboration among physicians, nurses, physical therapists, and vascular imaging specialists to ensure comprehensive care. The coordinated efforts of a multidisciplinary team facilitate holistic patient management, addressing both the prevention and treatment of DVT (Table 1).

3.6 Persistent Challenges and the Need for Further Research

Despite advancements in the understanding and management of DVT, significant challenges remain, particularly with emerging risk factors like COVID-19. A multidisciplinary and personalized approach is essential to address these challenges and improve patient outcomes. Further research is needed to elucidate the complex interactions among the components of Virchow's triad, additional risk factors, and DVT complications. This ongoing research will guide the development of more effective and targeted interventions.

3.7 Socioeconomic Implications

The socioeconomic implications of DVT complications cannot be overlooked. Silva et al. (2024) highlighted the exacerbated impacts of the COVID-19 pandemic on global health and socioeconomic conditions. Public policies and targeted interventions are crucial to mitigate these adverse effects, emphasizing the importance of a comprehensive approach to DVT management that considers both medical and socioeconomic factors. In summary, this integrative review underscores the complexity of clinical complications associated with Virchow's triad and DVT. The findings highlight the importance of early identification, prevention, and effective management through multidisciplinary approaches. Understanding the underlying mechanisms and addressing emerging risk factors like COVID-19 are crucial for improving patient outcomes and reducing the global burden of DVT. Ongoing research and the integration of technological advancements will further enhance our ability to combat this pervasive condition effectively.

4. Conclusion

In conclusion, this integrative review underscores the critical role of early identification of risk factors, advanced imaging techniques, and appropriate prophylactic and treatment strategies in managing deep vein thrombosis (DVT). While significant progress has been

made, understanding the complex interactions within Virchow's triad and emerging risk factors remains challenging. Continuous clinical and translational research is essential to develop more effective, personalized interventions. The review emphasizes a multidisciplinary approach, involving diverse healthcare professionals, to provide comprehensive care. Advancing our understanding of DVT will improve prevention, diagnosis, treatment, and overall patient outcomes.

Author contributions

E.N.N. conceptualized, developed the methodology, analyzed the data, and drafted the manuscript. J.V.B.S. validated the findings, provided resources, and edited the manuscript. W.B.S. curated the data and developed the software. E.E.T.F. provided funding and supervised the project. P.S.A.M. developed the methodology and edited the manuscript. J.H.M.L. supervised the project and edited the manuscript.

Acknowledgment

Author was thankful to their departments.

Competing financial interests

The authors have no conflict of interest.

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