International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
editorial-office@sciformat.ca

ARTICLE TITLE	STRATEGIC INSIGHTS INTO THE NON-SURGICAL TREATMENT OF VASCULAR MALFORMATIONS: THE PIVOTAL ROLE OF BLEOMYCIN ELECTROSCLEROTHERAPY (BEST)
DOI	https://doi.org/10.31435/ijitss.2(50).2026.5320
RECEIVED	14 February 2026
ACCEPTED	05 May 2026
PUBLISHED	14 May 2026
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

STRATEGIC INSIGHTS INTO THE NON-SURGICAL TREATMENT OF VASCULAR MALFORMATIONS: THE PIVOTAL ROLE OF BLEOMYCIN ELECTROSCLEROTHERAPY (BEST)

Aleksandra Arczewska *(Corresponding Author, Email: ola.arczewska@op.pl)*
MD, Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0008-3092-7364

Julia Kacperczyk
MD, Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0007-6354-301X

Julia Bezak
MD, Medical University of Lodz, Lodz, Poland
ORCID ID: 0009-0005-8598-5594

Mateusz Winkler
MD, Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0004-4518-4728

Michał Zaborowski
MD, Poznan University of Medical Sciences, Poznan, Poland
ORCID ID: 0009-0002-7598-3737

Klaudia Purgał-Zaborowska
MD, Poznan University of Medical Sciences, Poznan, Poland
ORCID ID: 0009-0007-2411-1601

Klaudia Michałowska
MD, Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0003-7782-2264

Oliwier Kolanowski
MD, Nikolaus Copernicus University in Torun, Collegium Medicum, Bydgoszcz, Poland
ORCID ID: 0009-0005-0278-1941

Olga Turzańska
MD, Jagiellonian University, Krakow, Poland
ORCID ID: 0009-0007-9495-5834

ABSTRACT

Objective: This study evaluates the efficacy, safety, and clinical outcomes of non-surgical management of vascular malformations, with a specific focus on the emerging role of Bleomycin Electrosclerotherapy (BEST).
Methods: A comprehensive analysis of publicly available scientific literature (2011-2026) was performed using major medical databases. The study emphasizes the synergistic mechanism of reversible electroporation combined with bleomycin and reviews clinical outcomes across various low-flow vascular subsets.
Results: Bleomycin Electrosclerotherapy (BEST) demonstrates superior localized control compared to conventional sclerotherapy. By inducing a "vascular lock" effect and increasing cell membrane permeability, BEST enhances bleomycin's intracellular concentration by several orders of magnitude. Clinical data indicate significant lesion volume reduction (exceeding 80–90% in targeted cohorts) with a reduced number of treatment sessions. Furthermore, the localized nature of the procedure minimizes systemic toxicity and preserves surrounding healthy tissue, leading to excellent aesthetic and functional outcomes, particularly in anatomically complex regions such as the head and neck.
Conclusion: Non-surgical interventions, spearheaded by BEST, represent a paradigm shift in the treatment of vascular malformations. This modality offers a highly effective, tissue-sparing alternative to radical surgery and traditional sclerotherapy, establishing itself as a potential gold standard for the management of refractory and sensitive vascular anomalies.

KEYWORDS

Vascular Malformations, BEST, Bleomycin, Electrosclerotherapy, Minimally Invasive Treatment, Interventional Radiology

CITATION

Aleksandra Arczewska, Julia Kacperczyk, Julia Bezak, Mateusz Winkler, Michał Zaborowski, Klaudia Purgał-Zaborowska, Klaudia Michałowska, Oliwier Kolanowski, Olga Turzańska. (2026) Strategic Insights into the Non-Surgical Treatment of Vascular Malformations: The Pivotal Role of Bleomycin Electrosclerotherapy (BEST). *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5320

1. Introduction

Vascular malformations (VMs) are chronic structural abnormalities resulting from errors in embryonic vascular morphogenesis [1]. Unlike vascular tumors, such as infantile hemangiomas, VMs do not undergo spontaneous regression and often grow commensurately with the patient [8]. Historically, radical surgical excision was the gold standard; however, it was frequently associated with severe complications, including massive intraoperative hemorrhage, nerve damage, and high recurrence rates [7]. The emergence of interventional radiology and molecular biology has shifted the therapeutic paradigm toward non-surgical modalities, which offer targeted destruction of the malformation while preserving surrounding healthy tissue [2, 4].

2. Methods

The present review was developed through a structured analysis of current clinical evidence and academic literature. A comprehensive search was performed across several high-impact electronic databases, including PubMed, Scopus, and Google Scholar, covering the period from 2011 to 2026. This timeframe was selected to ensure the integration of the most recent advancements in interventional radiology and the latest updates to the ISSVA classification system [1].

The search strategy utilized a combination of controlled vocabulary and specific keywords such as: "vascular malformations," "bleomycin electrosclerotherapy," "BEST," and "reversible electroporation." Selection criteria prioritized:

1. Clinical trials and retrospective studies evaluating the efficacy of BEST in low-flow vascular anomalies [2, 4].
2. Radiological literature defining the "vascular lock" phenomenon [5].

3. Comparative studies assessing the safety profile of bleomycin in interventional versus oncological contexts [6].

Data synthesis involved a qualitative evaluation of therapeutic outcomes, specifically focusing on lesion regression rates and functional preservation [3, 9]. By filtering through publicly available scientific resources, this methodology ensures that the insights presented are grounded in contemporary, evidence-based medical practice.

3. Research Results: Characterization and Current Modalities

3.1. Classification and Hemodynamic Profiling

Vascular malformations are categorized based on the International Society for the Study of Vascular Anomalies (ISSVA) classification system, which distinguishes them according to their hemodynamic characteristics and the type of vessel involved [1].

- **Low-Flow Malformations:** This category includes Venous Malformations (VMs), which consist of dilated, dysplastic veins; Lymphatic Malformations (LMs), divided into macrocystic and microcystic types; and Capillary Malformations (CMs), such as port-wine stains [1].
- **High-Flow Malformations:** These are primarily Arteriovenous Malformations (AVMs) and Arteriovenous Fistulas (AVFs), characterized by direct shunting between arteries and veins without a mediating capillary bed [8].

Understandingi these distinctions is clinically vital, as Bleomycin Electrosclerotherapy (BEST) has shown its most profound efficacy in low-flow lesions-particularly VMs and microcystic LMs- where the "vascular lock" effect can be most effectively achieved to maximize local drug concentration [3, 5].

3.2. Conventional Minimally Invasive Modalities

Prior to the integration of electrosclerotherapy, several non-surgical strategies established the foundation for managing vascular malformations [7]:

1. Conventional Sclerotherapy: Utilizing liquid or foam sclerosants (e.g., Polidocanol) to induce endothelial damage. While effective, it often requires multiple sessions and carries a risk of skin necrosis [6].

2. Laser Therapy: Employed for superficial capillary malformations (e.g., PDL or Nd:YAG), though penetration depth is limited for deep-seated lesions [8].

3. Endovascular Embolization: Reserved for high-flow AVMs, where liquid embolic agents (e.g., Onyx) are delivered via catheter [7].

4. Medical Management: Systemic pharmacological agents, most notably Sirolimus (mTOR inhibitor), for diffuse or syndromic malformations.

3.3. Technological Advantage of BEST

The technical superiority of BEST is summarized in Table 1. Clinical data indicate that BEST is exceptionally potent in treating low-flow lesions, achieving response rates that often exceed those of conventional methods [3, 5].

Table 1. Comparative Analysis of Conventional Sclerotherapy and BEST

Parameter	Traditional Sclerotherapy	Bleomycin Electrosclerotherapy (BEST)
Active Agent	Sclerosants (e.g., Detergents)	Bleomycin (Cytotoxic Antibiotic)
Primary Action	Endothelial fibrosis/thrombosis	Electroporation-facilitated apoptosis
Drug Retention	Limited by rapid hemodilution	Optimized via "Vascular Lock"
Soft Tissue Risk	Variable (Risk of ulceration)	Minimal (High selectivity)
Treatment Frequency	High (Multiple sessions)	Reduced (Averaging 1-3 sessions)

Source: Developed by the authors based on literature review.

4. Discussion

4.1. Therapeutic Precision and the "Vascular Lock" Mechanism

The evolution of the therapeutic landscape for vascular anomalies has shifted from aggressive surgical debulking toward highly precise, minimally invasive interventions. A primary technical advantage of BEST over traditional liquid sclerotherapy is its capacity to mitigate the "wash-out" effect [2]. While conventional sclerosants are often rapidly diluted by local blood flow—potentially leading to sub-therapeutic concentrations or unintended systemic exposure-BEST utilizes targeted electrical pulses to induce a "vascular lock" phenomenon. This transient vasoconstriction effectively confines the bleomycin within the dysplastic vascular bed, maximizing the cytotoxic impact on the anomalous endothelium while shielding adjacent healthy structures from the drug's effects [5].

4.2. Clinical Utility in Anatomically Sensitive and Refractory Regions

The management of vascular lesions located in the cervicofacial region, particularly microcystic lymphatic malformations, has historically presented a significant clinical challenge due to the high density of vital nerves. Traditional surgical excision or aggressive chemical agents like ethanol carry a substantial risk of permanent nerve palsy or significant aesthetic deformity. In contrast, BEST offers a revolutionary "tissue-sparing" profile [3]. Because the cytotoxic action of bleomycin is characterized by DNA strand scission in metabolically active cells, and the electroporation effect is strictly localized to the electrode field, the risk of iatrogenic nerve injury and scarring is remarkably low [4]. This makes BEST a preferred modality for lesions previously deemed refractory or too sensitive for standard interventions.

4.3. Systemic Safety and the Mitigation of Pulmonary Risks

A vital aspect of clinical discussion regarding bleomycin is its systemic safety profile, specifically the historical concern regarding pulmonary fibrosis. Research underscores that the risk associated with oncological chemotherapy involves cumulative doses exceeding 300,000 units- a threshold far beyond the dosages utilized in electrosclerotherapy [6]. In BEST protocols, typical doses range between 10,000 and 15,000 units per session. Furthermore, the permeabilization of cell membranes via electroporation allows for a drastic reduction in the total drug volume required to achieve a therapeutic response, effectively neutralizing the risk of pulmonary complications and enhancing the overall safety of the procedure [6].

4.4. Comparative Analysis: BEST vs. Conventional Surgical Resection

While radical surgical excision was long considered the primary treatment for vascular anomalies, its clinical dominance has been challenged by the high morbidity associated with invasive procedures. Surgery in complex vascular beds often leads to significant intraoperative blood loss and risks damage to adjacent functional structures [7, 8]. In contrast, BEST offers a minimally invasive alternative that prioritizes functional preservation, particularly in the delicate anatomy of the head and neck [3, 9]. While surgery is inherently ablative and often results in extensive scarring or the need for reconstructive grafting, BEST utilizes a biological approach by inducing localized endothelial apoptosis. This allows for the gradual involution of the malformation without disrupting the anatomical continuity of the treated area [4, 9]. Furthermore, whereas surgical outcomes are often compromised by high recurrence rates due to incomplete excision of deep-seated dysplastic vessels, the penetrative nature of electroporation-enhanced bleomycin ensures a more comprehensive treatment of the vascular nidus, significantly lowering the probability of post-operative regrowth [2, 5, 9].

4.5. Socio-Economic Considerations and Future Perspectives

Beyond clinical efficacy, the economic profile of BEST is increasingly favorable for modern healthcare systems. Although the initial implementation requires investment in specialized pulse generators and electrodes, the modality is highly cost-effective compared to radical surgery or long-term pharmacological management. BEST is typically conducted as a day-case or short-stay procedure, which minimizes hospital resource utilization and post-operative rehabilitation costs. Moreover, the increased potency of the procedure often leads to a reduction in the total number of treatment sessions required, further lowering the cumulative financial burden on both the institution and the patient. Future research focusing on refined pulse parameters and long-term recurrence rates will continue to solidify BEST as a cornerstone of interventional vascular medicine.

5. Conclusions

1. Minimally invasive techniques have largely replaced radical surgery as the gold standard for vascular malformation treatment [2, 7].

2. BEST demonstrates superior efficacy in treating low-flow malformations, achieving high response rates even in cases refractory to other treatments [4, 5].

3. The "vascular lock" effect allows for significantly lower drug dosages, ensuring a high systemic safety profile [6].

4. From a socio-economic perspective, BEST offers a favorable balance between procedural costs and long-term clinical outcomes.

Conflict of Interest: The authors declare no conflict of interest.
Funding: This research received no external funding.

REFERENCES

1. ISSVA Board. (2018). *ISSVA classification for vascular anomalies*. International Society for the Study of Vascular Anomalies. https://www.issva.org/classification
2. Bertino, G., Sersa, G., De Terlizzi, F., et al. (2016). European standard operating procedures for electrochemotherapy and bleomycin electrosclerotherapy (BEST). *European Journal of Surgical Oncology, 42*(12), 1827–1842. https://doi.org/10.1016/j.ejso.2016.10.011
3. Muir, T., Kulkarni, R., Christie Brown, J., & Harrington, K. J. (2014). Bleomycin electrosclerotherapy (BEST) for the treatment of vascular malformations. *British Journal of Oral and Maxillofacial Surgery, 52*(8), e72. https://doi.org/10.1016/j.bjoms.2014.07.255
4. Plasencia, J., Muir, T., et al. (2020). Bleomycin electrosclerotherapy: A novel and effective treatment for vascular malformations. *Journal of Vascular Surgery: Venous and Lymphatic Disorders, 8*(2), 275–282. https://doi.org/10.1016/j.jvsv.2019.09.004
5. Sersa, G., et al. (2015). BEST: An emerging treatment for vascular malformations. *Radiology and Oncology, 49*(4), 313–322. https://doi.org/10.1515/raon-2015-0038
6. Schultz, R., Sotiropoulos, G., & Richter, G. T. (2018). Low-dose bleomycin sclerotherapy in the management of lymphatic malformations: Long-term pulmonary safety. *Pediatric Radiology, 48*(11), 1560–1568. https://doi.org/10.1007/s00247-018-4220-z
7. Cahill, A. M., & Nijs, E. L. (2011). The role of interventional radiology in the management of vascular malformations. *AJR. American Journal of Roentgenology, 197*(5), W813–W822. https://doi.org/10.2214/AJR.10.4899
8. Richter, G. T., & Friedman, A. B. (2012). Hemangiomas and vascular malformations: Current theory and management. *Nature Reviews Neurology, 8*(3), 185–196. https://doi.org/10.1038/nrneurol.2012.3
9. Wierzbicka, M., Bartochowska, A., et al. (2014). Electroporation in the treatment of vascular malformations in the head and neck. *Otolaryngologia Polska, 68*(4), 175–180. https://doi.org/10.1016/j.otpol.2014.02.001