Editorial

Ultrasound – An Underused Diagnostic Tool for Ventricular Assist Device Driveline Infections

Kristina Krzelj,[1]* Tomislav Tokic,[1] Tomislav Kopjar,[1] Maja Cikes,[2] Davor Milicic,[2] and Hrvoje Gasparovic[1]

[1]Department of Cardiac Surgery, University Hospital Centre Zagreb, Zagreb, Croatia; [2]Department of Cardiovascular Diseases, University Hospital Centre Zagreb, Zagreb, Croatia

*Corresponding author: kristina.krzelj.md@gmail.com

Citation: Krzelj et al. Ultrasound – An Underused Diagnostic Tool For Ventricular Assist Device Driveline Infections. *The VAD Journal*. 2024;10(1): e20241011.

Editor-in-Chief: Maya Guglin, University of Indiana

Received: September 29, 2023

Accepted: December 13, 2023

Published Online: January 30, 2024

Abstract

Patients with ventricular assist device (VAD) driveline infections (DLI) have reduced quality of life and increased risk of severe complications, such as sepsis, hemorrhagic or ischemic stroke, and wound infections. The management of VAD patients imposes a significant financial burden due to prolonged in-hospital stays, frequent re-admissions, expensive diagnostics, and the need for antibiotic therapy and/or surgical intervention. There is considerable room for improvement in DLI management, particularly in the early detection and treatment stages. Ultrasound, an easily applicable device available in almost every hospital, offers an unrecognized potential for the early detection of DLI. By increasing awareness about the potential advantages of ultrasound in DLI management, especially in specialized tertiary centers with a high number of VAD patients, this method may contribute to creating valuable databases, establishing recommendations, and improving outcomes.

Keywords: ultrasound, ventricular assist device, driveline, infection

Introduction

Ventricular assist devices (VADs) are a well-established therapy in managing patients with advanced heart failure, whether as a bridge to heart transplant or as destination therapy. The need for a driveline connecting the implanted VAD pump and the extracorporeal controller unit and batteries results in a skin-driveline interface, increasing the risk for microbial contamination and infection at the driveline exit site (DLES). Of the VAD-specific infections, driveline infections (DLI) represent the most common type in patients with a VAD, with a prevalence of up to 20% annually.[1]

Patients with DLI have reduced quality of life and an increased risk of severe sepsis, hemorrhagic or ischemic stroke, and post-transplant complications, such as wound infections.[1,2] The significant financial burden is another issue regarding DLI, attributed to prolonged in-hospital stay, frequent re-admissions, expensive diagnostics, prolonged antibiotic therapy, and surgical interventions.[3]

It is imperative to find ways to improve outcomes associated with DLIs. Numerous DLI prevention measures have been reported, including established standard operating procedures, perioperative antibiotic prophylaxis, dressing change, and expert-derived DLES care protocols.[2] However, there is ample room for improvement in detecting and treating DLIs earlier, which may reduce costs and improve outcomes in patients with VADs.

Challenges in the Detection of DLIs

Determining whether the patient has a DLES infection or an infection affecting deeper parts of the driveline can be challenging. Furthermore, a DLES infection may be hard to distinguish from local irritation due to antiseptic skin products or dressing material.

Currently, there is no evidence-based diagnostic algorithm recommended for early driveline infection. Laboratory findings may not be helpful in some cases because of specific immunological alterations in patients with VADs,[4] and systemic inflammatory signs may be absent.[5] This problem complicates the decision-making process because deeper DLIs may require more aggressive treatment, including abscess aspiration, intravenous antibiotics, or surgical debridement. Some diagnostic methods, such as positron emission tomography and single-photon emission computed tomography, are unavailable in regional hospitals. Computed tomography scans may result in unclear results regarding the extent of an infection because of pump material artifacts. If a DLI is suspected, clinical practice usually involves taking DLES swab cultures. However, the most commonly detected microorganisms belong to normal skin flora; therefore, it is difficult to conclude whether the detected microorganism caused the DLI.

Ultrasound as a Diagnostic Tool

Ultrasound is an easily applicable device available in most hospitals, with unrecognized potential in the early detection of DLIs. In emergency departments worldwide, ultrasound detects soft tissue infections and guides therapeutic and diagnostic aspiration of soft tissue abscesses. The major ultrasound characteristics of soft tissue infection include the cobblestone appearance of the soft tissue due to increased interstitial fluid in edema and hyperemia, as assessed by Doppler. Using ultrasound, a soft tissue abscess can be easily recognized as it appears as a hypoechoic (or mixed echogenicity) fluid collection, indicating liquefaction.[6-9]

There are limited reports in the literature regarding the use of ultrasound in DLI management. A case series published by Lissandrin et al.[10] reported that ultrasound findings in patients with DLIs were concordant with computed tomography findings regarding the extent of infection.

However, the use of ultrasound in DLIs may offer several benefits. First, an ultrasound assessment of driveline tunnel characteristics and changes over time after VAD implantation can help determine driveline tunnel maturation properties. This assessment will help differentiate between normal and infected driveline tunnels. Early assessment is critical because several studies have reported that the majority of VAD infections develop within three months after device implantation.[2] Next, ultrasound findings in DLIs may assist in deciding when to use more expensive imaging methods to assess the extent of infection, thus reducing the financial burden in this patient subgroup. Consistent ultrasound use in the outpatient clinic during regular follow-ups of DLES could also establish an invaluable database. Pre-defined measurements would include the driveline tunnel diameter, the estimated amount of driveline-surrounding fluid, and the echogenicity of the surrounding fluid. The presence or absence of secretions, granulations, clinical signs of local infection, laboratory values of inflammation markers, and nutritional status would also be included. This database could differentiate early and late driveline infections and may provide a basis for antibiotic therapy or surgical intervention recommendations. Additionally, ultrasound could guide diagnostic and therapeutic aspiration. Finally, many medical specialists have basic knowledge and skills in ultrasound; therefore, a high suspicion of driveline infection could be established early, even in local hospitals, resulting in timely referral of patients with a DLI to a specialized tertiary center.

Nevertheless, ultrasound application in the diagnosis of DLIs poses several challenges. While basic knowledge of ultrasound is sufficient to recognize a DLI, obtaining relevant data for establishing guidelines requires consistent ultrasound application over a relatively long timeframe, at multiple time points, and in a significant number of patients. Since recommended measurements do not exist, diagnostic protocols depend on the enthusiasm and creativity of the involved researchers. Furthermore, because of the underutilization of this diagnostic method in DLIs, evidence-based recommendations for therapeutic intervention based on obtained information are unavailable. It is important to note that no harm from ultrasound application in patients with VADs has been reported so far.

Conclusion

This method may be more successfully applied by increasing awareness of the potential advantages of ultrasound as a widely available tool in DLI management, especially in tertiary centers with a high number of patients with VADs. This could result in valuable databases, recommendations establishment, and improved outcomes in the future.

Acknowledgements and Funding

The authors have no conflicts of interest to report. No funding was received for the development of this article.

References

1. Qu Y, Peleg AY, McGiffin D. Ventricular assist device-specific infections. *J Clin Med*. 2021;10(3):453.
2. Krzelj K, Petricevic M, Gasparovic H, Biocina B, McGiffin D. Ventricular assist device driveline infections: A systematic review. *Thorac Cardiovasc Surg.* 2021;70(6):493-504.
3. Slaughter MS, Bostic R, Tong K, Russo M, Rogers JG. Temporal changes in hospital costs for left ventricular assist device implantation. *J Card Surg.* 2011;26(5):535-41.
4. Itescu S, John R. Interactions between the recipient immune system and the left ventricular assist device surface: Immunological and clinical implications. *Ann Thorac Surg.* 2003;75(6 Suppl):S58-65.
5. Nienaber JJC, Kusne S, Riaz T, et al. Clinical manifestations and management of left ventricular assist device-associated infections. *Clin Infect Dis.* 2013;57(10):1438-48.
6. Jain N, Goyal N, Mukherjee K, Kamath S. Ultrasound of the abdominal wall: What lies beneath? *Clin Radiol.* 2013;68(1):85-93.
7. Squire BT, Fox JC, Anderson C. Abscess: Applied bedside sonography for convenient evaluation of superficial soft tissue infections. *Acad Emerg Med.* 2005;12(7):601-606.
8. Wu J, Ge L, Wang X, Jin Y. Role of point-of-care ultrasound (POCUS) in the diagnosis of an abscess in pediatric skin and soft tissue infections: a systematic review and meta-analysis*. Med Ultrason.* 2022;24(3):339-347.
9. Subramaniam S, Bober J, Chao J, Zehtabchi S. Point-of-care ultrasound for diagnosis of abscess in skin and soft tissue infections. *Acad Emerg Med*. 2016;23(11): 1298-1306.
10. Lissandrin R, Sangani A, Pesare R, et al. Ultrasound for management of left ventricular assist device driveline infections: A single-center experience. *Transpl Infect Dis*. 2023;e14178. doi: 10.1111/tid.14178. [Online ahead of print].