Pacemaker Syndrome - A Dyssynchronous Future

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Introduction

Intradialysis hypotension (IDH) is the most common complication experienced in patients undergoing hemodialysis (HD) sessions with a frequency of up to 12%. This may occur due to the inability to maintain a steady plasma refill rate as fluid is mobilized from intracellular to extracellular compartments as it is removed during dialysis. This risk may be increased in patients with leadless ventricular pacemakers due to atrial and ventricular dyssynchrony, a phenomenon known as pacemaker syndrome.

Case Presentation

A 71-year-old male with a past medical history of hypertension, type 2 diabetes mellitus, end-stage renal disease on hemodialysis via a tunneled central venous catheter (CVC), and a single-chamber leadless pacemaker presented after experiencing chest pain and hypotension during hemodialysis sessions. He had visited the emergency room three times for similar symptoms over the past two weeks. Initial EKG showed sinus rhythm with first-degree AV block. A left heart catheterization revealed non-obstructive coronary artery disease. An echocardiogram demonstrated normal left ventricular function, no structural abnormalities, and the distal tip of the CVC was visualized in the right atrium.
While hospitalized, he had multiple episodes of chest pain and hypotension associated with dialysis. During these episodes, telemetry revealed intermittent runs of ventricular paced rhythm. Notably, his symptoms and paced rhythm resolved when he was repositioned to an upright position and given fluid resuscitation. Keeping the patient upright with the head of the bed elevated at 45 degrees and reducing the ultrafiltration rate prevented further episodes for the remainder of his hospital stay.

Figure 1 Chest X-ray showing a leadless pacemaker in right ventricle, also with a centrally placed dialysis catheter.

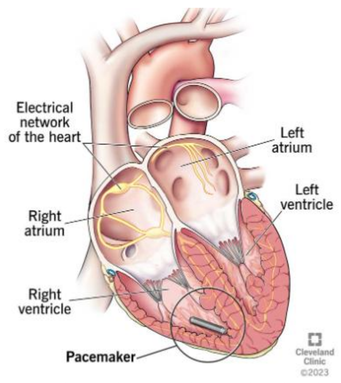

Figure 2 Illustration depicting a leadless pacemaker embedded within the myocardium of right ventricle.

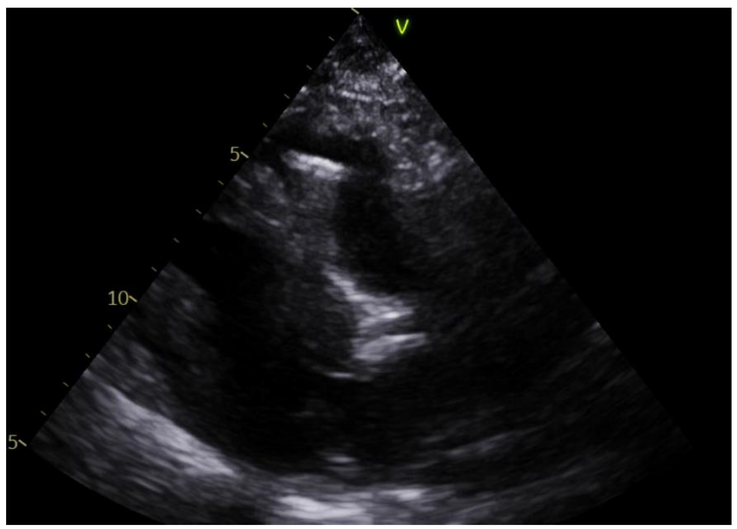

Figure 3 TTE depicting the presence of the leadless pacemaker within the right ventricle.

Discussion

Although IDH is a common complication in patients on hemodialysis, this patient was at increased risk due to his pacemaker. Specifically, a leadless pacemaker functions by sensing atrial mechanical signals rather than the electrical signals seen in traditional pacemakers. Rapid fluid removal during hemodialysis, the distally placed tunneled CVC, and the patient's hunched positioning contribute to altered atrial mechanical signals, leading to AV dyssynchrony. This dyssynchrony, known as pacemaker syndrome, occurs when devices pace the ventricles in isolation, causing improper or mistimed atrial and ventricular contractions, ultimately reducing cardiac output.

The use of leadless pacemakers has increased in recent years due to a lower overall complication risk, including fewer device-related complications, pneumothorax, and endocarditis. However, this rise in usage may contribute to an increased rate of IDH. In ESRD patients, leadless pacemakers may be favored due to their lower risk profile and the need to preserve vasculature or accommodate unique anatomical challenges, such as unsuitable vessels for hemodialysis in the indicated extremity. Given these considerations and potential complications, the type of pacemaker implanted in ESRD patients on hemodialysis warrants careful discussion.

Conclusion

This case presents an interesting example of a patient experiencing recurrent IDH during hemodialysis sessions, attributed to pacemaker syndrome. While IDH is common among hemodialysis patients, this individual was at increased risk due to the presence of a single-chamber leadless pacemaker.

References

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