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Ultrasonographic Detection of Kussmaul Sign in Cardiac Tamponade: A Case Report

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Case Report

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Abstract

Background: The Kussmaul sign, marked by a paradoxical rise in jugular venous pressure (JVP) or a failure of JVP to decrease during inspiration, signifies impaired right ventricular (RV) filling. While well-recognized in various pathologies, the use of ultrasonography for its detection is underrepresented despite its potential to optimize management.

Case Presentation: A 21-year-old obese woman with Systemic Lupus Erythematosus (SLE) presented with acute chest pain and dyspnea. Examination revealed hemodynamic instability, tachypnea, and muffled heart sounds, raising suspicion of cardiac tamponade. Bedside echocardiography confirmed the diagnosis, showing significant pericardial effusion and RV diastolic collapse. Jugular vein assessment using ultrasonography, hindered by anatomical factors, revealed a positive Kussmaul sign, further supporting impaired RV filling. Emergent pericardiocentesis led to rapid clinical improvement.

Conclusions: This case highlights the utility of bedside ultrasonography, particularly the ultrasonographic Kussmaul sign, in managing cardiac tamponade in complex scenarios. Ultrasonography provides a non-invasive, rapid, and reliable method to detect impaired right ventricular function and guide management, helping to tailor fluid therapy and improve outcomes.

Keywords: Kussmaul sign; cardiac tamponade; ultrasound; POCUS; case report; systemic lupus erythematosus.

INTRODUCTION

The timely diagnosis of cardiac tamponade is crucial, as delays can have life-threatening consequences. Cardiac tamponade is classically identified by Beck's triad: hypotension, muffled heart sounds, and jugular Venous Distention (JVD). While JVD remains a cornerstone clinical finding, its accurate detection depends on a precise evaluation of Jugular Venous Pressure (JVP). This process, however, can be significantly hindered by various anatomical and physiological challenges such as obesity, neck masses, or interstitial edema, which can obscure the visualization of JVD, making traditional physical examination findings less reliable [1]. These limitations are particularly pronounced in emergency settings, where time-sensitive decisions are critical, further complicating the timely and accurate assessment of the jugular vein. Similarly, the Kussmaul sign a paradoxical rise in JVP during inspiration and an important indicator of impaired Right Ventricular (RV) filling could be underutilized due to the aforementioned challenges. However, the advent of bedside ultrasonography has enhanced the evaluation of cardiac tamponade by overcoming these barriers. Ultrasonography enables clinicians to conduct a more comprehensive

assessment, facilitating rapid diagnosis and informing critical management decisions [2]. In this report, we emphasize the utility of bedside ultrasonography to detect the Kussmaul sign in a young, obese patient with cardiac tamponade secondary to Systemic Lupus Erythematosus (SLE). This case underscores the diagnostic value of integrating ultrasonography into the assessment of JVP, enabling clinicians to bypass conventional limitations and expedite life-saving measures.

CASE PRESENTATION

A 21-year-old woman presented to the emergency department with progressive dyspnea and squeezing chest pain over the preceding two days. Her medical history was notable for a recent diagnosis of SLE, managed on an outpatient basis with regular follow-ups. She described the chest pain as gradual in onset on the first day, with marked intensification approximately three hours prior to admission. She denied any recent cough, fever, rash, or joint pain. On admission, her vital signs were unstable with a blood pressure of 80/60 mmHg, heart rate of 120 beats/min (regular rhythm), a respiratory rate of 26 breaths/min, and an oxygen saturation of 94% on room air without cyanosis. Her temperature was 36.5°C. Physical examination revealed a mildly obese young woman in significant distress and agitation secondary to chest pain. Although fully alert and oriented, she was only able to speak in short sentences due to marked dyspnea. Bilateral lung sounds were clear and unremarkable, but heart sounds were distant and muffled without any pericardial friction rubs.

Given the patient's history and clinical findings, a provisional diagnosis of acute cardiac tamponade was made. However, jugular venous assessment was limited due to the patient's increased neck tissue mass and agitation. An emergent bedside ultrasound was subsequently performed, revealing significant pericardial effusion with right ventricular diastole collapse and therefore, confirming the diagnosis of cardiac tamponade. To further evaluate the patient's RV hemodynamic status, ultrasonography was employed to seek the Kussmaul sign, as its presence suggests impaired RV handling of preload and can further guide fluid resuscitation. Using a high-frequency linear ultrasound probe, the patient's right internal jugular vein (RIJV) was scanned while she was positioned supine and instructed to perform deep cyclic inspiratory and expiratory maneuvers. The ultrasonographic evaluation demonstrated enlargement of the RIJV during inspiration and reduction in size during expiration, confirming a positive Kussmaul sign (Figure 1).

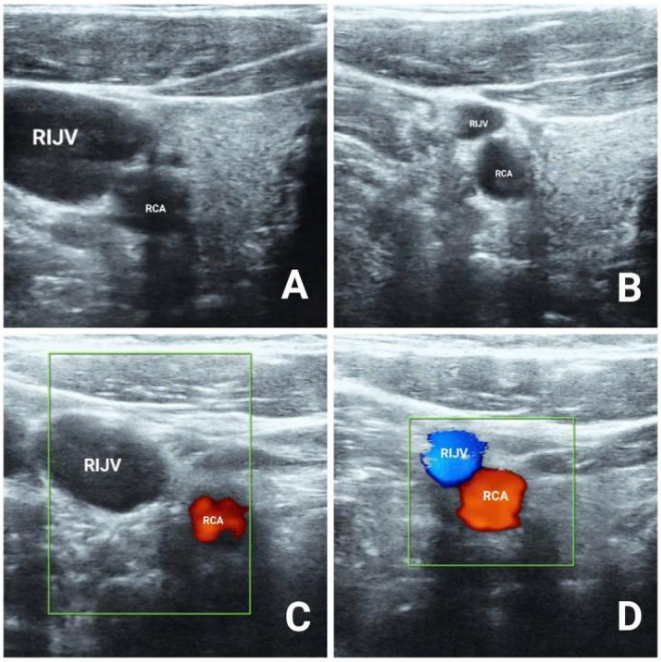

Figure 1: (A) Cross-sectional echocardiographic image of the Right Internal Jugular Vein (RIJV) and Right Carotid Artery (RCA) during inspiration, and (B) during expiration. (C) and (D) display the same structures, the RIJV and RCA, with Doppler ultrasound applied

An emergent pericardiocentesis was performed, yielding 300 mL of pericardial fluid and resulting in immediate symptom alleviation without needing an aggressive initial fluid bolus. The patient was admitted to the intensive care unit for monitoring and was discharged in stable condition on the third day following admission.

DISCUSSION

The timely diagnosis of cardiac tamponade is essential, as delayed recognition can lead to fatal outcomes. Classical clinical findings, including Beck's triad (hypotension, muffled heart sounds, and JVD), have demonstrated limited sensitivity and specificity in diagnosing cardiac tamponade in recent studies. Stolz et al [3] found that muffled heart sounds occur in only 7.2% of pericardial effusion cases, with a 37.5% sensitivity for tamponade diagnosis, while JVD is present in just 5.9% with a sensitivity of 12.5%. Notably, no patients exhibited all three components of Beck's triad, giving it an overall sensitivity of 0%. This highlights the limitations of traditional physical examination in identifying tamponade, particularly in time-sensitive settings. With the availability of Point-Of-Care Ultrasound (POCUS) in emergency departments, bedside ultrasonography has emerged as a reliable and efficient tool for diagnosing pericardial effusion and cardiac tamponade [4]. Echocardiography, whether performed as a focused POCUS or a formal cardiology study, is widely regarded as the gold standard for bedside imaging. Studies demonstrate

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that emergency physicians with limited echocardiographic training can effectively use POCUS to detect clinically significant pericardial effusions with high accuracy [5]. Echocardiography not only confirms the presence and size of pericardial effusion but also identifies key features of tamponade physiology, such as right ventricular diastolic collapse, right atrial systolic collapse, and a plethoric Inferior Vena Cava (IVC) [6]. The Kussmaul sign, a paradoxical rise in JVP or failure of JVP to decrease during inspiration, provides additional diagnostic value by reflecting impaired RV diastolic filling or venous return. Normally, inspiration lowers intrathoracic pressure, increasing venous return to the right atrium and RV, which results in a drop in JVP. However, in conditions such as cardiac tamponade, constrictive pericarditis, or severe RV dysfunction, the RV cannot accommodate the increased venous return due to external compression, restrictive forces, or intrinsic dysfunction. This leads to venous blood backing up into the systemic venous circulation, causing the inspiratory rise in the JVP characteristic of the Kussmaul sign. Identifying the Kussmaul sign allows clinicians to refine the differential diagnosis in patients presenting with dyspnea or heart failure symptoms and evaluate the severity of RV dysfunction. For example, the absence of JVD and the Kussmaul sign in patients with inferior myocardial infarction significantly decreases the likelihood of RV infarction. [7] In the context of cardiac tamponade, assessing jugular venous pressure and the presence of Kussmaul's sign provides valuable insights into RV function and informs initial stabilization strategies. The detection of Kussmaul's sign reflects impaired RV preload tolerance, indicating that aggressive fluid resuscitation may be harmful [8]. Excessive fluid loading can over-distend the RV, compress the left ventricle, and further compromise cardiac output. Conversely, patients with low-pressure tamponade, who are often volume-depleted, may benefit from cautious fluid administration to restore hemodynamic stability [9]. Recognizing this sign can prevent inappropriate fluid administration and guide tailored management. Our case report highlights the utility of ultrasonography, particularly the application of the ultrasonographic Kussmaul sign, in the evaluation of patients presenting with cardiac tamponade. This non-invasive, rapid, and highly efficient technique surpasses traditional physical examination methods by providing critical insights into right ventricular function. It enhances diagnostic precision, especially in challenging scenarios where anatomical or physiological barriers limit conventional physical examination. The decision to proceed with pericardial drainage is primarily guided by the underlying etiology of the effusion and the patient's clinical condition [10]. However, the broader incorporation of ultrasonographic Kussmaul signs into the comprehensive evaluation of cardiac tamponade cases could provide valuable insights, enabling individualized management of the condition.

CONCLUSION

This case highlights the utility of bedside ultrasonography, particularly the detection of the ultrasonographic Kussmaul sign, in managing cardiac tamponade with challenging clinical scenarios. Traditional physical examination findings, such as JVD, may be obscured by anatomical or physiological barriers, as seen in our obese patient with SLE. Ultrasonography offers a non-invasive, rapid, and reliable method for detecting impaired right ventricular function and guiding subsequent management. Incorporating ultrasonographic Kussmaul signs into the standard evaluation of cardiac tamponade cases can help tailor fluid management and optimize patient outcomes.

DECLARATION

I. Ethics approval: All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013).

II. Written informed consent for publication of this case report and accompanying images was obtained from the patient.

III. Availability of data and material: Not applicable

IV. Competing interests: The authors declare that they have no competing interests

V. Funding: None

VI. Authors' contributions: Thang Nguyen, study concept, design, collection and assembly of data, manuscript original drafting; Nghia Nguyen and Van Nguyen, administrative support, provision of patients, contribution to manuscript writing and editing.

VII. All the authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work

VIII. Acknowledgments: Not applicable

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