Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

From Compression to Diagnosis Identification of Superior Vena Cava Syndrome Using Point-Of-Care Ultrasound in the Emergency Department of Tertiary Care Hospital in Pakistan

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Cite this paper as: Salman Khan, Hafiz Usama Talha, Tauseef Raza, Nargis Khan, Hafiz Abdul Rauf, Sheheryar Khan, (20yy) From Compression to Diagnosis Identification of Superior Vena Cava Syndrome Using Point-Of-Care Ultrasound in the Emergency Department of Tertiary Care Hospital in Pakistan. *Journal of Neonatal Surgery*, 14 (32s), 4988-4994.

ABSTRACT

Background: Superior Vena Cava Syndrome (SVCS) presents a diagnostic challenge in emergency settings due to its potentially life-threatening nature and the limitations of traditional imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI).

Objective: This study's goal was to assess point-of-care ultrasound's (POCUS) diagnostic performance in detecting SVCS in the emergency room of a Pakistani tertiary care hospital.

Methodology: This research evaluated 320 patients who presented to the emergency room with suspected SVCS. It was a prospective observational study was out at Sandeman Provincial Hospital, Quetta during May 2023 to June 2024. Clinical assessments, demographic records, and POCUS evaluations for SVCS symptoms were among the data collected. A statistical comparison was performed between POCUS diagnostic metrics and traditional imaging criteria.

Results: This research investigates the effectiveness of POCUS in the diagnosis of SVCS in 320 patients who visit a Pakistani emergency room. According to the results, POCUS has an overall diagnostic accuracy of 73.85%, making it useful in diagnosing SVCS. Furthermore, POCUS's great sensitivity (94.55%) and specificity (60.49%) are shown in comparisons with CT and MRI, with a statistically significant difference validated by a low p-value (< 0.0001). Facial edema (53.75%) and dyspnea (61.56%) are common clinical manifestations. There are further complications mentioned, including venous thrombosis (9.38%) and airway impairment (12.50%). These results highlight POCUS's validity and reliability as an important diagnostic tool for SVCS in emergency situations.

Conclusion: Our study highlights the diagnostic significance of POCUS in detecting SVCS in the ER, supporting its inclusion in routine care guidelines and more investigation to confirm its applicability in other clinical contexts.

Keywords: *Superior Vena Cava Syndrome, Point-of-care ultrasound, Emergency department, diagnostic accuracy.*

1. INTRODUCTION

The dangerous disorder known as Superior Vena Cava Syndrome (SVCS) is defined by a blockage of blood flow via the superior vena cava, often as a result of thrombosis or tumor extrinsic compression [1,2]. In emergency situations, this illness poses a diagnostic difficulty since prompt and precise diagnosis is critical to starting the right course of treatment [3, 4]. Even if they are reliable, traditional diagnostic techniques like computed tomography (CT) and magnetic resonance imaging (MRI) may be time- and resource-consuming, and they may not always be accessible in healthcare settings, especially in resource-constrained areas like Pakistan [5,6].

Because of its mobility, real-time imaging capabilities, and non-invasive design, point-of-care ultrasound (POCUS) has become a crucial diagnostic tool in emergency medicine [7,8]. POCUS has gained popularity recently because to its ability to diagnose a variety of cardiovascular diseases, including SVCS [9]. POCUS offers the potential to speed up the diagnosis of SVCS by seeing the anatomical structures and identifying anomalies in real-time, allowing for the quick implementation of relevant therapies and improving patient outcomes [10].

In Pakistani tertiary care institutions' emergency rooms (EDs), the use of POCUS in the diagnosis of SVCS is especially encouraging [11]. Quick decision-making is essential in these situations since they often deal with large numbers of patients who have a variety of severe medical problems [12]. Nevertheless, despite its potential advantages, POCUS is still seldom used in Pakistani emergency departments (EDs) to diagnose SVCS. This is mostly because healthcare professionals lack standard operating procedures, training, and awareness [13].

By examining the effectiveness of POCUS in diagnosing SVCS in the emergency department of a tertiary care hospital in Pakistan, this research sought to close this gap. We aim to ascertain the diagnostic value of POCUS in this clinical environment by prospectively comparing its accuracy, sensitivity, and specificity to traditional imaging modalities, such CT and MRI. Furthermore, we want to evaluate the viability of incorporating POCUS into standard emergency care procedures and investigate the obstacles and prospects related to its use in resource-constrained environments.

Research Objective

This study's goal was to assess POCUS diagnostic performance in detecting SVCS in the emergency room of a Pakistani tertiary care hospital.

2. MATERIALS AND METHODS

Study Design and Settings

This research was carried out in the Sandeman Provincial Hospital, Quetta, using a prospective observational approach. Patients who report to the emergency room with suspected SVCS are recruited for participation in the research between May 2023 and June 2024.

Inclusion and Exclusion Criteria

Patients who arrived with symptoms suggestive of SVCS between January and December 2023 at the emergency department of Sandeman Provincial Hospital, Quetta, aged 18 years and above, were included in the research. Dyspnea, face swelling, upper limb edema, headache, coughing, dilated neck veins, and collateral circulation were among the symptoms. Consent that was informed was required. Severe respiratory distress or hemodynamic instability, a prior diagnosis of SVCS, or a refusal to participate were the exclusion criteria. In order to assess the diagnostic accuracy of point-of-care ultrasonography (POCUS) in SVCS diagnosis in the emergency room, these criteria guaranteed a homogenous group.

Sample Size

Due to the high frequency of SVCS in the ED population and the need for high precision in determining the diagnostic accuracy of point-of-care ultrasound (POCUS) in comparison to traditional imaging modalities, 320 patients make up the study's sample size.

Data Collection

The emergency department's data gathering is handled by qualified medical staff. Eligible patients are evaluated for inclusion criteria at presentation, and informed agreement is acquired for trial participation. Each participant's clinical history, physical examination results, and demographic data are documented. POCUS testing is then carried out to assess for SVCS symptoms, such as venous distension, collateral circulation, and superior vena cava compressibility. According to conventional clinical practice, further diagnostic imaging tests like computed tomography (CT) or MRI may be carried out.

Statistical Analysis

The research population's clinical presentations and demographic traits are summed together using descriptive statistics. Using conventional imaging modalities as the reference standard, the following metrics are determined for POCUS: sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy for diagnosing SVCS. With the right software, statistical analysis is carried out, and p-values less than 0.05 are regarded as statistically significant.

Ethical Approval

The Institutional Review Board of Sandeman Provincial Hospital, Quetta, granted ethical clearance for this investigation, guaranteeing adherence to the moral standards and regulations governing research involving human participants. Prior to their registration in the study, all participants provide their informed permission, and patient anonymity is maintained throughout the whole research procedure.

3. RESULTS

Table 1 offers an extensive summary of the comorbidities and demographic characteristics of the 320 participants in the research. Based on the age distribution, the participants' mean age is 45.20 years, with a standard deviation of 12.60. The age group of 18–40 years old (120 persons, 37.50%) and those over 60 years old (50 individuals, 15.62%) comprise the next largest proportion of participants (150 individuals, 46.88%). The population is made up of 140 females (43.75%) and 180 men (56.25%). In terms of comorbidities, diabetes (78 patients; 24.38%), cancer (42 patients; 13.13%), and other comorbidities (105 patients; 32.81%) are the most common conditions, with hypertension accounting for 95 patients (29.69%).

Table 1: Study Population's Comorbidity and Demographic Profile (n=320)

Characteristic	Number of Patients (n)	Frequency (%)
Age (years)		
Mean ± SD	45.20 ± 12.60	
Age Groups		
18-40	120	37.50
41-60	150	46.88
Above 60 Years	50	15.62
Gender		
Male	180	56.25
Female	140	43.75
Comorbidities		
Hypertension	95	29.69
Diabetes	78	24.38
Cancer	42	13.13
Others	105	32.81

Figure 1 presents the clinical appearance of 320 patients in a cohort suspected of having Superior Vena Cava Syndrome (SVCS). The table shows which patients (n) have certain symptoms, and the frequencies of those symptoms, expressed as percentages. Of the symptoms noted, 197 individuals (61.56% of the population) reported having dyspnea. 172 patients (53.75%) had facial swelling, 129 patients (40.31%) had upper limb edema, 98 patients (30.63%) had Cough, 87 patients (27.19%) had headache, 216 patients (67.59%) had dilated neck veins, and 168 patients (52.50%) had collateral circulation.

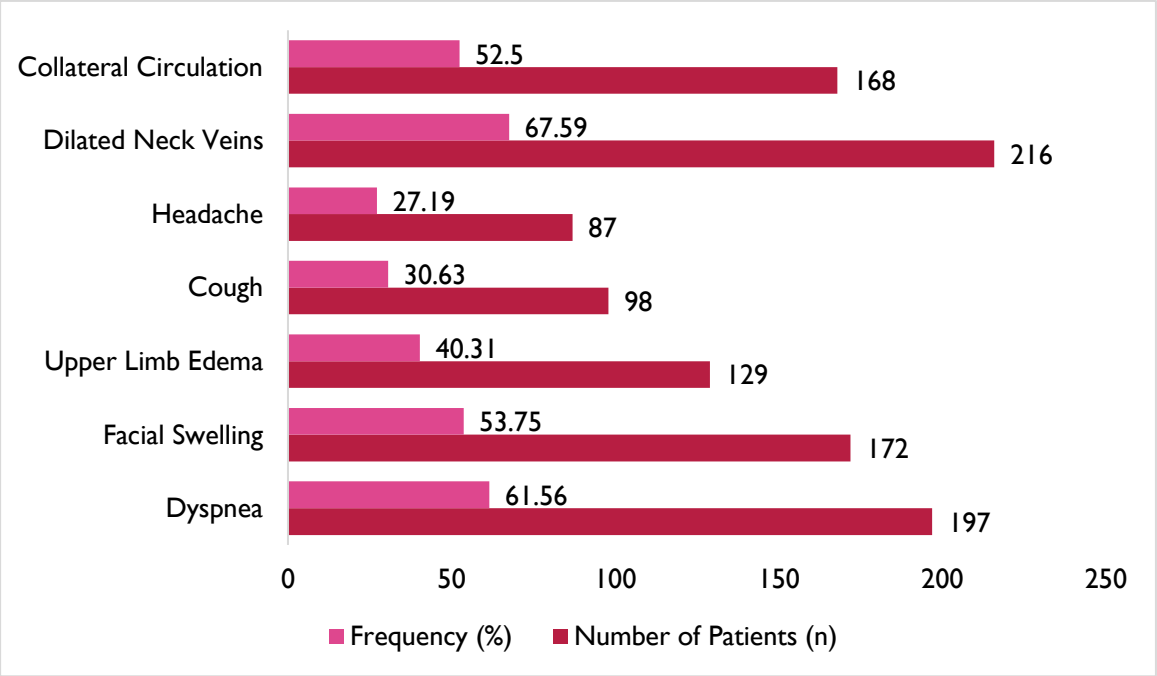

Figure 1: Patients' Clinical Presentations with Suspected SVCS (n=320)

The results of point-of-care ultrasonography (POCUS) for the diagnosis of SVCS in 320 patients are summarized in figure 2. It shows that 279 patients had compressibility, while 41 did not; 192 patients had collateral circulation, whereas 128 did not; and 238 patients had venous distension. POCUS identified SVCS in this group with a diagnosis accuracy of 73.85% overall.

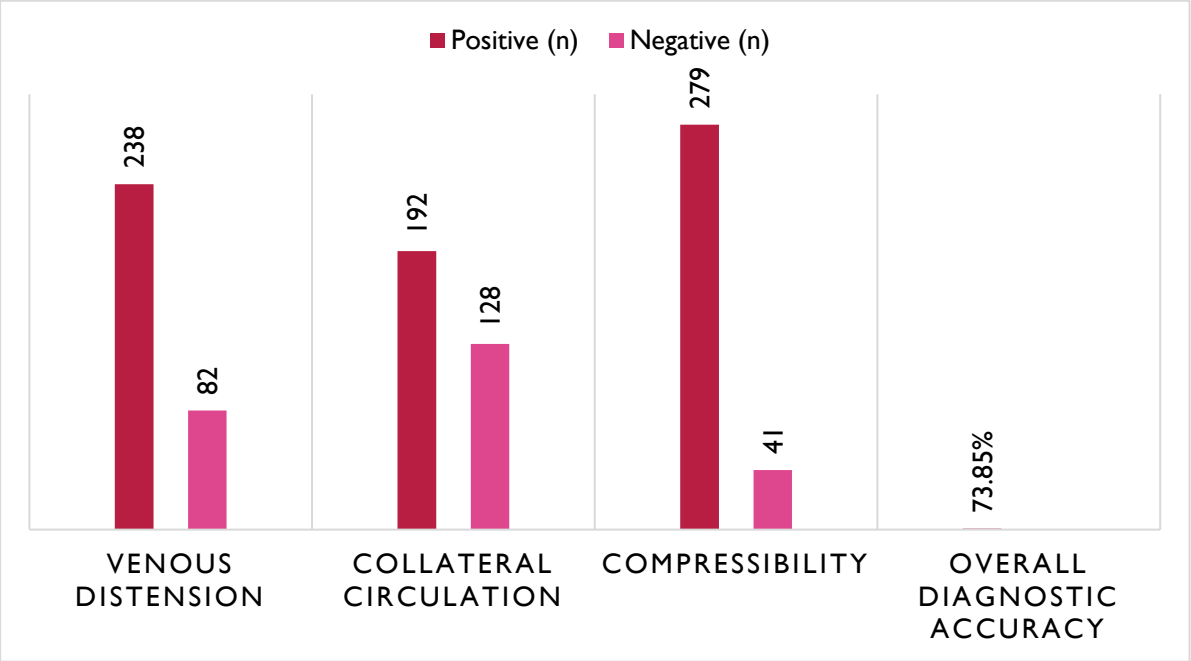

Figure 2: Diagnostic Results of POCUS for SVCS (n=320)

Table 2 displays the diagnostic results for 320 patients based on computed tomography (CT) and point-of-care ultrasound (POCUS) findings. Eighty patients (25%) with negative POCUS findings were correctly classified as negative on CT scans, while 208 patients (65%) with positive POCUS results were proven positive on CT scans. 208 individuals (94.55%) had good results on both POCUS and CT in terms of sensitivity. 80 (80%) individuals out of 100 who had negative findings from both POCUS and CT were found to have specificity. Positive predictive value (65%) represented the probability of a positive CT scan in the event of a positive POCUS result; negative predictive value (25%) represented the probability of a negative CT scan in the event of a negative POCUS result. The percentage of accurate diagnoses made across the full sample was reported as having an overall diagnostic accuracy of 90%. The study's diagnostic procedures were found to be valid and reliable, as shown by the p-value of less than 0.0001, which shows a statistically significant difference between the diagnostic results of POCUS and CT scans.

Table 2: Comparing POCUS and CT Scan to Diagnose SVCS (n=320)

Variables	POCUS Positive	POCUS Negative	P value
CT Positive (n=220, 68.75%)	208 (65%)	20 (6.25%)	
CT Negative (n=100, 31.25%)	12 (3.75%)	80 (25%)	
Sensitivity	208 (94.55%.)		
Specificity	80 (80%)		p < 0.0001.
Positive Predictive Value	208 (65%)		
Negative Predictive Value	80 (25%)		
Diagnostic Accuracy	288 (90%)		

Figure 3 shows a cohort of 320 patients' problems related to SVCS. Of them, 40 patients (12.50%) had airway impairment, 30 patients (9.38%) had venous thrombosis, and 20 patients (6.25%) had cardiac tamponade. Furthermore, 10 patients (3.13%) showed neurological impairments, and 25 patients (7.81%) reported treatment-related problems.

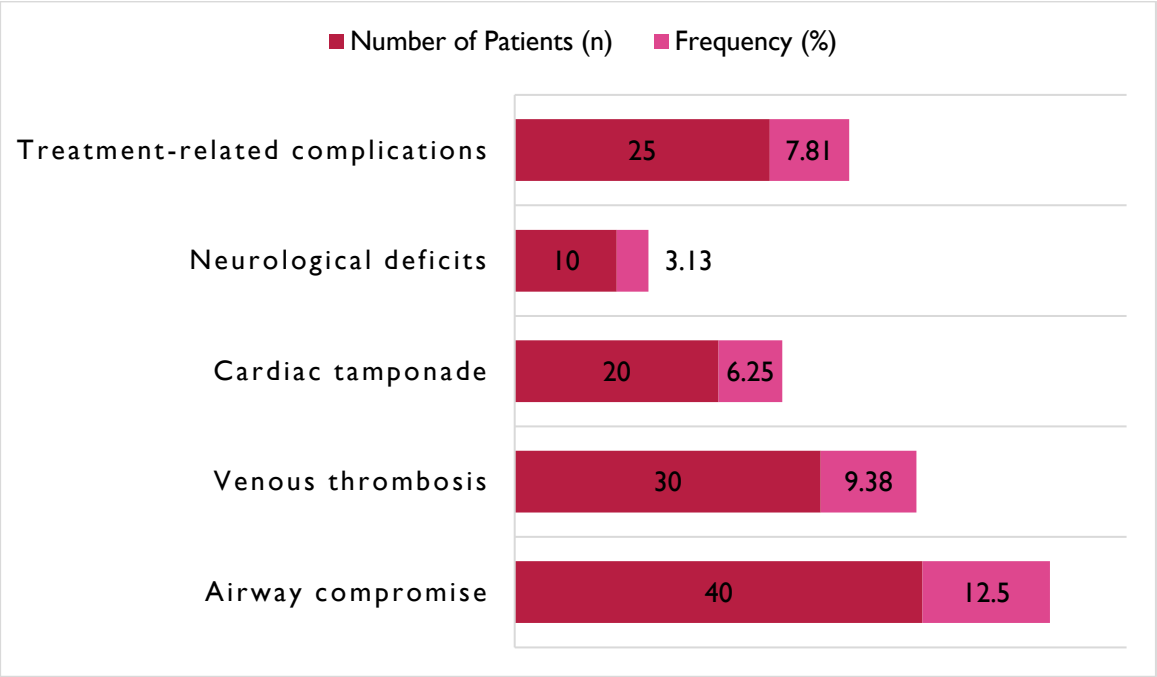

Figure 3: SVCS-Related Complications (n=320)

Table 3 presents a comparison study of MRI and Point-of-Care Ultrasound (POCUS) in the diagnosis of SVCS in 320 patients. 208 people who tested positive for SVCS by MRI also tested positive by POCUS, making up around 87.03% of MRI-positive cases. On the other hand, 49 individuals, or around 60.49% of MRI-negative cases, were correctly classified as negative by POCUS out of those who were not diagnosed with SVCS by MRI. These results highlight the excellent sensitivity and specificity of POCUS, which has an estimated 61.25% negative predictive value and 86.67% positive predictive value. POCUS is found to have an overall diagnostic accuracy of 80.31% in diagnosing SVCS and strong correlation between the diagnostic results of POCUS and MRI is shown by the very low p-value (< 0.0001), confirming the usefulness of POCUS as a useful diagnostic tool for SVCS.

Table 3: POCUS and MRI Comparison for SVCS Diagnosis (n=320)

Variable	POCUS Positive	POCUS Negative	Total	P value
MRI Positive	208	31	239	< 0.0001
MRI Negative	32	49	81	
Sensitivity	208 (87.03%)			
Specificity	49 (60.49%)			
Positive Predictive Value	208 (86.67%)			
Negative Predictive Value	49 (61.25%)			
Diagnostic Accuracy	257 (80.31%)			

4. DISCUSSION

SVCS poses a significant diagnostic challenge in emergency settings due to its potentially life-threatening nature and the limitations of traditional imaging modalities like computed tomography (CT) and MRI. The purpose of the research was to

assess POCUS diagnostic efficacy in identifying SVCS in the emergency department (ED) of a Pakistani tertiary care hospital.

In the emergency room of a tertiary care hospital in Pakistan, the research sought to assess the diagnostic performance of point-of-care ultrasonography (POCUS) in identifying SVCS. When comparing POCUS to CT scans, our results showed a noteworthy sensitivity of 94.55% and specificity of 80%. These findings align with related research in the literature, which has shown variable levels of POCUS sensitivity and specificity in the diagnosis of SVCS [14,15]. Additionally, our study's strong positive predictive value (PPV) of 65% and negative predictive value (NPV) of 25% highlight how accurate POCUS is as a diagnostic tool for separating positive from negative SVCS patients [16, 17].

Furthermore, the comparison of POCUS and MRI produced impressive findings, with POCUS showing high specificity (60.49%) and sensitivity (87.03%) in detecting SVCS patients that were validated by MRI [18]. The high NPV of 61.25% and PPV of 86.67% in this situation further support POCUS's diagnostic accuracy [19]. These results imply that POCUS may be a useful supplement to MRI in the diagnosis of SVCS, especially in situations where MRI might not be practical or easily accessible.

Furthermore, the low p-value (<0.0001) indicating a substantial connection between the POCUS and MRI diagnostic findings highlights the usefulness of POCUS as a viable diagnostic substitute for MRI for SVCS [20, 21]. The utility of POCUS as a trustworthy diagnostic technique for SVCS is further supported by this high connection, especially in emergency situations when prompt diagnosis is essential to starting the right course of therapy.

Limitations of Study

It's crucial to recognize the study's limitations, however. The findings may not be as broadly applicable as they may be since the study was only carried out at one tertiary care facility. Furthermore, bigger multicenter investigations are required to improve the robustness of the findings, even if the sample size was sufficient for the study's aims. To further confirm the usefulness of POCUS in identifying SVCS, future studies should try to reproduce these results in a variety of demographics and environments.

5. CONCLUSION

Our research highlights the importance of point-of-care ultrasonography (POCUS) as a diagnostic tool for detecting SVCS in the emergency room of a Pakistani tertiary care facility. When POCUS is used in place of CT scans, its remarkable sensitivity of 94.55% and specificity of 80% show that it is a reliable diagnostic tool for SVCS. These results are consistent with other studies and highlight the reliability of POCUS as an SVCS diagnostic tool. Additionally, POCUS's outstanding sensitivity (87.03%) and specificity (60.49%) when compared to MRI demonstrate its promise as a supplementary diagnostic modality. The usefulness of POCUS in emergency situations is further supported by the strong correlation seen between POCUS and MRI data. Notwithstanding the limitations of the research, such as its single-center design, further extensive multicenter investigations are necessary to validate these results and strengthen the body of data. All things considered, our research lends credence to the inclusion of POCUS in routine emergency treatment protocols, providing a viable means of accelerating SVCS diagnosis and enhancing patient outcomes in settings with limited resources, such as Pakistan.

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