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Focused Cardiac Ultrasonography and Simple Echocardiographic Scoring For Aortic Stenosis Screening In the Urgent Care

J. Jacob Justin[1], Sabu Augustine[2]

[1]Associate Professor, Department of General Medicine, Dr. Somervell Memorial C.S.I Medical College, Trivandrum, Kerala, India
[2]Associate Professor, Department of General Medicine,Dr. Somervell Memorial C.S.I Medical College, Trivandrum, Kerala, India

Abstract

Background: There is currently no tried-and-true approach for diagnosing aortic stenosis by the use of focused cardiac ultrasonography. We assessed the diagnosis accuracy of the visual AS score that we had established for use in screening patients with AS in an emergency room setting. **Material and Methods:** A total of seventy-two emergency outpatients with a possible cardiovascular disease were examined for this study. In addition to performing the conventional FOCUS, emergency physicians evaluated the patient's visual AS score. After that, specialist sonographers in the echocardiography laboratory determined the patient's aortic valve area index (AVAI). AVAI values of >0.85 cm2/m2, 0.6–0.85 cm2/m2, and 0.6 cm2/m2 were categorised, respectively, as having no or mild AS, moderate AS, and severe AS. **Results:** 17 patients (24%) had moderate to severe AS. In this study, there was a significant correlation between the visual AS score determined by emergency physicians and the AVAI determined by expert sonographers (R = -0.71, p 0.0001) and excellent agreement between the visual AS scores determined by emergency physicians and those determined by expert sonographers (= 0.93). Emergency physicians discovered that a visual AS score of 3 had a sensitivity of 82%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 95% when diagnosing moderate or severe AS. [7 (50%) vs. 2 (3%), p 0 .0001] Patients having a visual AS score of 3 as determined by emergency physicians had a higher prevalence of new-onset AS-related incidents during hospitalisation than the other patients. **Conclusion:** Emergency physicians who are not expert cardiologists can benefit from using the visual AS score as an AS screening tool because of its simplicity.

Keywords: Arterial stenosis, point-of-care ultrasound, echocardiography, heart ultrasonography, emergency.

Corresponding Author: Dr Sabu Augustine,Associate Professor, Department of General Medicine,Dr. Somervell Memorial C.S.I Medical College, Trivandrum, Kerala, India

Introduction

In clinical practise, aortic stenosis (AS) is a prevalent form of the valvular illness known as aortic stenosis, and its prevalence is expanding worldwide in older populations.[1] Patients who present themselves to emergency departments complaining of a variety of symptoms may frequently have pathophysiology connected to AS, and they may at times require prompt diagnosis and treatment.[2,3] However, performing a comprehensive evaluation of AS in emergency situations can be difficult because the assessment takes time, experienced knowledge or techniques, and special equipment such as spectral Doppler. The standard procedure for screening AS and for diagnosing the severity of AS is transthoracic echocardiography.[4-7] In recent years, since the development of point-of-care (POC) ultrasonography, there has been a substantial improvement in the speed with which acute or critical medical situations can be evaluated. Focused cardiac ultrasound, also known as

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FOCUS, is a form of point-of-care testing that is frequently utilised in emergency situations for the purpose of evaluating hemodynamic or cardiovascular pathophysiology. This can include the evaluation of conditions such as hypovolemic shock, cardiogenic shock, congestive heart failure, pulmonary embolism, or cardiac tamponade.[8-11] Nevertheless, FOCUS has not yet been standardised as a diagnostic tool for AS, and there is currently none available. In the past, we have developed a visual AS score that may be used as a straightforward index for AS screening with quick echocardiography utilising a device that is portable and small enough to fit in a pocket.[12-15] In that study, we demonstrated that there is a strong relationship between the visual AS score and the degree to which AS is present, as determined by an aortic valve area index (AVAI). Using the visual AS score, we were also able to accurately diagnose clinically severe AS with a high level of diagnostic accuracy. The combination of our visual AS score with the traditional aortic valve calcification score was able to predict further AS-related events, as we reported in a subsequent investigation.[16,17] As a result, we had the hypothesis that our visual AS score would be helpful in screening for AS in contexts that involve an emergency. The purpose of this study was to explore the diagnosis accuracy of the visual AS score for AS screening in an emergency department by emergency physicians who were not expert cardiologists. The investigation was carried out by emergency physicians who were trained in emergency medicine.

Material and Methods

This was a prospective study that was carried out by observation at the Health Sciences Center, which is an emergency public hospital. Participants were emergency outpatients with suspected cardiovascular diseases who presented with chest symptoms, consciousness disorders, abnormal vital signs, heart murmurs, or abnormal electrocardiograms. This participation period lasted from September 2020 to October 2022. Patients who had a known history of AS or an aortic valve that was bicuspid were not included in the study. Patients were also omitted from the study if there was a problem with the observation of the aortic valve cusps in a short-axis view or with the evaluation of the aortic valve area (AVA) calculated with the continuity equation during comprehensive echocardiography. Both of these difficulties were considered technical issues. The protocol for the study was given the go-ahead by the institutional review board of the Health Sciences Center, and signed informed consent was obtained from each patient participating in the research.

Emergency physicians' education:

Participants in the study included seven emergency physicians who were either in their third or thirteenth year of postgraduate training and were now employed in the emergency department. They did not have extensive knowledge of cardiology or ultrasound technology, but they did have experience with the fundamental FOCUS procedures. In addition, for the purpose of this study, they participated in a quick training session that lasted for thirty minutes. The curriculum was comprised of lectures that discussed the theoretical underpinnings as well as the potential problems involved in the evaluation of a visual AS score by an experienced echocardiographer.[18]

Emergency physicians using point-of-care echocardiography:

Patients who were seen as emergency outpatients in the emergency department received primary medical care from emergency physicians. The visual AS score and FOCUS were used to check patients who arrived at the hospital with abnormal vital signs. They were also immediately evaluated with FOCUS and the visual AS score if more patients showed up with chest complaints, anomalous vital signs, or other abnormal examination findings that were thought to be cardiovascular diseases. The patients' required treatment may then start once the emergency physicians were given the go-ahead to validate the results of further tests

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including auscultation, laboratory results, electrocardiograms, X-rays, or other imaging modalities like computed tomography scans.

The transducer was positioned and adjusted to display the aortic valve in the parasternal short-axis view while calculating a visual AS score. This made sure the valve was in the middle of the screen and was as visible as possible. The lines that connected each of the three commissures could be seen by the doctor in his mind's eye. Each aortic cusp opening was given a score based on visual examination, ranging from 0 (showing no limitation) to 1 (expressing considerable restriction) to 2 (indicating severe restriction). If the opening of the cusp did not go over the line dividing the commissures, it was deemed to have a restricted cusp opening. If there was a significant decrease in or absence of systolic motion at the cusp, the cusp opening was deemed to be considerably restricted. The points obtained on each of the three cusps were added together to determine the visual AS score (range, 0–6). POC-echo required fewer than five minutes to complete.[19]

Standard echocardiography:

After being admitted to the hospital, the people who took part in the study had an extensive standard echocardiogram (STD-echo) performed on them in the echocardiography lab that was controlled and maintained in line with the requirements. During hospitalisation, the STD-echo was performed no more than two weeks after the POC-echo, but this timeframe could vary from patient to patient depending on their individual needs. Sonographers with Level 3 training carried out the STD-echo while concealing their view of the POC-echo data from themselves. The EPIQ CVx, EPIQ 7 G, and Vivid E9 all utilised the secondharmonic mode in their respective designs (all from GE Vingmed Ultrasound, Horten, Norway).

Statistical analysis:

The chi-square test was utilised in order to make comparisons between categorical variables after they were given absolute value and percentage representations. The continuous variables were analysed using Student's ttest, with the results being expressed as the mean along with the standard deviation of the group. In order to investigate the degree of correlation between continuous variables, a linear regression analysis was carried out. The weighted Cohen's kappa coefficient, together with 95% confidence intervals, was used to determine the level of agreement (CIs). A kappa value of less than 0.20 was thought to indicate a poor level of agreement, whereas values between 0.21 and 0.40, 0.41 and 0.60, 0.61 and 0.80, and 0.81 and 1.0 were deemed to indicate a strong level of agreement.

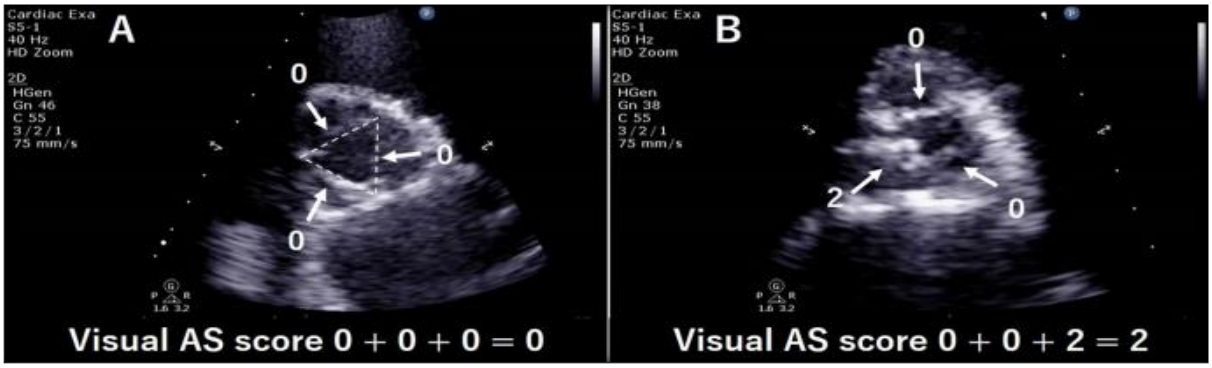

Figure 1: Examples of the visual aortic stenosis (AS) score assessment. The following visual scores were assigned to each aortic cusp opening: 0 = not restricted, 1 = restricted, or 2 = severely restricted. The visual AS score was calculated as the average of the three cusp scores (range, 0–6). The examples in (A) through (B)

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Results

We recruited sixty individuals who had been admitted to the Health Sciences Center as emergency outpatients in sequential order. It was possible to determine patients' visual AS scores in 74 (93%) of the patients. When trying to visualise the cusps of the aortic valve with POC-echo, six patients ran into technical issues; hence, these six patients were not included in the analysis. As a result of this, the visual AS score of five of these six patients could not be determined using STD-echo. We had to exclude two more patients from the study due to complications arising from the application of the continuity equation. These complications arose either as a result of poor image quality or the simultaneous presence of significant acceleration flow at the left ventricular outflow tract during STD-echo. No patients had bicuspid aortic valves. The final group for the research study consisted of the remaining 52 patients. On admission, the primary diagnosis for 17 (24%) patients was a cardiovascular disorder. These cardiovascular disorders included congestive heart failure in 9 (13%), arrhythmia in 3 (4%), ischemic heart disease in 2 (3%), syncope caused by AS in 1 (1%), pulmonary embolism in 1 (1%), and aortic dissection in 1 (1%). On the other hand, noncardiovascular disorders were determined to be the primary diagnosis for 55 patients (76%) at the time of admission. These disorders included infectious diseases in 14 (19%) of the patients, trauma in 9 (13%), cerebrovascular diseases in 8 (11%), respiratory diseases in 8 (11%), gastrointestinal diseases in 7 (10%), and other disorders in 9 (13%). Patients diagnosed with moderate or severe AS by STD-echo were found to be older than those diagnosed with no or mild AS by STD-echo. Other baseline clinical features were compared between individuals evaluated by STD-echo who had no or mild AS and those who had moderate or severe AS; however, no significant differences were found between the two groups. One patient with severe AS passed away during hospitalisation as a result of an acute myocardial infarction and subsequent heart failure, and another patient with severe AS passed away during hospitalisation as a result of sepsis and subsequent heart failure. Both patients had been diagnosed with moderate or severe AS. During their stay in the hospital, one patient who was diagnosed with moderate AS experienced a worsening of congestive heart failure, and another four patients who were diagnosed with severe AS received surgical or transcatheter aortic valve replacement. According to the results of the POC-echo, all seven of these patients who suffered from new-onset cardiovascular events or aortic valve replacement while they were hospitalised had visual AS scores that were lower than 3. The prevalence of new-onset AS-related events during hospitalisation was higher in patients with moderate or severe AS assessed by STD-echo than in patients with no or mild AS [7 (41%) vs. 2 (4%), p 0.0001 by the chi-square test; odds ratio 18.6 (95%CI 3.4–103), p = 0.0008 by the logistic regression analysis]. These events included cardiac death, congestive heart failure, and aortic valve replacement. Similarly, the prevalence of newonset AS-related events during hospitalisation was higher in patients with a visual AS score of 3 as assessed by POC-echo than in those with a visual AS score of 0.0001 as determined by the chi-square test; odds ratio 28.0 (95% CI 4.8–162), p = 0.0002 as determined by the logistic regression analysis].

Discussion

The purpose of this study was to investigate whether or not the visual AS score that we devised could be beneficial in screening for AS performed by emergency physicians who were not trained cardiologists. The most important takeaways from this research were the following: 1) the observation of a strong correlation between the visual AS score for POC-echo performed by emergency physicians and the AVAI for STD-echo performed by expert sonographers; 2) a visual AS score 3 for POC-echo performed by emergency physicians had an excellent diagnostic accuracy for moderate or severe AS; and 3) the prevalence of new-onset AS-related events during hospitalisation was higher in patients with visual AS scores of

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3 or higher. Patients can be managed in the emergency department, critical care unit, clinic, or even outside of the hospital by clinicians who have received at least focused training in ultrasound image acquisition and interpretation. This type of management can be performed by clinicians in any setting where ultrasound images are acquired and interpreted. It does not involve any intrusive procedures and can be quickly repeated at the bedside regardless of how the patient's condition evolves. Therefore, diagnostic point-of-care ultrasonography in emergency settings may lead to early diagnosis and early treatment, thereby shortening lengths of stay in the emergency department, preventing prolonged discomfort, circumventing adverse effects due to incorrect treatment choices, and decreasing morbidity and mortality rates. Because of the nature of the patient's illness, it is frequently challenging to position patients in the left-lateral decubitus position in an emergency situation. The patient's state may be less stable or less clear than it would be in an echocardiography laboratory. In addition, medical professionals may at times have trouble showing the aortic valve in the short-axis view due to geometrical factors, such as the presence of a sigmoid septum. In these kinds of situations, the visual AS scores have a tendency to overestimate the severity of the aortic stenosis. However, in order to determine the visual AS score, it is not required to see all three cusps of the aortic valve at the same time. Furthermore, it should be acceptable to evaluate the mobility of each of the cusps individually by modifying the angle or rotation of the probe. Therefore, the visual AS score for POC-echo indicates good accuracy for screening or diagnosing clinically severe AS in the current investigation. This was the conclusion reached by the authors of the study. In the current investigation, emergency physicians were able to perform point-of-care echocardiogram (POC-echo) in a relatively short amount of time using portable echocardiography. In total, 55 (78%) of the patients were investigated while lying supine, and a visual AS score was able to be assessed in a practicable manner in 93% of all of the patients who were enrolled in the study. The visual AS score in POC-echo corresponded well with the score obtained with STD-echo, and a visual AS score of 3 had reasonable sensitivity and excellent specificity for identifying moderate or severe AS. Our result that a visual AS score of more than three implies clinically severe AS seems plausible to us, so we will just leave it at that. Given that the radius of the aortic annular ring is 1 cm, the area of the regular triangle is estimated as 1.3 cm2, which roughly matches to the cut-off value of 1.5 cm2 for diagnosing more severe AS in accordance with the most recent recommendations. In addition, when taking into account the average body surface area of the people in this study, which was 1.5 m2, the AVAI would be 0.86 cm2/m2, which corresponds almost perfectly to the cut-off value of 0.85 cm2/m2 for diagnosing more severe AS according to the most recent criteria. According to the findings of this study, individuals who have a visual AS score of less than three require a specialised evaluation of the severity of their AS as well as a comprehensive diagnosis. This study suffered from a number of shortcomings. One limitation of our research is that it was conducted on a relatively small number of patients and attending physicians from a single location. In addition, the average body surface area of our patients was approximately 1.5 square metres, which is consistent with the typical appearance of the Japanese people. As a result, the collection of high-quality echocardiographic pictures may have been less difficult than it would have been in other populations. In order to clarify the general utility of our newly established visual AS score, it will be necessary to conduct multicenter trials that include larger patient groups, patients from a wider range of ethnicities, and emergency physicians. The findings from the physical examination weren't included in this study, which is the second limitation of this research.[20] The transmission to the neck of a systolic ejection murmur, a diminished second heart sound, a delayed carotid artery upstroke, and carotid artery shudder are the physical findings that represent significant AS, and they should be evaluated as the first-line means of diagnosing atherosclerosis in the aorta. In the current

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study, the ability to perform a physical examination was left up to the discretion of each emergency physician, and the diagnostic accuracy was not evaluated because there was a clear disparity in the capacities of emergency physicians to perform physical examinations. It is nonetheless a matter of worry that the findings of the physical examination might have introduced some element of bias into the following evaluation of the visual AS score. However, in our view, rather than being a weakness of the current study, we believe this may really be one of its strengths. FOCUS was originally performed in conjunction with physical examinations and has the potential to be a reliable method for augmenting the findings of physical examinations in some cases. As a result, it is highly likely that our findings represent clinical data from the actual world. The final shortcoming of this study is that it did not evaluate AS at low gradients. Since the visual AS score is derived from the straightforward idea of estimating the degree of aortic valve opening or valve area, both of which are determined by flow dynamics, it is possible that the cases of significant AS diagnosed with the visual AS score could include both genuine cases of significant AS and cases that were misdiagnosed as significant AS. It is therefore appropriate to rule-in significant AS using the visual AS score, and to then give a definitive diagnosis after a subsequent detailed examination, such as stress echocardiography. However, we believe that the remarkable utility of the visual AS score is in screening for AS. This is because we believe that screening for AS is the most effective way to identify AS.

Conclusion

As a screening tool, a visual AS score that was derived using our innovative and straightforward method by emergency physicians who were not cardiology specialists showed a reasonable level of diagnostic accuracy for AS. When using FOCUS, a visual AS score of less than three can effectively exclude the presence of clinically severe AS, however a visual AS score of more than three necessitates additional testing for quantitative assessment in order to determine the AS severity using complete echocardiography. Our findings also indicate that the visual AS score may be able to quickly identify patients in the emergency room who have a high risk of experiencing an AS-related incident.

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