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Case Report

Doppler alternans in pediatric emergency: correlation between clinical, Doppler waveforms and silent ventricular dysfunction by POCUS echo

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ABSTRACT

Pulsus alternans (PA), reported in nineteenth century, is a subtle abnormality, often missed in emergency situations. However, the significance lies in its association with severe ventricular dysfunction. This case reports an 8-year-old child presenting with heart failure in emergency department. Abdominal aortic Doppler displayed pulsus/Doppler alternans. Step by step investigation of Doppler clue unearthed severe left ventricular dysfunction secondary to systemic arterial hypertension.

Keywords: POCUS, PA, Aorta Doppler, Ventricular dysfunction

INTRODUCTION

Pulsus alternans (PA) is classically diagnosed by palpation or sphygnomanometry during sinus rhythm when patient's peak systolic arterial pressure and pulse volume are alternately strong and weak and every other impulse is less forceful. This phenomenon is related to a beat-to-beat alteration in systolic left ventricular output and pressure caused by changing ejection dynamics. Ludwig Traube had demonstrated its clinical utility in diagnosing cardiac distress/ dysfunction.[1] Unfortunately, meticulous clinical examination is always not possible in emergency situation and bedside echocardiography has evolved into futuristic stehthoscope.

CASE REPORT

An eight-year-old boy, apparently asymptomatic before, presented with history of intermittent low-grade fever, progressive respiratory distress progressive to the extent of orthopnoea, abdominal distension and poor appetite for 6 weeks. He was evaluated by paediatrician and started on oral antibiotics. Chest X-ray and Mantoux test were advised suspecting tuberculosis. Chest x-ray showed severe cardiomegaly with pulmonary venous hypertension and he was referred to paediatric cardiologist for further evaluation.

On examination, the child was malnourished (weighing14 kg, below 3rd percentile) and in congestive cardiac failure (NYHA class IV). There was pallor, tachypnoea (respiratory rate 40/minute), laboured breathing, subcostal retractions, pedal edema, and cold-clammy extremities. Per-abdominal examination revealed tender, soft hepatomegaly (liver 8 cm below right costal margin) with mild ascites. Fine basal crepts were auscultated bilaterally in the chest. All pulses were palpable but of low volume and qualitatively appeared irregular to the cardiologist. Precordial examination revealed gallop rhythm with tachycardia (heart rate 136/minute by sthethoscope), regular, severe cardiomegaly, LV S3 and grade 2/6 pansystolic murmur at apex. As child was sick, he was connected to portable monitor. Later showed pulse rate 70/minute, oxygen saturation 95% on room air

and BP 175/123 mmHg (severe systemic arterial hypertension) (Figure 1). This discordance between clinical examination and monitor in the setting of heart failure prompted bedside echocardiography.

Figure 1: Vital monitor readings are very high blood pressure along with heart rate of 70/minute as monitor is reading alternate pulse.

Echocardiography was done with Philips Affiniti 50 machine with use of broad band transducers. It showed structurally normal heart, dilated left atrium and ventricle, moderate mitral regurgitation (MR), mild tricuspid regurgitation (TR) with peak gradient 45 mmHg, and severe left ventricular dysfunction (ejection fraction 10-15% (Figure 2). Continuous wave Doppler tracing of MR and TR signals showed alternately varying peak Doppler velocities (Figure 3 A and B). Doppler interrogation of aorta at the level of diaphragm showed alternate weak and strong systolic waves, a feature depicting PA (Figure 4). Patient's heart rate was 140/minute and only alternate beats were forceful enough to be read by bedside monitor. Latter interpreted half of the actual cardiac impulses, thereby falsely calculating a pulse rate of 70 /minute.

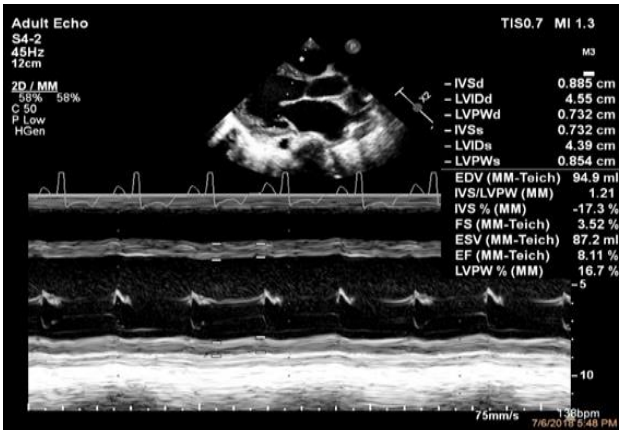

Figure 2: M-mode across ventricles from parasternal long axis view of dilated left ventricle with severely reduced fractional shortening and ejection fraction.

Child was stabilized in intensive care unit with propped up nursing, oxygen, injection frusemide and intravenous infusion of sodium nitroprusside. These later converted to oral frusemide, amlodipine and clonidine) over 48 h. Further investigations unmasked chronic glomerulonephritis as cause of systemic arterial hypertension.

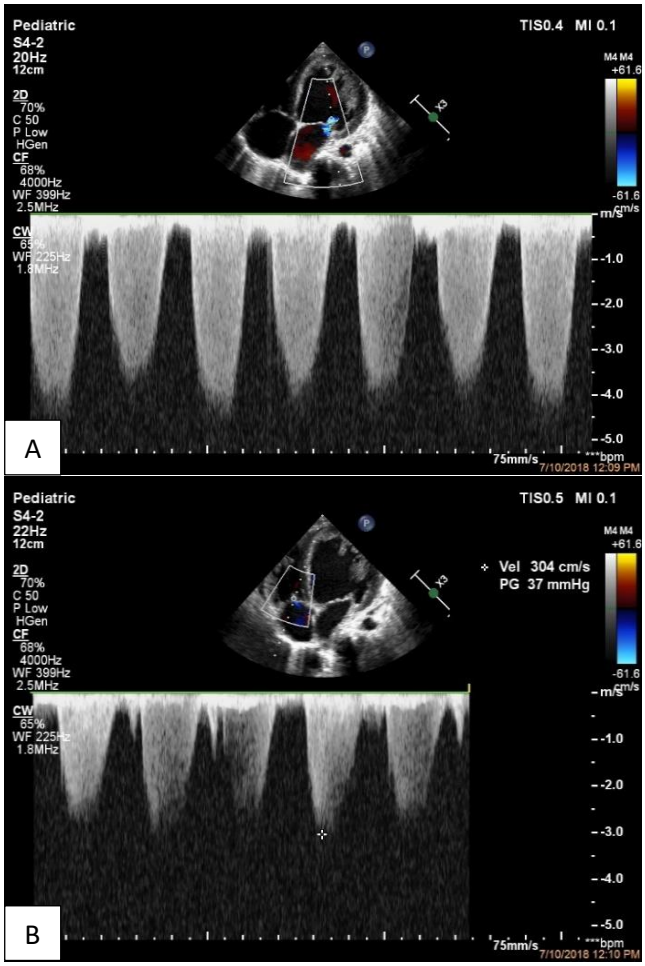

Figure 3 (A and B): Continuous wave Doppler interrogation of mitral regurgitation and tricuspid regurgitation showing changing peak wave velocities alternately.

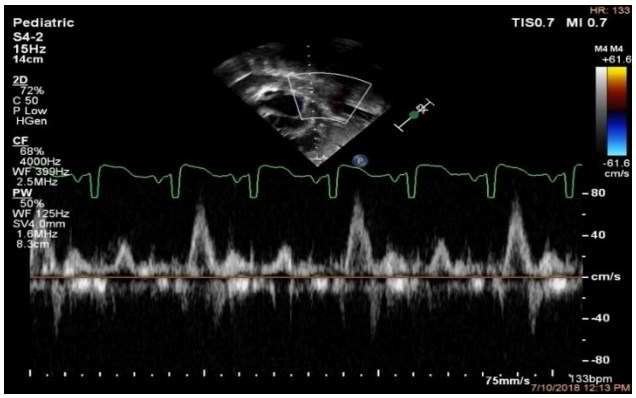

Figure 4: Pulse wave Doppler interrogation of abdominal aorta at the level of diaphragm showing significantly changing aortic peak systolic velocity alternately responsible for strong and weak peripheral pulse i.e., pulsus alternans.

DISCUSSION

PA is characterized by regular rhythm with beat-to-beat alternation of systolic pressures and was 1st described in 1872 by Traube.[1-3]

It is an ominous sign indicating severe heart failure. Early recognition aids in timely institution of appropriate treatment thereby favourably changing patient outcome.

PA is usually found in severe left ventricular dysfunction secondary to left ventricular outflow tract obstruction, cardiomyopathy, coronary artery disease, and systemic hypertension.[2] It is also reported in structurally normal heart during and after supraventricular tachycardia, hypothermia, hypocalcemia and acidosis.[4,5] Right sided PA is usually associated with PA on left side (biventricular PA) and also rarely in pulmonary embolism.[3,6,7]

This clinical sign is best detected in brachial or radial artery by application of light pressure with the fingers. It is a subtle abnormality that will not be detected unless meticulously investigated. There are few published reports of use of echocardiography to demonstrate PA by Doppler interrogation of inflow and outflow tracts and left ventricular M-mode.[3,8,9]

Our case, an 8-year-old child presented with non-specific findings to paediatrician till he deteriorated to a critical event. Preliminary examination was suggestive of heart failure with early stages of pulmonary edema. Although severe systemic hypertension was detected by monitor, the discrepancy between auscultatory heart rate and monitor-derived pulse rate intrigued the treating team. Echocardiography revealed o severe ventricular dysfunction. However, pulse Doppler interrogation of abdominal aorta showed alternate weak and strong systolic Doppler waves, a feature of PA. We refer this to as Doppler alternans. This simple echo technique can be employed in functional echocardiography by intensivists.

After stabilization with diuretics, and antihypertensive medications, pulsus and Doppler alternans disappeared. Thus. Doppler alternans can be a useful marker to assess the cardiac recovery.

CONCLUSION

The time for detailed clinical examination is often not available in emergency situations. Functional echocardiography is evolving to aid the clinician in rapid diagnosis and treatment. Our experience of using abdominal aortic Doppler in cardiac failure rapidly diagnosed PA and initiated early, customized treatment. We propose Doppler alternans as an excellent added armentarium in bedside point of care echocardiography in sick children. Complete reliance on monitosr or traditional markers may miss this invaluable sign. This skill can be easily taught, learnt and practised even with inexpensive ultrasound machines in resource constrained setups.

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Ethical approval: Not required

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