Subaortic Stenosis: What Lies Beneath

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INTRODUCTION

Discrete subaortic stenosis (DSS) is a condition generally diagnosed in the pediatric population, but it is becoming increasingly recognized in adult patients. Transthoracic echocardiography is indispensable for the assessment of dyspnea. Unfortunately, attenuation of ultrasound due to increased body mass index, among other factors, may significantly impair the quality of two-dimensional (2D) images, and transesophageal echocardiography may be required to better clarify an uncertain diagnosis.

CASE PRESENTATION

A 61-year-old woman with a history of breast cancer, increased body mass index, and prior smoking presented with several months of increasing exertional dyspnea (New York Heart Association functional class II). Cardiovascular examination revealed an ejection systolic murmur but was otherwise unremarkable. Electrocardiography demonstrated sinus bradycardia and nonspecific T-wave flattening in the inferolateral leads. Pulmonary function tests demonstrated relatively preserved lung function. Transthoracic echocardiography was arranged for further assessment.

Unfortunately, the 2D transthoracic images were limited by the patient's increased body mass index. The most salient finding was a significantly elevated gradient on CW Doppler interrogation of the aortic valve (mean gradient, 37 mm Hg; Figure 1A). The aortic valve leaflets, however, appeared to have normal leaflet excursion without obvious calcification but was poorly seen on 2D imaging (Figure 1B). Aside from mild concentric hypertrophy of the left ventricle, all other aspects of cardiac size and function were within normal limits, including left and right ventricular size, and the estimated systolic pulmonary pressure. The patient was subsequently referred for transesophageal echocardiography.

Transesophageal echocardiography revealed a thin ridge of tissue in the anterior left ventricular outflow tract (LVOT) approximately 6 mm from the insertion of the right coronary cusp of the aortic valve (Figure 2A, Video 1). Color Doppler demonstrated significant flow acceleration in the LVOT and below to the aortic valve (Figure 2B). Cross-plane imaging of the LVOT revealed the true extent of the LVOT membrane, which was a crescentic fibromuscular membrane encircling the LVOT, narrowing to 0.8 to 0.9 cm^2 during systole (Figures 3A and 3B, Video 2). Three-dimensional assessment confirmed that this was a discrete fibromuscular membrane (Figures 4A and 4B, Video 3). There was mild aortic regurgitation.

Stress echocardiography was performed to assess for concomitant myocardial ischemia and document functional capacity. Although there was no evidence of ischemia, the maximum instantaneous outflow tract gradient increased to 124 mm Hg (mean gradient, 76 mm Hg) at 100 beats/min, indicating severe obstruction. Exercise capacity was reduced, achieving <5 min on the standard Bruce protocol (7.0 METs).

Invasive coronary angiography demonstrated angiographically normal coronary arteries. The peak-to-peak gradient was 48 mm Hg, and the calculated mean gradient was 42 mm Hg. Left ventriculography was performed in a left anterior oblique cranial view, which best demonstrated the membrane in the LVOT (Figure 5).

The patient was referred for cardiac surgery. At the time of writing, the patient remained stable and free of unplanned hospitalization.

DISCUSSION

DSS can develop at any age, but in the vast majority of cases, it is detected in childhood, although it is rarely seen in infancy. It may be slightly more common in male patients, with cohort studies displaying a 52%–67% male predominance.[1-3] In one large cohort, DSS accounted for 6.5% of adult congenital heart disease,[2] and although DSS is frequently categorized as congenital heart disease, it is considered to be an acquired condition.

In this case, the presence of a significant gradient on continuous-wave Doppler interrogation of the aortic valve and flow acceleration on color Doppler below the valve, but the appearance of a valve that opened well on transthoracic echocardiography, provided the clue that the most likely diagnosis was DSS. Transesophageal echocardiography was invaluable in confirming the presence, morphology, and extent of subaortic narrowing.

The hypothesized pathogenesis of DSS centers on abnormal LVOT geometry that predisposes to turbulent flow within the LVOT. Proposed anatomic aberrancies that may contribute to turbulent flow include a long, narrow LVOT; a steep aortoventricular septal angle; and aortic valve override of the ventricular septum. It is this turbulent flow that is thought to increase local sheer stress and consequently lead to local reactive cellular proliferation and progressive fibromuscular changes (including the differentiation of fibroblasts into contractile myofibroblasts).[4] Although there are rare reports of familial clustering, there is no firm evidence to support a primary genetic etiology.[4]

In the majority of cases (90%), the subvalvular membrane takes the form of a fibromuscular ridge that encircles the LVOT, but it can also be composed of a diffuse tunnel-like narrowing. Occasionally the defect can involve the base of the aortic cusp or the anterior leaflet of the mitral valve. It frequently occurs in conjunction with other congenital heart disease, 44% of the time in one large study.[2] The most common associated condition is a ventricular septal defect, occurring in up to 65% of patients in one cohort.[2,5] Other associated

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Keywords: Subaortic stenosis, Subaortic membrane, Discrete

Conflicts of interest: The authors reported no actual or potential conflicts of interest relative to this document.

2468-6441
https://doi.org/10.1016/j.case.2018.01.005

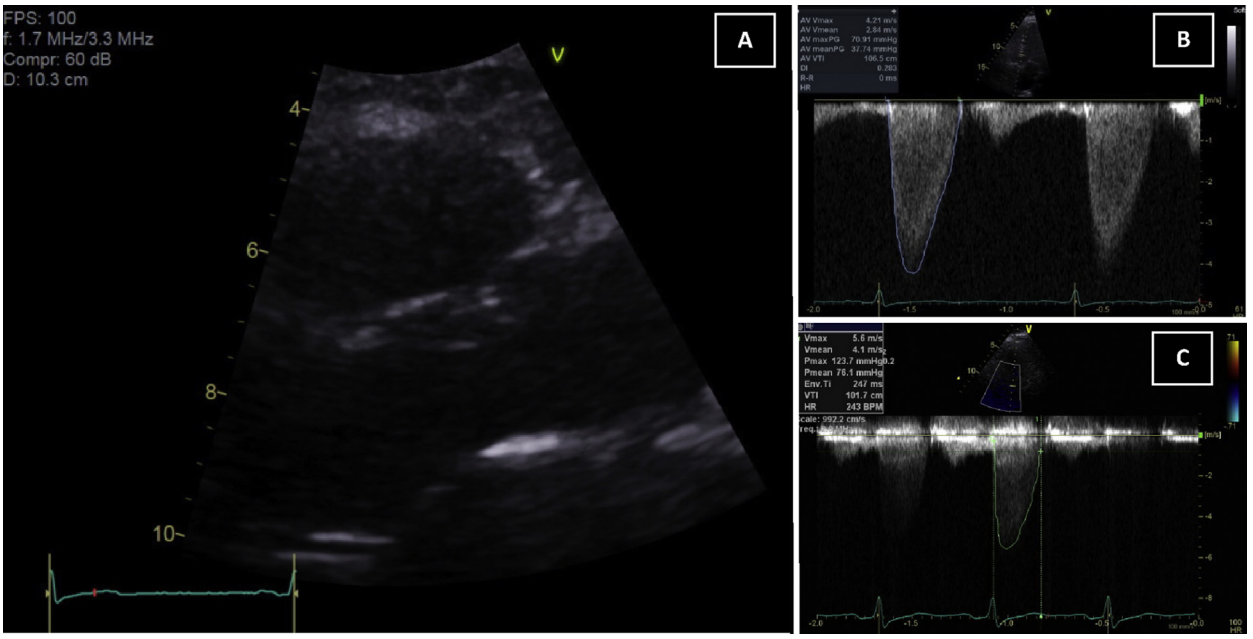

Figure 1 **(A)** Transthoracic echocardiography from parasternal long-axis view in systole, demonstrating seemingly patent LVOT and absence of significant aortic valve calcification. Continuous-wave Doppler through the aortic valve in the apical five-chamber window, demonstrating an early peaking spectral profile with a mean gradient of 37 mm Hg at rest **(B)** and 76 mm Hg after exercise **(C)**.

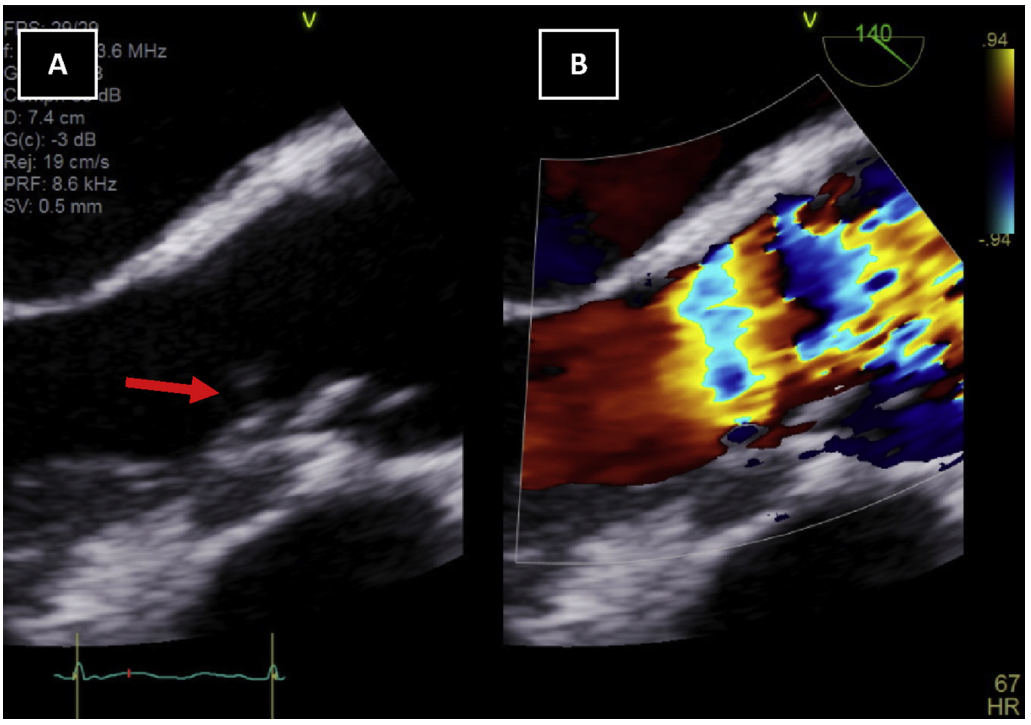

Figure 2 **(A)** Transesophageal midesophageal long-axis view (140°) demonstrating a thin ridge of tissue in the LVOT (*red arrow*). **(B)** Color Doppler demonstrating significant flow acceleration before the aortic valve.

conditions include coarctation of the aorta and a bicuspid aortic valve.[6]

Progression of DSS is unpredictable. One large retrospective study has reported that the rate of progression is slower in adults, compared with children, although this needs to be interpreted with caution, as the adults may be selected out as having less severe disease.[2] Risk factors for progression of LVOT gradient include initial mean gradient > 30 mm Hg, initial aortic valve thickening, and attachment of the subaortic membrane to the mitral valve. The reported rates of progression (peak instantaneous gradient) vary from center to center but are in the range of 1–3 mm Hg/year.[2,3]