A 37-year-old woman originally from Iraq was referred at 10 weeks of gestation after an abnormal result on an echocardiogram. At this time, her only symptom was intermittent palpitations. She had no recollection of previous rheumatic fever. Past obstetric history was significant for a miscarriage at 3 months of gestation a year before the current pregnancy. On examination, heart rate was 98 bpm and irregular, and blood pressure was 100/60 mm Hg. There was no jugular venous distension. Auscultation revealed a variable first heart sound, a normal second heart sound, and an opening snap with a short second heart sound to opening snap interval. A grade 3/6 diastolic rumble was heard best at the apex. The results of the remainder of the physical examination were normal. Investigations performed included an ECG (Figure 1), which showed atrial fibrillation at an average rate of 98 bpm with no evidence of right or left ventricular enlargement. An echocardiogram showed features typical of severe rheumatic mitral stenosis (MS) (Figure 2, Movies I

Figure 1. Twelve-lead ECG on initial presentation showing atrial fibrillation at a rate of 98 bpm.
Laboratory investigation results were normal. The patient was started on systemic anticoagulation (Dalteparin) and metoprolol, and was referred to the perinatology service for assessment and follow-up for the duration of pregnancy.

At 25 weeks, the patient continued to report only mild dyspnea, but this was now on minimal exertion. She denied orthopnea, paroxysmal nocturnal dyspnea, and peripheral edema. On examination, she was in atrial fibrillation at a heart rate of 105 with evidence of jugular venous distension. Her echocardiographic findings had worsened (Figure 3 and Table). The patient was hospitalized with New York Heart Association class III symptoms at 29 weeks. At this time, she was on high doses of metoprolol and was started on a low dose of furosemide. Anticoagulation with Dalteparin was continued. After joint discussion with interventional cardiology, anesthesia, and perinatology, percutaneous mitral valvuloplasty was performed. A total of 3 inflations with a #26 Inoue balloon with echocardiographic monitoring after each dilatation was done to assess the degree of mitral regurgitation and mean diastolic gradients (Figure 4 and Movie III in the online-only Data Supplement). After the third inflation, the mean gradients had decreased by 50%, with increase in mitral regurgitation from trivial to mild-to-moderate (Figures 5–8 and Movies IV–VII in the online-only Data Supplement). The patient’s symptoms improved, and she was able to return home for the remainder of her pregnancy on continued therapy with metoprolol and systemic anticoagulation with Dalteparin. She presented at 36 weeks with premature rupture of membranes, and a cesarean delivery was performed. She delivered a healthy baby girl, and was completely asymptomatic during the postpartum period. Anticoagulation was switched to warfarin before she was discharged from the hospital. At 2 months postpartum, her echocardiogram showed even further improvement in mitral valve hemodynamics, and in left atrial volumes, as well (Table).

**Discussion**

Women with MS often become symptomatic during pregnancy because of significant increases in plasma volume (≈50%) and heart rate (≈20%–30%). Common complications in pregnant patients include the development of pulmonary edema or atrial tachyarrhythmias (atrial fibrillation/flutter), and thromboembolic complications in the presence or absence of atrial arrhythmias, as well. There is also a significant risk for fetal complications (premature birth and intrauterine growth restriction). In 1 cohort of pregnant patients with severe MS, 67% developed a maternal cardiac event, and 44% of infants were born prematurely or died.\(^1\)

All women with significant MS are advised to decrease their activity (leading to bed rest in the latter stages), are started on β-blockers (if there are no contraindications), are given diuretics as needed, and are often anticoagulated. Almost three-fourths of

![Figure 2. Parasternal long-axis view without (A) and with (B) color Doppler assessment showing typical features of rheumatic involvement of the mitral valve with only a trivial degree of regurgitation.](image-1)

<p>| Table. Echocardiographic Hemodynamics |
|-------------------------------|----------------|----------------|----------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Mitral Valve Area (cm²)</th>
<th>Mean Diastolic Gradient Across the Mitral Valve (mm Hg)</th>
<th>Right Ventricular Systolic Pressure (mm Hg)</th>
<th>LA Anteroposterior Dimension (mm)</th>
<th>Indexed LA Volume (mL/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 wk</td>
<td>0.9</td>
<td>14</td>
<td>32</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>25 wk</td>
<td>0.7</td>
<td>30</td>
<td>37</td>
<td>60</td>
<td>71</td>
</tr>
<tr>
<td>29 wk</td>
<td>0.5</td>
<td>36</td>
<td>53</td>
<td>65</td>
<td>92</td>
</tr>
<tr>
<td>31 wk (1 wk postvalvuloplasty)</td>
<td>1.3</td>
<td>9</td>
<td>32</td>
<td>48</td>
<td>66</td>
</tr>
<tr>
<td>2 mo postpartum</td>
<td>1.6</td>
<td>5</td>
<td>25</td>
<td>46</td>
<td>60</td>
</tr>
</tbody>
</table>

Echocardiographic hemodynamics throughout the pregnancy, after mitral valvuloplasty at 30 weeks gestation, and postpartum in a patient with severe mitral stenosis. Parameters continued to be maintained and actually improved postpartum in this patient. LA indicates left atrium.
pregnant women with MS respond to the above treatments, leading to a reduction in New York Heart Association functional class III/IV to I/II.\textsuperscript{2} Interventional and surgical options are reserved for those who deteriorate despite aggressive medical therapy. There is also a significant risk of thromboembolic complications with MS, which is further increased because of the hypercoagulable state of pregnancy. These patients should be maintained on systemic anticoagulation with close follow-up, preferably with a low-molecular-weight heparin, for the duration of pregnancy and in the early postpartum phase. The postpartum (beyond 4–6 weeks) management of anticoagulation in these patients can follow the guidelines for patients with rheumatic MS and atrial fibrillation.

Not surprisingly, prepregnancy symptoms predict the likelihood of serious adverse outcomes. Hence, those with severe MS diagnosed before pregnancy should undergo intervention before becoming pregnant. However, if a patient is diagnosed with MS early in pregnancy, the procedure should be delayed until 12 to 14 weeks to prevent radiation exposure during the period of organogenesis.\textsuperscript{3} If intervention becomes necessary after 20 weeks, it is best deferred to between 26 and 30 weeks gestation to prevent complications associated with births in the extremes of prematurity.\textsuperscript{3}

Surgical commissurotomy has a lower maternal mortality rate, but is more risky for the fetus with fetal mortality rates at 33%,\textsuperscript{4} and in those where surgical commissurotomy is not appropriate, mitral valve replacement may be necessary. Given the increased risk of surgery, percutaneous mitral valvuloplasty is now the procedure of choice for pregnant patients with rheumatic MS. Surgical intervention should be reserved only for those patients who have symptoms refractory to medical therapy in whom valvuloplasty is contraindicated. One of the concerns with percutaneous mitral valvuloplasty is the incidence of restenosis requiring surgical intervention in the future. In a cohort of 71 patients who underwent valvuloplasty during pregnancy, the restenosis-free rate was 70% at 87 months, and 90% of the patients were free of surgical intervention at 48 months.\textsuperscript{2} Severe mitral regurgitation requiring surgery was present in 4.6% of the patients.\textsuperscript{2} Maternal mortality rates for percutaneous mitral valvuloplasty were 0.2%, and fetal mortality rates were 2%, which included elective terminations; overall, the procedural success rate was 98%.\textsuperscript{3}

Disclosures

None.

References

Figure 5. Parasternal long-axis view without (A) and with (B) color Doppler assessment showing typical features of rheumatic involvement of the mitral valve with a mild degree of regurgitation postvalvuloplasty.

Figure 6. Continuous-wave Doppler assessment of mitral valve hemodynamics (A) and estimates of pulmonary artery pressures (B) after balloon valvuloplasty. PASP indicates pulmonary artery systolic pressure.
Figure 7. Cardiac hemodynamic tracings in a pregnant patient at 30 weeks of gestation with severe mitral stenosis. Left atrial (LA) and ventricular (LV) pressures prevalvuloplasty show a widened gradient that continues throughout diastole (shaded area). S indicates systole; d, diastole.

Figure 8. Cardiac hemodynamic tracings after valvuloplasty. Left atrial (LA) and ventricular (LV) pressure illustrating improvement in left atrial pressures, and reduction in the mean diastolic gradients (shaded area), as well. S indicates systole; d, diastole.
Management of Severe Mitral Stenosis During Pregnancy
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