

## Effect of pulmonary stenosis on pregnancy outcomes—A case-control study

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**Background** Pulmonary stenosis (PS) accounts for 10% to 12% of congenital heart disease in adults, and the probability of survival to child bearing age is high. The impact of PS on pregnancy has not been extensively studied in the recent era.

**Methods** We evaluate the effect of isolated PS on maternal and fetal outcomes in a case-control study of 17 cases with PS in pregnancy from 1995 to 2006. The control group was matched by age, ethnicity, obstetrical history, and year of delivery. Patients with PS were assessed for maternal New York Heart Association (NYHA) functional class and other maternal complications at baseline and during pregnancy; and the 2 groups were compared for fetal and neonatal outcomes including birth weight, gestational age at delivery, Apgar scores, and placental weight.

**Results** A total of 11 patients were in NYHA functional class I and 6 in class II at the time of presentation. All patients remained stable during pregnancy except for two. One of them deteriorated from NYHA functional class I to II, and the other from class II transiently to class III. There were no other maternal complications. In addition, there were no statistically significant differences in fetal/neonatal outcomes between patients and their controls and between patients with mild and severe PS.

**Conclusions** In contrast to mitral and aortic stenosis, PS does not adversely impact maternal or fetal outcomes of pregnancy. (*Am Heart J* 2007;154:852-4.)

Cardio circulatory changes associated with pregnancy may result in a significant hemodynamic burden and can lead to morbidity and even mortality in women with cardiac disease.<sup>1,2</sup> Recent publications have described an important impact of mitral and aortic stenosis on pregnancy outcomes of both the mother and the fetus.<sup>3-5</sup> Pulmonary stenosis (PS) accounts for 10% to 12% of congenital heart disease in adults,<sup>6</sup> and the probability of survival to child bearing age is high. Many of these patients remain asymptomatic to adult life<sup>7,8</sup> even if the PS is severe, and therefore, diagnosis during pregnancy is not uncommon. The impact of PS on pregnancy has not been extensively studied, and available reports lack appropriate control population and fail to provide detailed outcome information.<sup>2,3,9,10</sup> The purpose of this study was therefore to evaluate by comparison to a well-matched normal pregnant women

the impact of PS on maternal and fetal outcome in the recent era.

### Methods

The study was designed as a single-center, case-control evaluation of pregnant patients diagnosed with isolated PS in comparison with individually matched normal control patients. All subjects were followed at the high-risk obstetrics/cardiology clinic and delivered at the Los Angeles County/University of Southern California Medical Center between 1995 and 2006. For each patient, a normal control case that received prenatal care and delivered at the same medical center was selected to match the patient for age, ethnicity, obstetrical history, and the year of delivery. All patients received antibiotic prophylaxis for labor and delivery. Fetal outcomes included gestational age at time of delivery, Apgar scores at 1 and 5 minutes, birth weight, and placental weight. These end points were compared to those of the control group. In addition, the study population was divided into 2 groups based on the severity of PS; mild PS was defined as a peak pressure gradient across the pulmonic valve of less than 50 mm Hg, and severe PS as pressure gradient 50 mm Hg or greater. Pregnancy outcomes were compared between these subgroups. The study protocol was approved by the Institutional Review Board of the University of Southern California, Keck School of Medicine.

### Statistical analysis

The data were expressed as mean  $\pm$  SD, and Student test was used to compare all patients to their controls. Non-paired

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**Table I.** Fetal and neonatal outcomes in patients with PS and their controls

	Patients	Controls
Gestational age	38.4 ± 1.9	39.3 ± 1.2
Apgar score at 1 min	9 (8-9)	9 (8-9)
Apgar score at 5 min	9 (8-10)	9 (8-9)
Birth weight	3278 ± 474	3360 ± 432
Placental weight	648 ± 184	693 ± 421

*t* test was used for comparison between patients with mild and severe PS. Mann-Whitney test was used for comparisons of median Apgar scores. A *P* value of less than .05 was considered significant.

## Results

We evaluated the outcomes of 17 pregnant patients with isolated PS. None of the patients had significant pulmonary regurgitation, right ventricular dysfunction, or a history of valve repair. Eight pregnancies were evaluated retrospectively and 9 prospectively. The age at the time of pregnancy ranged between 16 and 36 years (mean, 25 ± 5.5); ethnic background was Hispanic in 15 (88%) and white in 2 (12%) subjects. Ten (59%) patients had mild PS with a mean peak transvalvular gradient of 34 ± 11 mm Hg, and 7 (41%) had severe PS with a mean peak transvalvular gradient of 82 ± 28 mm Hg. Patients were closely matched with their normal controls for age, ethnicity, obstetrical history, and the year of delivery. Eleven (65%) patients were in the New York Heart Association functional class I on presentation, and 6 (35%) were in class II. Most (88%) patients remained stable throughout their pregnancy, except 2 patients with severe PS. One of these patients advanced from class I at initial presentation to class II, and another patient advanced from class II to class III during the second trimester but returned to class II during the third trimester. The great majority (94%) of the patients had an uncomplicated vaginal delivery, and one of these patients with severe PS required vacuum assistance for fetal indications. There was one cesarean delivery performed in the mild PS group for the failure of labor to progress. The control group also had one cesarean delivery for an obstetrical indication. Intrapartum and postpartum courses were uncomplicated in both groups.

No statistically significant difference was found between patients and controls in length of gestation (Table I), Apgar scores (all infants were assigned scores of 8-10), mean birth weight (3278 ± 477 g in PS patients vs 3360 ± 432 g in control; *P* = .7), and placental weight (648 ± 184 vs 693 ± 421 g; *P* = .23). In addition, there was no difference in the fetal outcomes between patients with mild and severe PS (Table II).

**Table II.** Fetal and neonatal outcomes in patients with mild and severe PS

Peak gradient	<50 mm Hg (mean 34 ± 11 mm Hg)	≥50 mm Hg (mean 82 ± 28 mm Hg)	<i>P</i>
Gestational age (wk)	39.5 ± 1.6	37.5 ± 2.2	.17
Apgar score at 1 min	9 (8-9)	9 (8-9)	.2
Apgar score at 5 min	9 (8-9)	9 (8-10)	.98
Birth weight (g)	3289 ± 426	3192 ± 553	.99
Placental weight (g)	681 ± 205	597 ± 150	.38

## Discussion

Our study demonstrates no significant impact of PS on maternal and fetal well-being regardless of the severity. Most patients demonstrated clinical stability without a significant impact of pregnancy on functional status. These findings may not be surprising considering reports of high athletic activity in young patients with severe PS.<sup>8</sup> These findings are in contrast to the effect of stenosis of other valves such as mitral and aortic on pregnancy outcomes. Studies in these populations have shown a high incidence of both maternal and fetal complications that are proportionately related to the severity of the lesion.<sup>3-5</sup> It should be noted that our study population was limited by a relatively small number of patients. This, however, is the only case-control study available comparing the outcome of pregnancy in patients with isolated PS to control subjects in the same medical center. In addition, the study included only patients with isolated PS and normal right ventricular function who were either asymptomatic or mildly symptomatic at the initial presentation. The findings of the present study can therefore not be applied to patients with PS and associated cardiac defects or those who are more symptomatic before pregnancy. This conclusion is supported by occasional congestive heart failure described in an earlier report.<sup>11</sup> Preconception evaluation in symptomatic patients with PS or in those with signs of right ventricular dysfunction should include an exercise test preferably with measurement of peak oxygen consumption during exercise to assess the potential of such patients to tolerate the increase hemodynamic burden of pregnancy.

Favorable maternal outcome in patients with PS as shown in this study is confirmed by previous studies. A recent review<sup>12</sup> summarizing data in approximately 100 patients with PS published in 6 different studies reported no cases of arrhythmias, heart failure, and endocarditis. Our findings demonstrate a favorable fetal outcome comparable to the outcome in normal healthy women. A recent publication by Drenthen et al<sup>10</sup> has reported an increased incidence of fetal and neonatal complications including premature deliveries, congenital defects and neonatal death. The differences between

the 2 studies may be related to high incidence of pregnancy-induced hypertension, preeclampsia, and the severity of the pulmonary valve disease as reflected by history of cardiac surgery in the patients reported by Drenthen et al.

Ninety-four percent of our patients had vaginal delivery. The small incidence of cesarean delivery in the study population probably reflects the practice approach at our institution, although it is also supported by the report by Drenthen et al,<sup>12</sup> who described vaginal delivery in 90% of their patients with PS. These data clearly indicate that vaginal delivery should be the preferred route in patients with PS, and cesarean delivery should be reserved for obstetrical indications.

Recently published American Heart Association/American College of Cardiology practice guidelines have recommended balloon valvuloplasty in asymptomatic nonpregnant patients with PS when the peak gradient across the pulmonic valve is greater than 40 mm Hg.<sup>13</sup> The performance of balloon valvuloplasty during pregnancy may impact unfavorably on fetal well-being secondary to the use of ionizing radiation and the potential for hemodynamic instability during the procedure. Our results showing stability of patients with PS during pregnancy suggest that balloon valvuloplasty is not indicated during gestation in patients who are either asymptomatic or mildly symptomatic before pregnancy.

In summary, the results of our study demonstrate no significant unfavorable effect of isolated pulmonic stenosis, even if severe, on pregnancy outcomes in asymptomatic or mildly symptomatic patients on presentation. The low rate of cesarean delivery indicates that vaginal delivery is safe in women with isolated PS, and that cesarean delivery should be reserved for patients with obstetrical indications or cardiac instability. Because of the documented clinical stability of women with PS during pregnancy and the potential risk to the fetus, balloon valvuloplasty is not indicated during gestation in patients who are either symptomatic or mildly symptomatic before pregnancy.

## References

1. Elkayam U, Gleicher N. Hemodynamics and cardiac function during normal pregnancy and the puerperium. In: Elkayam U, Gleicher N, editors. *Cardiac problems in pregnancy*. 3rd ed. New York: Wiley-Liss; 1998. p. 3-20.
2. Siu SC, Sermer M, Colman JM, et al. Prospective multicenter study of pregnancy outcomes in women with heart disease. *Circulation* 2001; 104:515-21.
3. Hameed A, Karaalp IS, Tummala PP, et al. The effect of valvular heart disease on maternal and fetal outcome of pregnancy. *J Am Coll Cardiol* 2001;37:893-9.
4. Silversides CK, Colman JM, Sermer M, et al. Early and intermediate-term outcomes of pregnancy with congenital aortic stenosis. *Am J Cardiol* 2003;91:1386-9.
5. Silversides CK, Colman JM, Sermer M, et al. Cardiac risk in pregnant women with rheumatic mitral stenosis. *Am J Cardiol* 2003;91:1382-5.
6. Brickner ME, Hillis LD, Lange RA. Congenital heart disease in adults. First of two parts. *N Engl J Med* 2000;342:256-63.
7. Hayes CJ, Gersony WM, Driscoll DJ, et al. Second natural history study of congenital heart defects. Results of treatment of patients with pulmonary valvar stenosis. *Circulation* 1993;87(2 Suppl):I28-I37.
8. Perloff JK. Congenital heart disease and pregnancy. *Clin Cardiol* 1994;17:579-87.
9. Oliveira TA, Avila WS, Grinberg M. Obstetric and perinatal aspects in patients with congenital heart diseases. *Sao Paulo Med J* 1996;114: 1248-54.
10. Drenthen W, Pieper PG, Roos-Hesselink JW, et al. Non-Cardiac complications during pregnancy in women with isolated congenital pulmonary valve stenosis. *Heart* 2000;269:244-53.
11. Neilson G, Galea EG, Blunt A. Congenital heart disease and pregnancy. *Med J Aust* 1970;1:1086-8.
12. Drenthen W, Pieper PG, Roos-Hesselink JW, et al. Outcome of pregnancy in women with congenital heart disease. *J Am Coll Cardiol* 2004;49:2303-11.
13. Bonow RO, Carabello BA, Kanu C, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease): developed in collaboration with the Society of Cardiovascular Anesthesiologists: endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. *Circulation* 2006;114:e84-e231.