

Rheumatic Heart Diseases in Pregnancy

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Abstract

Acute rheumatic fever and rheumatic valvular disease remain prevalent in many parts of the world, and are probably the most common cause of heart disease in pregnancy. Mitral stenosis is the most frequently encountered rheumatic valvular lesion. A variety of pregnancy-associated cardiovascular changes often exacerbate the signs and symptoms of valvular lesions. Pregnancy should not be allowed to proceed, if possible, in patients with uncorrected severe valvular lesions or mechanical heart valves requiring anticoagulation, as maternal and fetal morbidity and mortality are high. For those with milder disease, pregnancy is best undertaken after the valvular lesion has been rectified or stabilised. Recent advances in the management of valvular disease include the use of beta-blockers for patients with mitral stenosis, vasodilators in those with aortic and mitral regurgitation, and percutaneous balloon valvuloplasty for mitral and aortic stenosis. Application of these therapies in the pregnant patient is as yet unclear, and management decision needs to be individualised, weighing the risk and benefit to ensure maternal survival and to promote fetal well-being.

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Introduction

Rheumatic heart disease comprises acute rheumatic fever following group A beta-haemolytic streptococcal infection of the tonsillopharynx, and its long-term sequelae of heart valve fibrosis causing chronic valvular lesions. Severe myocardial and pericardial involvements are much less common. With improved socio-economic conditions, and the widespread use of antimicrobial treatment of streptococcal pharyngitis, incidence of acute rheumatic fever has significantly declined in developed countries.^{1,2} However, they remain a common and virulent disease worldwide. The resultant valve and myocardial disease is probably the most common cause of heart disease during pregnancy.

The aim of management of rheumatic heart disease during pregnancy, as well as many other medical disorders, is to ensure maternal survival and to promote fetal well-being. This requires a close collaboration between the attending cardiologist and obstetrician, and an intimate knowledge of pregnancy-related cardiovascular changes and of pharmacology.

Cardiovascular Physiology during Pregnancy and the Puerperium

Pregnancy and the peripartum period are associated with important cardiovascular changes, imposing stress on both

the normal and diseased hearts. Three major pregnancy-induced haemodynamic burdens are increased cardiac output and heart rate, expanded blood volume, and intensified oxygen demand.

Salient features of these changes are (Table I, Figs. 1 and 2):

1. Blood volume: Blood volume increases substantially from early to mid-pregnancy, thereafter continues to rise but at a much slower rate. On average, there is a 50% increase in circulating blood volume in pregnancy. During labour, uterine contraction results in autotransfusion of 300 to 500 mL of blood. Further blood volume expansion occurs immediately after delivery from contracted uterus and relief of aortocaval compression.
2. Haematocrit: As increase in blood volume is more rapid than increase in red blood cell mass, haemoglobin concentration and haematocrit fall gradually during pregnancy until week 30, causing the "physiological anaemia of pregnancy".
3. Cardiac output, stroke volume and heart rate: Cardiac output begins to rise around 5th week and increases rapidly until about 24th week, when it plateaus or continues to rise slightly. On average, there is a 40% to 50% increase in cardiac output to accompany the similar increase in blood volume. The increase in cardiac

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TABLE I: CARDIOVASCULAR CHANGES DURING NORMAL PREGNANCY

Parameter	Changes at various gestational weeks					
	5	12	20	24	32	38
Heart rate	↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑
Stroke volume	↑	↑↑↑↑	↑↑↑↑↑	↑↑↑↑↑	↑↑↑↑	↑↑↑↑
Cardiac output	↑↑	↑↑↑↑↑	↑↑↑↑↑↑	↑↑↑↑↑↑	↑↑↑↑↑↑	↑↑↑↑↑↑
Systemic vascular resistance	↓↓	↓↓↓↓	↓↓↓↓	↓↓↓↓	↓↓↓↓	↓↓↓↓
Systolic blood pressure	=	↓	↓	=	↑	↑↑
Plasma volume	↑	↑↑	↑↑↑	↑↑↑↑↑	↑↑↑↑↑↑	↑↑↑↑↑↑
Red blood cell mass	↑	↑	↑↑	↑↑	↑↑↑	↑↑↑↑
Haematocrit	↓	↓	↓↓	↓↓↓	↓↓↓	↓↓

↑, ≤5%; ↑↑, 6-10%; ↑↑↑, 11-20%; ↑↑↑↑, 21-30%; ↑↑↑↑↑, 31-40%; ↑↑↑↑↑↑, ≥40%; =, no change

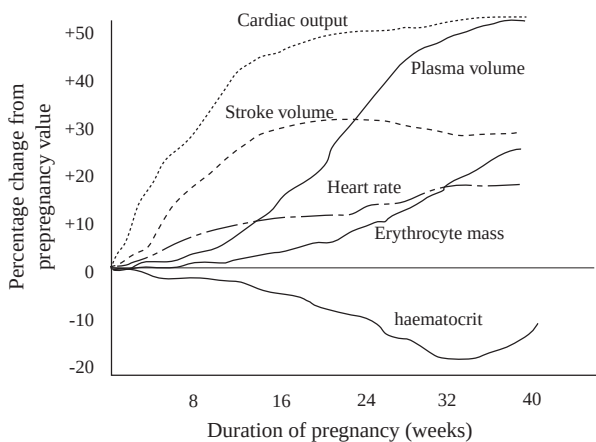


Fig. 1. Cardiovascular changes during pregnancy.

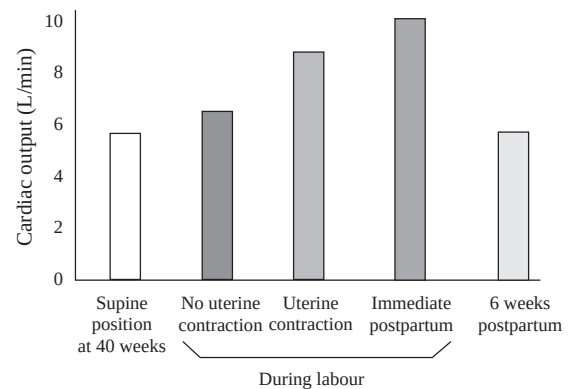


Fig. 2. Cardiac output at term and during labour.

output early in pregnancy is predominantly contributed by augmented stroke volume; whereas in the third trimester it is largely due to increased heart rate. During labour (Fig. 2), cardiac output rises progressively owing to increase in both stroke volume and heart rate. Immediately after delivery, relief of caval compression causes further surge in cardiac output, which generally returns to pre-labour level by 1 hour after delivery.

4. Blood pressure and systemic vascular resistance: Because of the effects of uterine circulation and endogenous hormones causing reduced vascular tone, there is a marked decrease in systemic vascular resistance nearly throughout the pregnancy. Systemic arterial pressure begins to fall during the first trimester, reaches a nadir in mid pregnancy, and returns toward pregestational levels before term, as the progressive rise in cardiac output compensates for the drop in

vascular resistance (blood pressure $\propto$ cardiac output $\times$ vascular resistance). There is a disproportionately greater lowering of diastolic blood pressure and a wide pulse pressure.

Acute Rheumatic Fever

This disease occurs most often in children, before puberty, and only rarely during pregnancy. It is a form of collagen-vascular disease, with inflammatory reactions involving many organs, primarily the heart, the joints and the central nervous system. The inflammation is attributed to immunological reactions to group A streptococcal throat infection in susceptible host. The affected host tissues appear to share similar antigen structures to the M protein and other streptococcal antigens. These tissues then become the 'bystander victim' of the immunological response induced by rheumatogenic strains of group A streptococci. Not surprisingly, with improvement in socio-economic

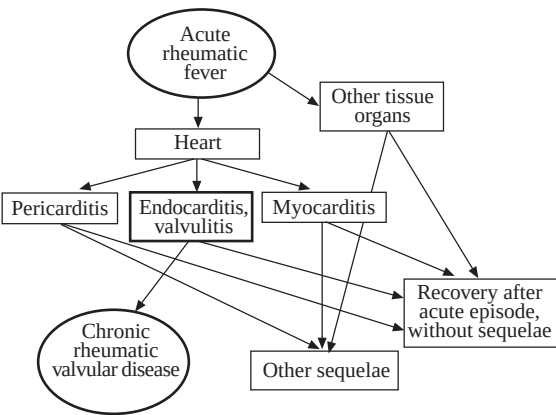


Fig. 3. Acute and chronic rheumatic heart diseases.

conditions, and more widespread use of antimicrobial treatment for streptococcal throat infection, the incidence of acute rheumatic fever has significantly declined.

Though many organ tissues and all 3 anatomical cardiac layers (causing pericarditis, myocarditis and endocarditis respectively) can be involved, the major importance of acute rheumatic fever is its potential to cause fibrosis of heart valves, leading to crippling haemodynamics of chronic rheumatic valvular disease (Fig. 3).

The diagnostic criteria³ and management of acute rheumatic fever during pregnancy are similar to that of non-pregnant patients. Heart failure is usually due to an incompetent mitral or aortic valve, rather than myocardial failure. Diuretics and vasodilators remain the therapy of choice. Surgical restoration of valvular competence should only be performed in patients not responding to medical therapy. Milder degrees of acute rheumatic fever require only bed rest, treatment of streptococcal pharyngitis, and correction of coexistent anaemia and nutritional deficiency. After recovery from the acute episode, patients who develop streptococcal pharyngitis are at high risk for a recurrent attack of rheumatic fever. For this reason, they require continuous antimicrobial prophylaxis for duration that depends on exposure risk and presence or absence of residual valvular disease.

Chronic Rheumatic Valvular Heart Disease

Management of pregnant patients with chronic rheumatic valvular disease should be individualised according to the site and severity of the lesion. However, several general principles apply:

- 1. Prophylactic antibiotic treatment (preferably with penicillin) for all patients to prevent streptococcal infection and recurrence of rheumatic fever;
- 2. Restriction of physical activity for symptomatic patients to prevent haemodynamic and symptomatic deterioration;

- 3. Close haemodynamic monitoring from the onset of labour to approximately 24 hours postpartum is recommended for symptomatic patients with severe valvular disease or left ventricular dysfunction.

Antibiotic prophylaxis against endocarditis, though commonly used, has not been uniformly recommended for uncomplicated vaginal and abdominal deliveries in the absence of infection.⁴ Antibiotics should be prescribed for high-risk patients with prosthetic heart valves, a previous history of endocarditis, complex congenital heart disease, or a surgically-constructed systemic-pulmonary conduit.

Table II lists the rheumatic valvular lesions that are poorly tolerated during pregnancy, and are associated with high maternal and/or fetal risk. Table III lists the valvular lesions generally better tolerated with low maternal and fetal risk during pregnancy. In general, regurgitant lesions are better tolerated than stenotic lesions during pregnancy.

Many patients with valvular heart disease can be successfully managed throughout pregnancy and during labour and delivery with conservative medical measures designed to optimise intravascular volume and systemic loading conditions. Bed rest and avoidance of supine

TABLE II: VALVULAR HEART LESIONS ASSOCIATED WITH HIGH MATERNAL AND/OR FETAL RISK DURING PREGNANCY

1. Mitral stenosis with NYHA functional Class II-IV symptoms
2. Mitral regurgitation with NYHA functional Class III-IV symptoms
3. Severe aortic stenosis with or without symptom
4. Aortic regurgitation with NYHA functional Class III-IV symptoms
5. Aortic and/or mitral valve disease resulting in severe pulmonary hypertension (pulmonary pressure >75% of systemic pressures)
6. Aortic and/or mitral valve disease with severe left ventricular dysfunction (ejection fraction <40%)
7. Mechanical prosthetic valve requiring anticoagulation

NYHA: New York Heart Association

TABLE III: VALVULAR HEART LESIONS ASSOCIATED WITH LOW MATERNAL AND FETAL RISK DURING PREGNANCY

1. Mild to moderate mitral stenosis (mitral valve area >1.5 cm ² , gradient <5 mm Hg) without severe pulmonary hypertension.
2. NYHA functional Class I-II mitral regurgitation with normal left ventricular systolic function.
3. Asymptomatic aortic stenosis with low mean pressure gradient (<50 mm Hg) in presence of normal LV systolic function (ejection fraction >50%)
4. NYHA functional Class I-II aortic regurgitation with normal left ventricular systolic function
5. Mild to moderate pulmonary valve stenosis

NYHA: New York Heart Association

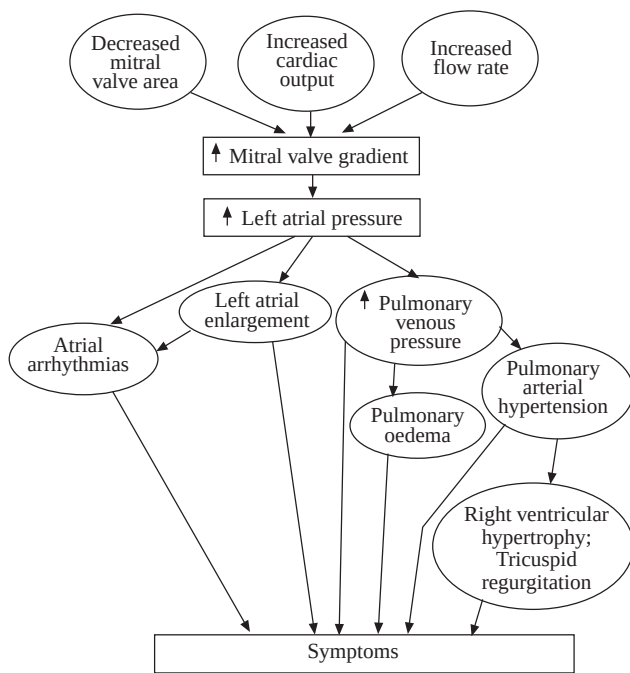


Fig. 4. Pathophysiology of mitral stenosis.

position are helpful. Whenever possible, symptomatic and severe valvular lesions should be addressed and rectified before pregnancy.

Mitral Stenosis

This is the most common rheumatic valvular lesion in pregnancy, and is also the one most likely to lead to a potentially serious outcome.

Pathophysiology

In normal adults, the cross-sectional area of the mitral valve orifice is 4 to 6 cm². Haemodynamically, significant stenosis occurs when the valve area progressively reduces to approximately 2 cm², which is considered to represent mild mitral stenosis. At this point, a small pressure gradient is required to propel the blood from the left atrium to the left ventricle. Further narrowing in the mitral valve orifice causes a progressive rise in the diastolic pressure gradient between the left atrium and ventricle, elevation in the mean left atrial and pulmonary capillary wedge pressure, and decrease in cardiac output. When mitral valve area is critically narrowed—to about 1 cm²—a large diastolic left atrioventricular pressure gradient of approximately 20 mm Hg is required to maintain normal cardiac output at rest. Any demand for increased cardiac output is accompanied by significant elevation of left atrial pressure, predisposing to pulmonary oedema. Besides mitral valve area, transvalvular pressure gradient is also determined by cardiac output and flow rate across the valve (Fig. 4). At any given

level of cardiac output, tachycardia increases transmitral pressure gradient. This increase in heart rate occurs with exercise, emotional stress, sexual intercourse, infection, atrial fibrillation and with pregnancy. Pregnancy imposes three major haemodynamic burdens on the heart. It 1) increases cardiac output and heart rate, 2) expands blood volume, and 3) intensifies oxygen demand. Hence, a majority of patients with moderate to severe mitral stenosis demonstrate a worsening of one or two classes in the New York Heart Association functional status during pregnancy, leading to more hospitalisations and the need to either starting or increasing cardiac medications. The greatest haemodynamic stress occurs during late pregnancy, labour, and the early postpartum period, since the increase in cardiac output, heart rate and blood volume is progressive to term, and further intensifies during labour.

Symptoms

The principal symptom of mitral stenosis is exertional dyspnoea (Fig. 4). Those with severe critical stenosis may also experience orthopnoea and attacks of frank pulmonary oedema. Ankle oedema associated with elevated jugular pressure is indicative of right heart failure from chronic severe mitral stenosis. As sinus rhythm is usual in reproductive-age females, embolic phenomenon is fortunately less common.

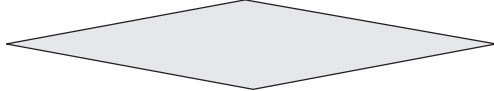
Echocardiography

This is the most useful test in mitral stenosis, and can be easily and safely performed in all patients. Two-dimensional echocardiography, Doppler study and colour flow mapping can help confirm the diagnosis and assess stenosis severity. Additional information is obtained regarding presence of concomitant valve lesions or left atrial thrombus, and suitability of the valve for balloon or closed surgical mitral commissurotomy. This is largely determined by the severity of mitral regurgitation and mitral valve morphology,⁵ taking into consideration leaflet rigidity, leaflet thickening, valvular calcification and subvalvular apparatus disease (Fig. 5).

Management

Optimal management of mitral stenosis (Fig. 6) remains a challenge in pregnant patients because of the need to consider the risks of cardiac medications to the fetus, radiation exposure during percutaneous balloon mitral valvuloplasty, or anaesthesia with or without cardiopulmonary bypass during surgical valve repair or replacement. Obstetrically, 3 main patient populations can be identified:

- 1) those with known mitral stenosis who desire to get pregnant,
- 2) those pregnant patients with well-compensated mitral stenosis, and

Echocardiographic score				
	1	2	3	4
Leaflet mobility	Highly mobile valve			Immobile valve
Valvular thickening	Thin leaflets			Markedly thickened leaflets
Valvular calcification	No bright echos			Multiple bright echos
Subvalvular apparatus	Minimal thickening of chordal structures			Extensive thickening and shortening of all chordae down to papillary muscle
	The sum of the four factors equals the echocardiographic scores			
	Lower scores (≤8) favour successful balloon valvuloplasty			Higher scores (>8) are associated with less impressive results with balloon valvuloplasty

Adapted from: Wilkins G, Gillam L, Weyman A, et al. Percutaneous balloon dilatation of the mitral valve: An analysis of echocardiographic variables related to outcome and the mechanism of dilatation. *Br Heart J* 1988; 60:299-308⁵

Fig. 5. Echocardiographic mitral valve score and suitability for percutaneous valvuloplasty.

3) those who present usually in advanced stage of pregnancy or early postpartum with compromised haemodynamic state.

1) Patients with Known Mitral Stenosis who Desire Pregnancy

Asymptomatic patients do not require specific treatment for the valve, except for antibiotic prophylaxis against rheumatic fever recurrence and infective endocarditis. Women with asymptomatic mitral stenosis should consider

bearing children before symptoms occur, since pregnancy is usually well tolerated with mild mitral stenosis.

Intervention should be offered to patients who reach the symptomatic threshold. For younger women with pliable, non-calcified valve without significant mitral regurgitation, this means either percutaneous mitral balloon valvuloplasty or closed mitral valvotomy, depending on local expertise. This approach attenuates any anticipated deterioration in functional class and obviates the need for pharmacotherapy during pregnancy.

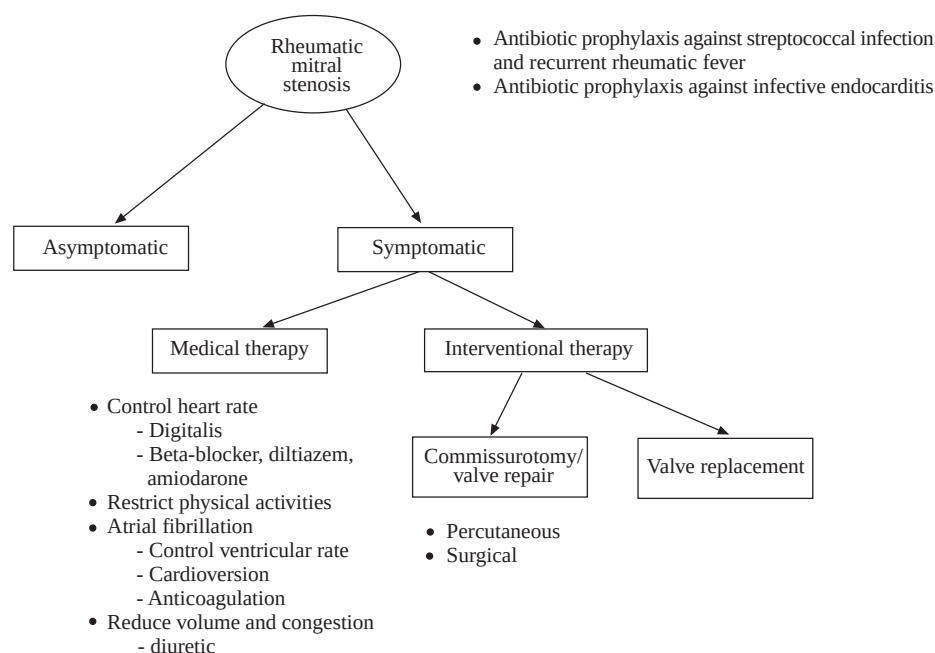


Fig. 6. Management scheme of mitral stenosis.

For patients deemed not suitable for valvuloplasty treatment, careful judgement is required regarding the risk and benefit of mitral valve replacement. For those with minimal symptoms, and have no adverse prognostic factors such as pulmonary hypertension and atrial fibrillation, intensive medical therapy may be safer than mitral valve replacement. If mitral valve replacement is required prior to pregnancy, choice of prosthetic valve can be problematic. Compared with bioprosthetic valve, metallic valve is more durable, but more thrombogenic, and hence requires long-term anticoagulation. In the past, to avoid the fetal and maternal risks associated with anticoagulant therapy during pregnancy, the use of bioprosthetic valves had been advocated. Though pregnancy does not accelerate the rate of deterioration of bioprosthetic valve,⁶ the long-term durability of tissue valves is short, and their use in these young women implies the need for reoperation, with approximately 30% of the patients requiring rereplacement of the valve within 10 years. Though still controversial, current recommendation favours the choice of metallic valves in this patient subgroup, acknowledging the need for, and risk of, anticoagulation.

Anticoagulation: There remain significant problems and an impressive risk to both the mother and fetus with the use of either warfarin or heparin. These risks include embryopathy, an increased likelihood of maternal and fetal bleeding, increased fetal loss and failure to prevent maternal thromboembolic events.⁷⁻⁹ As such, patients with prosthetic valve should be strongly discouraged from embarking on pregnancy. While there have been successful pregnancies, patients, spouses and families must be informed of the high risks to both the mother and fetus. Close follow-up by the obstetrician, cardiologist and haematologist is mandatory for pregnant patients with prosthetic valve.

The risks associated with oral anticoagulants occur primarily during the second part of the first trimester (embryopathies) and the peripartum period (maternal and fetal haemorrhages). Outside these critical periods, oral anticoagulants, compared to heparin, better stabilise the intensity of anticoagulation and thereby limit maternal haemorrhagic and thromboembolic risks. Warfarin crosses the placenta, and fetal exposure during the first 3 months is associated with 5% to 10% incidence,^{7,8,10} and even higher in some reports, of “warfarin embryopathy syndrome” (facial abnormalities, optic atrophy, digital abnormalities, epithelial changes and mental impairment). Women receiving the drug during the 7th to 12th week of gestation are particularly prone to having children with this syndrome.¹¹ Warfarin has been reported to be associated with increased fetal loss, prematurity and fetal growth retardation. Warfarin use at any time during pregnancy increases the risk of fetal bleeding and maternal uterine

haemorrhage,¹² especially during delivery and early postpartum. Fetal complications appear to be related to warfarin dosage.¹³ Salazar et al¹⁴ described neonatal death due to cerebral haemorrhage in a case of premature labour (35 weeks) in a woman treated with oral anticoagulants. The risk of fetal cerebral haemorrhage will be higher if instrument delivery is necessary.

In contrast to warfarin, both the unfractionated and low-molecular-weight heparin (LMWH) do not cross placenta, and are generally considered safer for fetal well-being. Long-term use of unfractionated heparin, however, is complicated by sterile abscesses, osteoporosis, thrombocytopaenia and bleeding. When used in high-risk pregnant women with older-generation and more thrombogenic mechanical prostheses, subcutaneous unfractionated heparin have been reported to be associated with unacceptable incidence of thromboembolic complications, including fatal valve thrombosis.¹⁴⁻¹⁶ The risk is higher if there is inadequate heparin dosing, and/or the lack of meticulous monitoring strategies. LMWH is rapidly gaining favour over unfractionated heparin. It offers several potential advantages, including greater bioavailability (90% versus 30% for unfractionated heparin), ease of administration (once or twice daily), no need for close laboratory monitoring, and a lower incidence of thrombocytopenia and osteoporosis. Unfortunately, the number of reported cases of pregnant women with prostheses and LMWH is too limited to guide their use in the management of patients with mechanical heart valves.¹⁶⁻²⁰

The risk associated with the use of anticoagulants must therefore be weighed against the increased thromboembolic complications from pregnancy-related hypercoagulable state (from changes in blood coagulation factor levels, stasis, suppression of antithrombin III and protein S activities, and a decrease in fibrinolytic activity). Maternal thromboembolic phenomenon have been reported in 4% to 14% of pregnancies in women with mechanical prostheses despite adequate anticoagulation as measured by the serum international normalised ratio (INR) or activated partial thromboplastin time (aPTT).^{11,12} Available data suggest that heparin protects the fetus and aggravates maternal risk, whereas oral anticoagulants protect the mother and aggravate fetal risk.

Guidelines for the management of the pregnant patient with a mechanical prosthesis have been difficult to formulate due to the lack of adequate prospective randomised controlled trial data. Recent practice guidelines¹⁹ have favoured use of warfarin either during the entire pregnancy (especially if the dose is ≤ 5 mg)¹³ or substituted by heparin only during the peak teratogenic period. Some advocate using heparin for the first trimester and warfarin for the next 5 months, with a return to heparin prior to labour and

delivery (no later than 35th or 36th week of gestation). Higher level of anticoagulation seems justified in patients with mechanical prosthesis in the mitral versus the aortic position, in patients with more than one mechanical prostheses, and in patients with atrial fibrillation and a history of systemic embolisation. Addition of small dose of aspirin (80 to 100 mg/d) to warfarin therapy (INR, 2.0–3.5) further decreases the risk of thromboembolism.^{21–23} This combination is recommended by a committee²⁴ addressing antithrombotic therapy during pregnancy. There is a slight increase in the risk of bleeding with the combined use of aspirin and warfarin.

In the absence of significant bleeding, heparin can be resumed 4 to 6 hours after delivery, and warfarin begun orally. Neither warfarin nor heparin is contraindicated in postpartum mothers who breastfeed.

2) Pregnant Women with Compensated Mitral Stenosis

Careful assessment of the risk/benefit ratio to mother and fetus of standard pharmacologic therapy (β blockers and diuretics) versus interventional therapy is required for the optimal management of this group of patients. Patients with mild to moderate mitral stenosis can almost always be managed with judicious use of diuretics and β -blockade. Diuretics are given to relieve pulmonary and excess systemic venous congestion, but care must be taken to avoid vigorous volume depletion to protect against utero-placental hypoperfusion. Though β -adrenergic blockers have been reported in earlier studies to cause intrauterine growth retardation, neonatal hypoglycaemia, neonatal bradycardia, neonatal hyperthyroidism and respiratory dysfunction, larger studies show that the cardioselective β blockers are generally safe and well tolerated by both mother and fetus.²⁵ β -blockers are chiefly indicated to treat or prevent tachycardia to optimise diastolic filling. By reducing heart rate, β -blockers significantly ameliorate the haemodynamics of mitral stenosis. Some authorities recommend the use of a cardioselective β -blocker (e.g. metoprolol and atenolol) as β_2 -blockade by non-selective agents (e.g. propranolol) may have the potential deleterious effect of initiating uterine contractions.

For rare patients with mitral stenosis who fail medical management during pregnancy with repetitive or persistent heart failure, the option of mitral valvotomy should be carefully considered. Since the first case reports in 1988 of mitral balloon valvuloplasty during pregnancy by Safian²⁶ and Palacios,²⁷ numerous publications have confirmed the technical feasibility and haemodynamic improvement following the procedure,^{28–34} performed with very limited fluoroscopy (less than 1 to 2 minutes exposure with both pelvic and abdominal shielding) or echocardiographic guidance. However, long-term risk of even low level of

irradiation to the fetus is as yet unknown. Mitral balloon valvuloplasty should only be performed by experienced team; and preferably beyond 20 weeks of gestation, when irradiation risk to the fetus is less.

When balloon valvuloplasty cannot be performed, surgical closed mitral valvotomy is a suitable alternative.^{35,36}

3) Pregnant Patients with Mitral Stenosis in Critical State of Haemodynamic Compromise

This group of patients may present with pulmonary oedema, hypotension and right heart failure. In this situation, maternal survival takes precedence. Failure to achieve clinical improvement with intensive medical therapies (including the use of intravenous diuretics, beta blockers if in sinus rhythm, digitalis if in atrial fibrillation, and DC cardioversion, if necessary) is an indication for urgent mechanical relief of mitral stenosis, either percutaneously or surgically, depending on echocardiographic valve characteristics and local expertise. Significant fetal mortality is expected.

Obstetric Considerations during Labour and Delivery

Vaginal delivery is the preferred method, with caesarean section reserved for obstetric indications, or when labour begins in patients who are still on warfarin treatment. Epidural anaesthesia attenuates wide fluctuations in blood pressure and is recommended for patients with mitral stenosis. The second stage of labour should be shortened when appropriate by assisted delivery. Tocolytic agents that have positive chronotropic effects may exacerbate the haemodynamics of mitral stenosis and are contraindicated for premature labour. In the absence of infection, routine antibiotic prophylaxis is not recommended for uncomplicated vaginal or abdominal deliveries.

Mitral Regurgitation

Common causes of mitral regurgitation in pregnant women include mitral valve prolapse (MVP) and rheumatic heart disease. Compared to mitral stenosis, symptomatic mitral regurgitation is much less frequently encountered in pregnancy as it is better tolerated. The volume of mitral regurgitant flow depends on the regurgitant orifice size and systolic pressure gradient between the left ventricle and left atrium. Left ventricular systolic pressure in turn depends on systolic blood pressure and systemic vascular resistance. Since both systemic blood pressure and vascular resistance drop during pregnancy, forward stroke volume increases with proportionate reduction in mitral regurgitation flow.

Asymptomatic patients require no specific therapy. Rare patients with symptoms of congestive cardiac failure can usually be managed medically with the use of diuretics and digitalis. Vasodilator therapy is indicated only in the

presence of concomitant systemic hypertension and should not be advised in the setting of normal or low systemic blood pressure. Hydralazine, with wide experience of its use, is the agent of choice and is generally considered safe. Angiotensin converting enzyme (ACE) inhibitors are considered unsafe because of their multiple adverse effects on fetal development.

Rarely is surgery required or advisable during pregnancy, bearing in mind a maternal mortality of 2% to 3% and fetal mortality of up to 30%. When mitral valve surgery is required, repair (rather than replacement) is always preferred for any young patient. This procedure preserves the patient's native valve without a prosthesis and therefore avoids the need for long-term anticoagulation. Preservation of mitral apparatus also leads to better postoperative left ventricular function and survival than in cases in which the apparatus is removed.³⁷⁻³⁹ Repair is more often feasible with degenerative mitral valve disease than with rheumatic valvular disease.^{40,41}

Aortic Stenosis

The most common cause of aortic stenosis in pregnant women is congenital bicuspid disease. Rheumatic aortic stenosis is rare during pregnancy, probably reflecting a predilection of this condition for older patients and males. Systemic hypotension may result when stenotic aortic valve limits the ability to increase stroke volume in the presence of pregnancy-induced decline in systemic vascular resistance.

Asymptomatic patients should be advised to have adequate bed rest and restriction of physical activity. With this, pregnant patients with mild to moderate obstruction and normal left ventricular systolic function can usually be managed conservatively. For those rare women with severe aortic stenosis whose disease is first appreciated during pregnancy, mechanical relief is the only therapeutic option available. Either percutaneous aortic balloon valvotomy or surgery (depending on the valve anatomy) should be considered before labour or delivery if heart failure has developed or syncope from severe systemic hypotension has occurred. Unlike the situation with rheumatic mitral stenosis, experience with percutaneous balloon valvotomy for aortic stenosis during pregnancy is extremely limited.⁴² ⁴³ Both the percutaneous and surgical treatments of severe aortic stenosis during pregnancy are fraught with danger to the mother and fetus, and should be undertaken only with great caution.

Aortic Regurgitation

Aortic regurgitation is seen more commonly than aortic stenosis in women of child-bearing age. When it is due to rheumatic disease, combined aortic and mitral valve involvement is the rule. As with mitral regurgitation, aortic

regurgitation is generally well tolerated during pregnancy. Pregnancy decreases aortic regurgitant volume:

- 1) by reducing diastolic aortic/left ventricular pressure gradient as a result of a decline in systemic vascular resistance, and
- 2) by an increase in heart rate, which shortens diastole and, hence, the time for regurgitation.

Isolated aortic regurgitation can usually be managed medically with a combination of diuretics and, if necessary, vasodilator therapy. In non-pregnant patients, vasodilator therapy using hydralazine⁴⁴ or long-acting nifedipine^{45,46} has reduced left ventricular end-diastolic volume, left-ventricular mass, and the need for surgery in patients with severe aortic regurgitation. Value of such therapy in pregnant patients is unknown. Vasodilator therapy is not recommended for asymptomatic patients with mild aortic regurgitation and normal left ventricular function.

As is true for mitral regurgitation, surgery for aortic regurgitation during pregnancy should be considered only for control of refractory Class III or IV symptoms.

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