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The Heart and Pregnancy

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Heart disease and pregnancy are two conditions that are handled commonly by a medical practitioner, and yet it is surprising to find that the influence which one has on the other is often not clearly understood. It would seem reasonable, therefore, to review briefly current concepts on the changes in haemodynamics that occur during pregnancy and labour, and thereafter consider the effects of pregnancy on the diseased heart.

Normal Haemodynamics

The normal readjustment to pregnancy involves a rise in cardiac output, in heart rate, and in blood volume, though these modalities do not run a parallel course.

There is an early (within the first three months) rise in cardiac output (C.O.), the rise being in the order of 30 per cent. to 60 per cent. by the end of this period. This increase is maintained until term and there is *not* the fall in cardiac output during the last 2-3 months as has been accepted previously. This reported drop in cardiac output was the result of an error in technique. Previously cardiac output was measured with the patient in the supine position, thus allowing the gravid uterus to press on the inferior vena cava and reduce venous return with a consequent fall in cardiac output. With the patient in the lateral position at the time of C.O. measurement, a drop is not recorded.

The heart rate also increases during pregnancy though this rise is not proportional to the rise in C.O., thus indicating an increase in stroke volume. As there is no associated increase in blood pressure (in fact a fall in diastolic pressure occurs) a

reciprocal fall in vascular resistance is found. In the absence of an increase in blood pressure the work of the heart will be proportional to cardiac output, and as there is an increased stroke volume it follows that an increase in blood volume must be present. This increase develops in early pregnancy and may be of the order of 50-60 per cent. It drops slightly in later pregnancy but does *not* return to normal.

The mechanism of these changes is not known — the increase in blood volume in the first trimester being particularly bewildering. It was suggested that the chorio-decidual space acts as an A-V fistula, but the counter argument is that the maximum increase in volume and cardiac output occurs in early pregnancy when chorio-decidual flow is still minimal. Placental steroids have been thought to be contributory, but again the mechanism is not defined.

Uterine blood flow, skin and renal blood flow are greatly increased during pregnancy, but not muscle blood flow.

During labour the cardiac output increases by about 15 per cent. to 20 per cent. during each contraction as does the mean arterial pressure, and hence an increase in left ventricular work results. Right atrial pressure may rise to 40-50 mm. Hg. during a contraction, probably due to an increase in blood volume following expression of blood from the contracting uterus into the circulation. The cardiac output rises further at the end of the second stage to a level some 40 per cent. above that present in late pregnancy. Following delivery cardiac output does not drop immediately, but returns gradually to normal during the subsequent few weeks.

It will be appreciated therefore that with the changes outlined above it may be difficult to determine whether a pregnant woman is manifesting normal circulatory changes or showing the signs of early congestive cardiac failure. Some of the commoner and differentiating features are presented in Table I.

Table I

	Pregnant Woman	C.C.F.
Shortness of breath	May be present	Usually present
Heart rate	Tachycardia	Tachycardia
Venous pressure	Raised in lower limbs — oedema *J.V.P. — normal	Raised in lower limbs — oedema *J.V.P. — raised
Heart sounds	P ₂ often accentuated	Third heart sound may be heard
Murmurs	Functional murmurs (usually soft systolic)	Murmurs usually present
Pulmonary congestion	Usually absent	Present.

(* — J.V.P. = Jugular venous pressure.)

Because they are common in pregnancy, functional murmurs should be recognised. They are due to increased flow, are usually systolic and may be more obvious in the presence of anaemia. (They are usually easy to recognise being short, superficial and of low grade intensity). Diastolic murmurs must be considered as organic until proved otherwise. Any doubt about a murmur should mean a detailed cardiological study to establish the diagnosis.

Heart Disease and Pregnancy

The diseased heart in pregnancy has, for too long, carried an emotional as well as a physical burden. With a better understanding of the haemodynamics of the circulation in health and disease, thinking and management can now be on a more rational basis.

In Britain about 1.2 per cent. of all pregnant women have heart disease, but in Rhodesia it is probable that this figure is higher, because the commonest cause of heart disease in a pregnant woman is rheumatic fever, a disease which in this country, to a large extent, remains untreated until the florid stage is reached or frank congestive failure has developed.

Deaths during pregnancy from heart disease are, in Britain, uncommon (about 0.04 per cent.) and of those that do occur over 50 per cent. have been recorded as due to mitral valve disease. It would seem wise therefore, when heart disease is noted during pregnancy, that the patient be investigated fully and if any doubt exists about fitness for delivery at home, she should be admitted to hospital for management.

In 90-95 per cent. of cases, heart disease in pregnancy is due to rheumatic fever, and the pathological conditions most commonly seen are:

- Mitral Stenosis 90%
- Mitral Incompetence 6.5%
- Aortic Stenosis and Incompetence 3.5%

Mitral stenosis therefore in Britain accounts for 80 per cent. of all heart disease associated

with pregnancy. In Rhodesia the questions that require answers are — How prevalent is rheumatic heart disease?; how frequently does it complicate pregnancy?; and is there still a significant maternal mortality from it? It would seem that in Africans the myocardium often is damaged severely (? from inadequate care during the florid state of the rheumatic attack) and hence the effects of rheumatic fever are not necessarily only the consequence of valvar disease.

Assessment of Severity of Mitral Stenosis

The most frequent problem is to decide whether the severity of the stenosis warrants surgery and this will require an assessment of the patient in hospital. The increased circulating blood volume during pregnancy will accentuate the assessed degree of stenosis, bearing in mind that the factors involved in a gradient across a valve are both pressure and flow.

A comparative evaluation of the severity of stenosis is set out in Table II.

Role of Surgery in Mitral Stenosis during Pregnancy

The usual indication for operation in pure mitral stenosis in a patient who is not pregnant is the development of undue dyspnoea (a difficult parameter to assess and measure); or the presence of clinical evidence of a tight stenosis (accentuated first heart sound in mitral area, an opening snap, a long mid-diastolic murmur, an accentuated pulmonary second sound together with E.C.G. and X-ray evidence) even if the patient does not give a history of dyspnoea.

In the pregnant patient the grading of the severity of stenosis can be misleading and hence a careful assessment is necessary. It has been the experience in clinics in Britain that the need for valvotomy during pregnancy has decreased, though it must be emphasised that, in this country, in African patients, it may be wrong to draw the same conclusions.

Table II

Feature	Severe Stenosis	Mild Stenosis
Dyspnoea	Undue even before pregnancy.	Undue dyspnoea develops during pregnancy.
Pulse	Usually tachycardia	Tachycardia not so marked.
Auscultation	Mitral first and pulmonary second sounds accentuated. Prolonged diastolic murmur with presystolic accentuation.	M ₁ and P ₂ may be accentuated. Diastolic murmur may be short.
Radiology	Marked venous congestion and pulmonary plethora. Loss in differential shadowing in upper and lower zones on X-ray.	These features are not so marked.
E.C.G.	Marked R.V. hypertrophy.	R.V. hypertrophy not marked.

The most likely reason for the decline in the need for valvotomy is that the operation, being a common and relatively simple procedure, is carried out on women in the non-pregnant state and hence fewer patients with severe stenosis become pregnant.

In Edinburgh, in a survey reported recently, mitral valvotomy was carried out in only 37 of 1,200 pregnant women with heart disease. Thirty of these patients had their operation during the 4th-6th month period of the pregnancy. Of the 30 patients, only one had an abortion which was attributed directly to the operation.

Indications for Surgery

The general policy advocated, with few exceptions, is the relief of the stenosis, whatever other factors are present. There is a small residue of patients in whom the decision is not simple and this arises out of the problem of assessing the severity of the stenosis.

In this country with its different social circumstances, it is recommended that if the operation is accepted, it be done sooner than later, as a refusal to accept surgery often follows medical treatment and improvement in the patient's condition, even though permission was granted prior to the beginning of medical management.

Timing and Risk of Operation

If valvotomy is considered advisable then probably it is best performed early in the pregnancy so that the subsequent months, with their increasing blood volume and other haemo-dynamic changes may be safeguarded.

It seems wise, though there is little clinical or statistical evidence to support this view, to wait if possible until after the 12th week. If, as will probably be the case in the majority of patients, the diagnosis is not made until the late second or third trimester, then, if there is not an immediate and rapid response to medical treatment, operation should be advised.

The risk of operation in a given patient cannot be expressed with great accuracy in terms of a percentage, but given adequate medical control, good operative and post-operative facilities, it can be accepted with confidence that this risk is extremely low.

The opinion is held that the risk of operation is equal to or higher than that of allowing the pregnancy to continue, but it is important to record that maternal death is more frequent in those

with cardiac disease than in normal mothers, and that the majority of these deaths have occurred in patients who, when first seen, were graded functionally as I or II (New York Heart Association Classification — see Appendix), i.e., the milder grades. Those women with more severe stenosis are likely to have been diagnosed before pregnancy and appropriate care given. Generally, those who are graded III or IV in early pregnancy, do not have valve defects that are suitable for surgery — they have multiple defects, myocardial insufficiency or some non-cardiac condition such as anaemia or pulmonary disease.

Great care and attention therefore must be given to those patients who in early pregnancy are graded I or II, because, too often, it is mistakenly thought that because they have been so graded, the risk involved is small. They are, however, greatly at risk, and can pass within hours into grade IV with the development of pulmonary oedema from, for example, pulmonary infection or the onset of a cardiac arrhythmia.

Management of Pregnancy in Patients with Rheumatic Heart Disease

The majority of women can be conducted safely through pregnancy. A careful assessment of the patient's cardiac state is made and this includes not only the valve defect and its effect on myocardium, but also a clinical appraisal of such problems as anxiety, the patient's threshold for symptoms, obesity, anaemia, nutritional state and general condition. This should be done in the first trimester, so that a base line is established and the patient concurrently "graded".

Objective observations of the heart and circulation include routine cardiac examination, electrocardiogram, chest X-ray and barium swallow, though care must be exercised in the use of radiological techniques in pregnancy. In general, hypertrophy of the heart reflects obstruction (valvular or hypertensive) and dilatation reflects valve incompetence or myocardial damage.

The patient should be seen routinely every two weeks until 32 weeks, and every week thereafter, preferably by a physician and obstetrician. Grade I and II may be supervised as out-patients and admitted at 38 weeks for rest to await the onset of labour. Grade III patients should be admitted by 32 weeks while Grade IV should be admitted immediately.

It is important to consider the patient's social background and home conditions. A Grade II patient who already has several children and may

in addition to her pregnancy be working in the fields, may deteriorate rapidly to Grade III or IV. An indication for immediate admission may be, therefore, the home and social circumstances as adequate rest may not be possible nor its need be appreciated.

Five major complications during the antenatal period may arise and careful examinations for them carried out. Their early detection and prompt treatment is essential.

1. Anaemia — check haemoglobin each month. It should not be allowed to fall below 11 Gm./100 ml.
2. Infection — especially respiratory.
3. Pre-eclamptic toxæmia.
4. Further attack of rheumatic fever.
5. Subacute bacterial endocarditis.

All cardiac patients should be allowed to go into labour spontaneously, induction of labour being carried out only for obstetric reasons and not because of the cardiac condition. Caesarian section is carried out only if it is anticipated that the labour will be difficult or prolonged. The patient should be nursed in an upright position during the first stage of labour and receive adequate sedation. Morphine Gr. $\frac{1}{4}$ (15 mg.) or pethidine 100 mg. may be used and if given near the end of the first stage, 1 mg. of Nalorphine intramuscularly will counteract the respiratory depressant effect on the baby. Intravenous fluids should be avoided or, if necessary, given cautiously. Immediately before the second stage of labour an intravenous injection of lasix, 40 mg., is given. This will remove 500-1,000 ml. of fluid from the circulation (a "dry venesection") before onset of the maximal effort of the second stage.

The second stage should be conducted with the patient in the upright position, her back supported with pillows. She should sit at the edge of the delivery table with her feet resting on two stools. This position further reduces the circulating volume by pooling the blood in the legs. The lithotomy position obviously should not be used. The second stage should be an elective assisted delivery with forceps or a vacuum extraction.

The management of the third stage is controversial. It is recommended that 0.25 mg. ergometrine intravenously be given at delivery of the anterior shoulder. The risk of postpartum haemorrhage, which can be uncontrollable and lethal, is reduced. The small hypertensive effect and the reported rapid contraction of the uterus with squeezing of blood into the circulation, thus precipitating cardiac failure, has probably been over-emphasised in the past. The Brandt-Andrews

technique for delivery of the placenta is also recommended in these patients.

The routine use of antibiotic cover during labour and the puerperium in cardiac patients is advised routinely. The risk of sub-acute bacterial endocarditis is low as the offending organism streptococcus viridans is not often found in the vagina.

The first 12 hours of the puerperium are critical and patients who pass through pregnancy and delivery satisfactorily may succumb from cardiac failure in this period. These patients should be kept in bed for 48 hours following delivery and a careful watch kept for signs of cardiac failure notably a rising pulse, raised jugular venous pressure and fluid retention in the lungs. Grade III and IV cardiac patients should remain in bed for at least seven days following delivery and in hospital for two weeks.

It is advisable that women with cardiac disease should limit their family, as pregnancy may cause deterioration in the cardiac condition. Each additional child requires more work to be done by the mother who is getting older, and also by a heart that does not have normal reserves. Tubal ligation six to eight weeks after delivery is advised when her family is complete and the family size should be limited to two or three children.

Acquired Heart Disease Other than Mitral Stenosis

Mitral incompetence, aortic stenosis and incompetence are the other major valvar abnormalities due predominantly to rheumatic involvement of the heart. Today, with these lesions, if the condition is considered operable, an open heart procedure with insertion of a prosthetic valve is the operation of choice. This would not be done during pregnancy and hence if the patient cannot be conducted through her pregnancy by medical means and her life is at risk, then termination of the pregnancy will have to be considered.

Cardiomyopathy

This is really a word that embraces a number of different conditions with different aetiologies. In this country it is thought that a cardiomyopathy is related to malnutrition and indeed a cardiomyopathy of pregnancy is a recognised entity. Suspicion of this condition is aroused if the patient has an enlarged heart with no obvious valvar lesion to account for it. A full investigation is called for under these circumstances. If congestive cardiac failure supervenes its management is along usual lines.

Congenital Heart Disease

Only the more common congenital defects will be considered as the others are seen so rarely that diagnosis generally would be made at a specialised centre equipped with the more sophisticated diagnostic procedures.

Atrial Septal Defect (Ostium Secundum Type)

Generally the right ventricle tolerates the effects of an atrial septal defect well, the natural history of the disease being a benign one. Only if pulmonary hypertension has developed may trouble arise during pregnancy. If the diagnosis is known before pregnancy has started, then, particularly if pulmonary arterial pressure is raised, operation for closure of the defect should be advised.

If the diagnosis is made during pregnancy, generally the course in the young woman may be expected to be uneventful and all that is required is a careful watch on the patient. If the patient is older and has E.C.G. evidence of right ventricular hypertrophy, then further investigation is mandatory. Operation is recommended during pregnancy if the patient's condition deteriorates in spite of adequate medical management.

Pulmonary Stenosis

This condition seldom poses a problem during pregnancy. A tight stenosis may lead to right ventricular failure as cardiac output and work increase during pregnancy. Again, if response to medical management is poor then relief of the stenosis during pregnancy can be done, but this would be a rare event in an already fairly rare condition.

Ventricular Septal Defect

Again, an extremely rare condition during pregnancy. The severity of the condition depends largely upon the size of the defect. If it is large the patient is unlikely to achieve pregnancy. Those who do survive until child-bearing age do well during pregnancy as usually they are mild cases. If the patient's condition deteriorates during pregnancy, then medical management will generally take the patient through her pregnancy and correction by means of open heart procedures carried out at least six months after delivery. Open heart procedures during pregnancy are not recommended.

Patent Ductus Arteriosus

The main considerations with patent ductus arteriosus will be:

- (a) the size of the shunt and hence the load on heart;
- (b) the age of patient;

- (c) the presence of raised pulmonary arterial pressure.

If the shunt is large, there are signs of pulmonary congestion and/or right ventricular strain on E.C.G., and if the patient is not in the flush of youth then the ductus should be closed during pregnancy.

If, however, the ductus is small, there is no right ventricular strain on E.C.G., and patient young, then there is no need to proceed to surgery during the pregnancy. Surgery, however, should be carried out after infant is weaned from the mother.

Coarctation of Aorta

A rare condition. The risks of this condition are cerebro-vascular accident, rupture of the aorta, congestive cardiac failure and subacute bacterial endocarditis. There are divergent views about management in these patients but there is little doubt that maternal mortality risk is higher than normal. The consensus of opinion is that coarctation should be corrected before pregnancy is started. If the condition is found during pregnancy then operation during the pregnancy is *not* advised, the patient being handled medically through her pregnancy.

If the danger of a complication arises it would seem better to terminate the pregnancy and correct the defect later.

Tetralogy of Fallot

Pregnancy in this condition is extremely rare, maternal mortality risk is high as is the danger of congestive heart failure. Premature delivery is the rule and infant complications also increase.

Hence, depending upon the cardiological state of the patient, serious consideration must be given to an early termination of pregnancy.

CONCLUSION

A brief review of the heart in health and disease during pregnancy is given. This article is presented as a compact guide to the present approach to those cardiac conditions in pregnancy that may present as an isolated phenomenon. It is not intended to discuss cardiac disease secondary to other conditions; e.g., thyrotoxicosis.

APPENDIX

New York Heart Association grading of functional capacity of the heart.

- Grade I — No limitation of activity.
- Grade II — Slight limitation with moderate effort.
- Grade III — Obvious limitation of activity even with less than moderate effort.
- Grade IV — Severe limitation with signs of heart failure even at rest.



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