

NON-INVASIVE EVALUATION OF CARDIAC CHANGES IN NORMAL PREGNANT WOMEN, THEIR CLINICAL SIGNIFICANCE AND IMPLICATIONS

MOHAMMED S. M. NOUH, MD; Mohammed R. Arafah, FRCP;
 SAAD AL HARTHI, MD; RANDA MS NOUH, MSC OBS & GYN;
 MOSTAFA AL SHAMMARI, MRCP; ZAINAB A BABAI, AB OBS & GYN
 HUSSAIN AL YAMMANY, JMB

One hundred and four symptomatic healthy pregnant women were examined clinically, and subjected to echocardiography, Doppler color studies, resting electrocardiogram and 24 - hour Holter monitoring. These were performed at 24th and 34th weeks of gestation, and eight weeks after delivery. The findings were compared with those of 50 young age-matched non-pregnant women without heart disease. Twenty-four cases showed pericardial effusion of different severity. Sixteen cases were not detected on clinical grounds. The posterior echo-free space which determines the size of the effusion was large in 4 cases, moderate in another 4 cases and small in 16 cases. Electrocardiograms showed low voltage tracing in 4 large effusions and 2 with moderate variety. Doppler color flow studies detected seven cases with trivial mitral regurgitation and seven cases with combined mild mitral and tricuspid regurgitation, while 24 cases had mild tricuspid regurgitation. Mitral and tricuspid regurgitation was diagnosed by color Doppler studies. Mitral valve prolapse was recorded in 23 cases of which 15 had no mitral insufficiency. Aortic valve dysfunction was not noted in any stage of pregnancy or in the puerperium. Nineteen pregnant participants had normal color Doppler echocardiographic findings, and electrocardiographic tracings, and no arrhythmias were detected in 24-hour ambulatory Holter monitoring. Eight weeks after delivery, mitral regurgitation was not detected but tricuspid insufficiency resolved in four cases only. In the studied group of cases, 24-hours Holter monitoring showed no ventricular or supraventricular arrhythmias, but after delivery atrial premature complexes were recorded in 12.5% while the ventricular variety was recorded in only 6.0% only.

Key words: Echocardiography, normal pregnancy, mitral valve prolapse, pericardial effusion, valvular insufficiency.

PHYSIOLOGICAL VOLUME OVERLOAD with hyperkinetic states associated with pregnancy represents an adaptation of the cardiovascular system induced by increased metabolic demands of the fetus. Campos et al. has stated that this circulatory burden is usually well tolerated by the normal pregnant women.¹ Changes in the heart occurring with normal pregnancy may give the impression of the presence of cardiac pathology. Obstetricians refer their patients for cardiac opinion when they develop abnormal heart sounds particularly murmur. The recent development of

non-invasive diagnostic techniques to evaluate any cardiac abnormalities justify the reluctance to utilize x-rays and other invasive diagnostic tools during pregnancy which has been a limiting factor in the ability to differentiate between normal physiologic changes and organic heart disease.

The use of echocardiography permits one to estimate as well as to evaluate myocardial performance, chamber size in the basal state and different stages of pregnancy and in the perperium. Rubier et al. has stated that echo-Doppler study is the only technique that can be employed with complete safety, repeated frequently and entirely without patient discomfort.² The present prospective study was designed to evaluate physiological cardiac changes in normal pregnancy by the use of non-invasive methods.

From the Department of Medicine, Division of Cardiology (Profs. Nauh, Al-Nozha, Al-Harthi, Drs. Al-Shammari and Yammany); Obstetrics and Gynaecology (Drs. Nauh & Babai).

Address reprint requests and correspondence to Prof. Nauh: Professor, of Medicine and Consultant Cardiologist, Department of Medicine, Division of Cardiology, P.O. Box 2925, King Saud University, Riyadh 11461, Saudi Arabia.



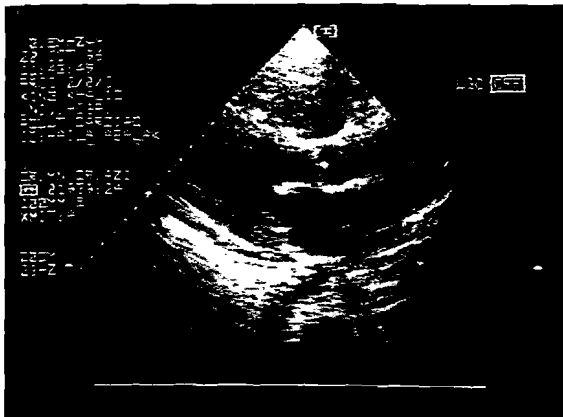


Figure 1. Long-axis view showing mild posterior pericardial effusion.

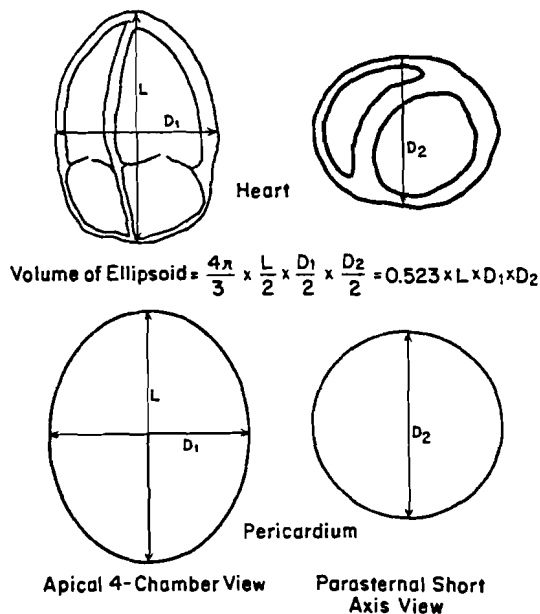


Figure 2. Diagram of Ellipsoid formula for estimating the volume of pericardial effusion.

Methods

Study Population

One hundred and four pregnant women aged between 22 and 32 years, and at their 24th week of gestation, were referred to the non-invasive cardiology laboratory. King Khalid University Hospital for evaluation of their cardiac status. The referrals were due to murmurs, detected by the referring physician, soft or inaudible heart sound, abnormal electrocardiogram tracings and/or

signs of arrhythmia on clinical examination. Patients were excluded from the study if there was a past history of cardiac disorders, either congenital or acquired.

A control group consisted of 50 young age-matched non-pregnant female volunteers who were non-smokers, not performing sports and not using oral contraceptive pills. Each participant from the control group was subjected to clinical examination of the cardiovascular system, followed by cross-sectional echocardiography with color Doppler studies, resting electrocardiogram and 24-hour Holter monitoring were performed for each participant. These investigations were performed in the last trimester of pregnancy at 24 and 34 weeks and were repeated eight weeks after delivery. The control group was submitted to single clinical examination and single-echo Doppler study.

Instrumentation and Technical Procedures

Echocardiographic studies with color Doppler facilities were performed, by utilizing HP 1000 SONO equipped with 2.5 Mhz transducers. These studies were recorded by video camera. Long axis, short axis and four-chamber views were utilized. The same investigator performed all studies while two independent researchers analyzed the obtained dates. Twenty-four hour Holter monitoring was performed using computerized Del Mar Avionic Model 900 A machine. The magnetic tap containing 24-hour ambulatory ECG were processed at 60 minutes real time using digital computer system. Two investigators analyzed the detected arrhythmias independently.

Results

Using the criteria set by Horowitz et al.,³ pericardial effusions were detected in 24 cases (Figure 1). The categorization of the size of the effusion according to the diameter of the posterior echo free space is roughly semi-quantitative.

A new approach was to estimate the volume of pericardial effusion based on assessing the pericardial sac volume as compared to cardiac volume by the Ellipsoid formula by which pericardial fluid volume is the difference between total pericardial sac volume and cardiac volume (Figure 2). Pericardial effusion was large in 4 cases, moderate in 4 cases and small in 16 cases.

The left ventricular function and dimensions

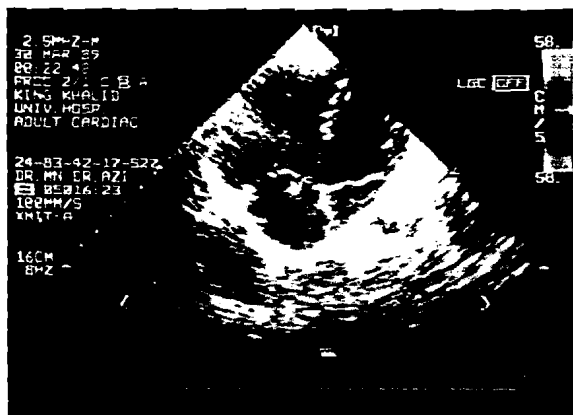


Figure 3A. Four chamber view with color imaging showing mild tricuspid insufficiency.

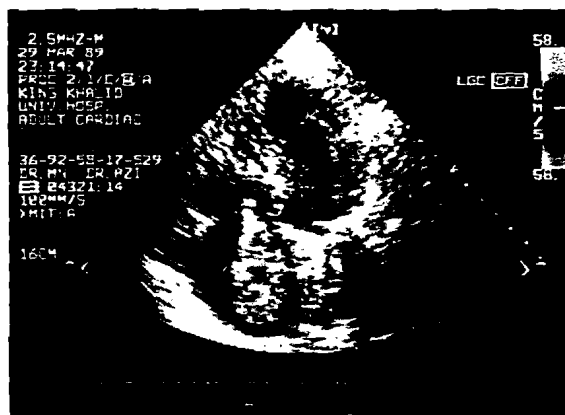


Figure 3B. Four chamber view with color imaging showing both mitral as well as tricuspid regurgitation.

Table 1. Valvular insufficiency during pregnancy and after delivery.

Regurgitant Valve	No. of cases in pregnancy	Grades	No. of cases after labour	Grades
Tricuspid	24	mild	24	mild
Mitral	7	mild	0	mild
MR & TR	7	mild	3 TR only	mild
Total TR	31	mild	27	mild

were within normal limits in all cases. Follow-up screening after delivery showed no evidence of effusion in 16 cases and with small effusion with major reduction in the posterior echo-free space in 8 cases of moderate as well as large effusions.

Twenty-four cases of pregnant women were found to have color Doppler evidence of mild tricuspid insufficiency with normal two-dimensional echocardiography results, while seven cases had mild mitral insufficiency and another seven had combined tricuspid as well as mitral regurgitation (Figure 3A and 3B).

Eight weeks after the delivery mitral regurgitation was not noted, however, tricuspid regurgitation resolved in only 4 cases. (Table 1)

Twenty-three cases showed echocardiographic evidence of mitral valve prolapse of the primary type in different cross-sectional echo views (Figure 4A, 4B and 4C), in the first visit, while in a follow-up echo in 8 weeks after delivery, mitral valve prolapse was detected in 15 cases only. Nineteen cases showed normal clinico-echo-Doppler studies.

Results of other Non-invasive Investigations

Scalar 12 leads-electrocardiograms showed no

abnormalities in the base line and in the follow-up period, while in 4 cases of large effusion and 2 cases with moderate pericardial effusion the ECG tracings showed low voltage and scattered T & ST changes. 24-hour Holter monitoring showed atrial and ventricular premature beats. The score were 12.5% and 6.0%, respectively, in pregnant women. Another arrhythmias were recorded and there were no abnormal findings in follow up studies.

Discussion

Normal pregnancy results in an increase in metabolic demands, a decrease in vascular resistance with its resultant diminution in afterload and expanded blood volume with consequent increase in the preload.⁴ Data from cardiac catheterization and animal studies provide valuable information concerning cardiac response to normal pregnancy.⁵⁻⁷ Before 1976, non-invasive procedures were not used to evaluate cardiac changes in response to normal gestation. Echocardiography with color Doppler facilities presents an unusual opportunity to assess cardiac changes in response to normal gestation. Echocardiography and color Doppler facilities, with



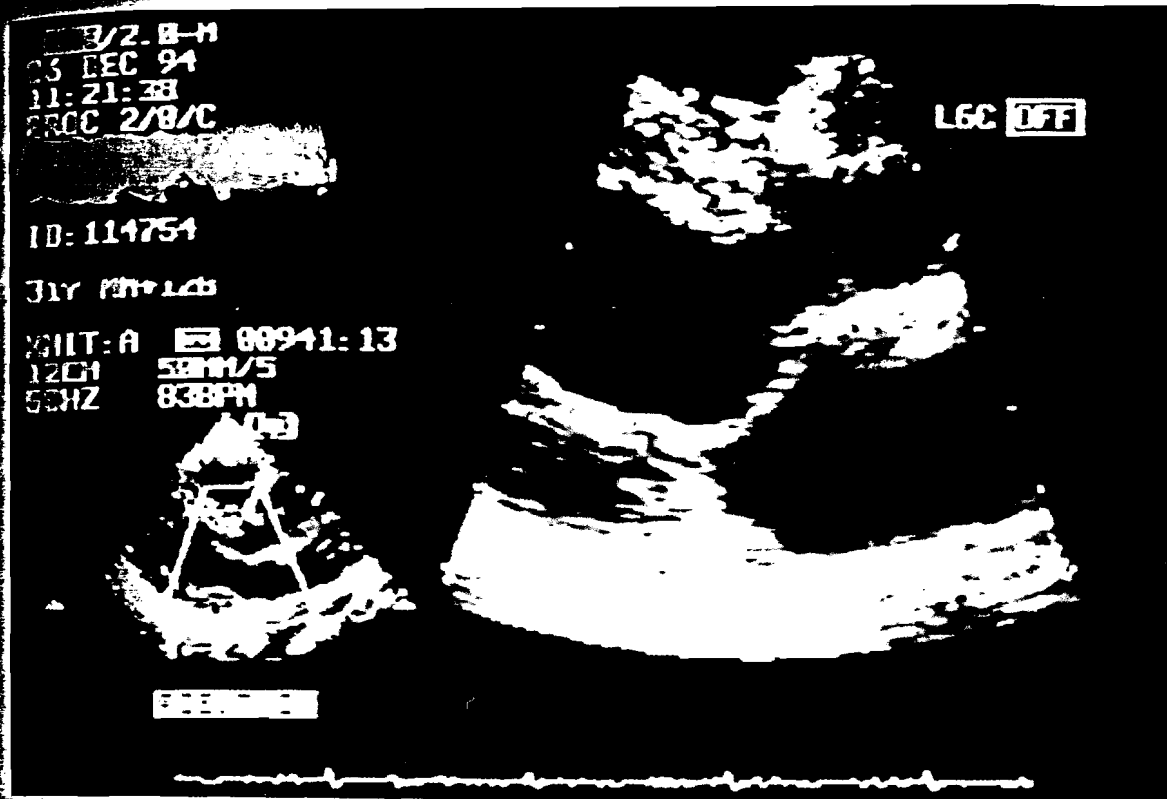


Figure 4A. Long axis view showing mitral valve prolapse of the anterior mitral leaflet.

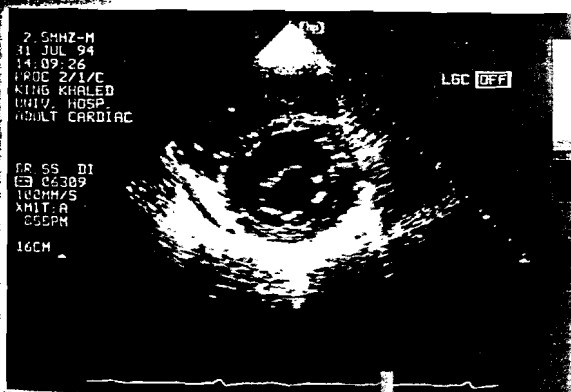


Figure 4B Short-axis view showing Helmet sign of mitral valve indicating bowing of the anterior mitral leaflet into the left atrium (diagnostic criterion of mitral valve prolapse).

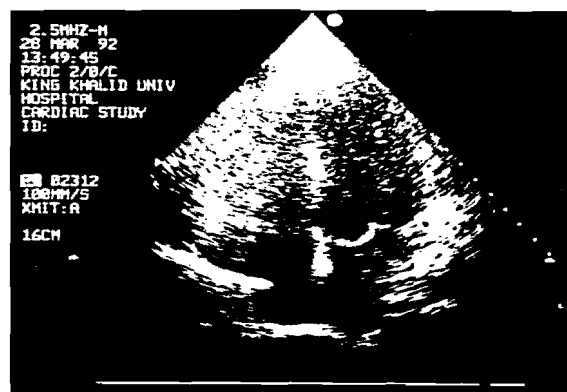


Figure 4C. Four chamber view showing mitral valve prolapse of the anterior mitral leaflet.

other non-invasive techniques such as Holter Monitoring and Sealer Electrocardiogram assesses cardiac changes during pregnancy. As echocardiography is a sensitive technique for identifying pericardial effusion and has become the tool for diagnosing and evaluating effusion.^{3,9} This

study confirms previous reports that pericardial effusion may occur in late stages of normal pregnancy.^{10,11}

Our observation of complete resolution of pericardial effusion in the studied cases has been confirmed by previous studies by Enein et al.¹⁰ and

Haiat et al.¹¹ where complete resolution of the effusion occurred within two months after delivery.

It was noted that small pericardial effusions necessitated careful scanning and the use of multiple echo views to determine the position of best view of echo-free space area. Although the mechanism leading to the development of pericardial effusion is still obscure, the high incidence in the previous reports^{10, 11} is due in part to the ability of echocardiogram to detect small amounts of fluids that may go unrecognized by other techniques. As the effusion develops gradually, it is likely that this is a result of excessive salt and water retention occurring pregnancy.⁷ Shabetai et al., pointed out the importance of pericardium in lymph drainage of myocardium and ventricular hemodynamic as pericardial effusion might be the result of a transient alteration of this function during pregnancy.⁹

Our studied cases with pericardial effusion had normal left ventricular systolic function and this ruled out prenatal cardiomyopathy as well as congestive cardiac failure as a cause of pericardial effusion. Enein et al. pointed out the importance of careful assessment of left ventricular systolic function by cross-sectional echocardiography to rule out possible causes of pericardial effusion.¹⁰

Our study demonstrated an increase in the prevalence of physiological regurgitation especially in the tricuspid and mitral valves. These observations confirmed the occurrence of multivalvular involvement by physiological regurgitation induced by pregnancy.

It was also noted that after eight weeks post-partum, mitral regurgitation was not detected while on tricuspid valve examination, insufficiency was noted in 27 cases and disappeared in four only cases. Campos et al. concluded from their study that pregnancy must be considered as an important factor that may affect the behavior of physiological valvular insufficiency in a young pregnant women.¹ Whereas Limacher et al. stated that multi valvular regurgitation occurs frequently in pregnancy and seems to be related to chamber and valvular annuli dilatation, they described it to be benign and may account for many murmurs heard during human gestation.¹²

Rhythm disturbances are not uncommon during pregnancy. Our studied group of pregnant women showed premature atrial and ventricular beats, which were described by Hong and Bhandari as being of little clinical significance.¹³ Mitral valve prolapse

(MVP) is one of the most common abnormalities resulting from the variety of congenital and acquired mechanisms. Savage et al.¹⁴ and Noah et al.¹⁵ stated that women predominate in MVP cases and the diagnosis is frequently made in young women of childbearing age. In our studied group, we followed the guidelines stated by Kisslo for the diagnosis of mitral valve prolapse,¹⁶ where 23 cases showed standard echocardiographic criteria of MVP, which was not detected in eight cases in the second half of pregnancy.

This was explained by Lutas et al.¹⁷ Sullivan et al.¹⁸ and Tank et al.¹⁹ They related MVP disappearance to the increase in left atrial and ventricular volumes during gestational period as sufficient increases may eliminate or decrease echocardiographic evidence of MVP.¹⁷⁻¹⁹

Conclusion

Color Doppler echocardiography and other non-invasive modalities for maternal cardiac evaluation during normal pregnancy present an objective and comprehensive tools which can be repeated with complete safety for the mother and the fetus. It has to be noted that the development of safe and exact non-invasive techniques has markedly improved the diagnostic potential of heart disease during pregnancy.

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