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**PHYSIOLOGICAL ADAPTATIONS OF THE FEMALE TO PREGNANCY**

Pregnancy is a unique period in a woman's lifetime. A number of

anatomic, physiologic, biochemical and psychological changes take

place. These changes may easily be misinterpreted by physicians

who lack experience in regards to pregnancy effects on a woman's

body. It is important that physicians caring for women

understand the implications of these physiological changes in

order to avoid any diagnostic errors and errors of management .

**SKIN CHANGES**

A number of changes take place in the skin of pregnant women.

Mechanical stretching of the skin over the abdomen and breasts

can lead to striae. The increased levels of estrogen and

progesterone have also been implicated. Usually striae remain

permanently with some change in color. Prevention may be

achieved with moisturizing creams, especially those containing

lanolin and other oily substances. It should be realized,

however, that striae may develop despite any preventative

measures.

**CHANGES IN THE GASTROINTESTINAL SYSTEM**

Nausea and vomiting are the most frequent complaints involving

the gastrointestinal system and usually happen in early pregnancy

while heartburn happen primarily in late pregnancy. The gums

become hyperemic and edematous during pregnancy and tend to

bleed. The muscular wall of the esophagus is relaxed and this

may cause reflux, which in turn can lead to esophagitis and

heartburn. The stomach and the intestines have decreased

motility presumably due to the effect of progesterone on smooth

muscle contractility. This causes an increase in the time that

it takes for the stomach to empty. Reduced gastric secretion has

also been documented and it could account for the improvement of

peptic ulcers sometimes observed in pregnancy. Decreased

motility of the large intestine may lead to constipation.

The liver is affected significantly by pregnancy. Cholestatic

jaundice is considered to be the result of estrogen effect on

elimination of bilirubin by the liver. The effect of estrogens

also, is to increase protein synthesis in the liver, which leads

to increased production of fibrinogen and binding proteins.

**CARDIOVASCULAR CHANGES**

Of all changes that happen in pregnancy, the single most

important is the one involving the cardiovascular system.

Adequate cardiovascular adaptation secures good placental

development and thus appropriate fetal growth.

In brief, the cardiovascular changes involve a substantial change

in the blood volume, cardiac output, heart rate, systemic

arterial blood pressure, systemic vascular resistance, oxygen

consumption and alterations in regional blood flow of various

organ systems.

Blood Volume

Significant increases in the blood volume start taking place in

the first trimester and continue until the mid third trimester,

at approximately the 32nd to the 34th week. Beyond this point in

gestation, the blood volume plateaus. This pattern was

established with studies that kept the patients in the left-

lateral position to avoid vena cava compression. However,

studies that kept the patient in the supine position had

controversial results indicating a decline in the blood volume

after 34 to 36 weeks. The average absolute increase in blood

volume during pregnancy is about 1600 ml and in terms of percent

change one should expect a 40 to 50 percent increase above pre-

pregnancy levels. The increase in the blood volume is achieved

by a combination of increases in the plasma volume and the RBC

mass. The calculated plasma volume expansion is approximately

1300 ml and the volume of the RBC increases about 400 ml. This

discordance in the change between the cellular elements of the

blood and the liquid portion leads to the so called "physiologic

anemia of pregnancy". The mechanisms leading to hypervolemia in

pregnancy are still not entirely understood and seem to be

multifactorial. Increased estrogen levels in pregnancy cause

increased production of renin from the kidneys, the uterus and

the liver and thus cause elevated renin plasma levels.

**Cardiac Output**

Cardiac output is a product of stroke volume and pulse rate. The

rise in cardiac output early in pregnancy is disproportionately

greater than the increase in heart rate, and therefore is

attributable to augmentation in stroke volume. As pregnancy

advances, heart rate increases and becomes a more predominant

factor in increasing cardiac output. At the late stages of

pregnancy, the stroke volume declines to normal, non-pregnant

values.

**Heart Rate During Normal Pregnancy**

The baseline heart rate increases by about 10 to 20 beats per

minute. This increase starts early in pregnancy and gradually

continues to go upward with the highest values achieved at term.

Some investigators, however, suggested that the total increase

happens early in pregnancy and remains so throughout the

remainder of gestation.

In twin gestations, the rise of the heart rate is more pronounced

and it can reach as much as 40 percent above the non-pregnant

state. A change also from the supine position to the lateral

position may cause the heart rate to drop slightly.

**The Heart**

A number of changes happen to the heart and are unique to

pregnancy. Increasing intra-abdominal contents displace the

heart upward with some forward rotation. As a result the

anterior posterior diameter and the cardiothoracic ratio are

increased. The overall dimensions of the heart are increased

during pregnancy as a result of increased diastolic heart volume

without any change in the ventricular wall thickness

Blood Flow Changes in Various Organ Systems During Pregnancy

The most profound changes in regional blood flow occur in the

uterus with a 5 to 10 fold increase. This change starts early in

pregnancy and continues until almost term. Approximately 20% of

the maternal cardiac output perfuses the uterine vessels

(placental and nonplacental). The kidneys also demonstrate

substantial increase of the regional blood flow as much as 30 to

80 percent and at the same time a 50 percent increase in

glomerular filtration rate is noted. The regional blood flow in

the extremities also increases and more so in the hands than the

legs. As it was mentioned previously, there is a significant

dilatation in the skin vessels which leads to an increase in the

regional blood flow. These changes in the skin vessels may cause

warm skin, clammy hands, vascular spiders, and palm erythema.

The liver circulation is not affected very much and the same is

true for the brain blood flow which is autoregulated. The blood

flow to the breast is increased during pregnancy to prepare the

breast for lactation. The effect of pregnancy on coronary blood

flow is still unknown. It is safe, however, to speculate that an

increase may happen since augmentation of cardiac function is

present during pregnancy.