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Assignment

Elucidate the 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.

Some physiological adaptations of women to pregnancy are:

* Skin changes
* Changes in the gastrointestinal system
* Cardiovascular changes
* Blood volume
* Cardiac output
* Heart rate during normal pregnancy
* The heart
* Blood pressure
* Systemic vascular resistance
* Blood flow changes in various organ system during pregnancy
* Cardiocirculatory changes during labor and delivery
* Hemodynamic changes in the postpartum period

**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 preventive measures.

Vascular spider nevi and Palmer erythema happen also during pregnancy. There is no clear explanation for these changes, but they most likely represent the result of vasodilation that happens in the skin during pregnancy. Chloasma and other pigmented lesions can happen as a result of increased melanocyte – stimulating hormone activity which in turn is a result of increased estrogen and progesterone levels. These lesions usually begin at about five to six months gestation. One way that these lesions may be prevented is by use of screening agents and avoidance of direct sunlight – skin pruritus affects a number of women and it may be related to increased retention of bike salts in the skin secondary to estrogen effects – scratching of the skin can then lead to infected excoriations. Local measures with anti-pruritic creams and lotions usually are sufficient.

**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 any 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 of estrogens also, is increase protein synthesis in the liver, which leads to increased production of fibrinogen and binding proteins. The liver enzymes are usually unaffected with the exception of alkaline phosphatase, which is increased at approximately two fold to four fold that is a result of a placental production. Pregnancy increases the size and decreases the motility of the gall bladder. The decreasing motility and increase in volume, combined with changes in the bile's composition, explain the correlation between the incidence of cholelithiasis and pregnancy.

**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.

**Blood volume:**

Significant increases in the blood volume starts 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 1600ml 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 1300ml and the volume of the RBC increases about 400ml. This discordance I’m 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. The increase in renin, which stimulates aldosterone secretion, is associated with sodium retention and an increase in total body water.

The increase in blood volume with pregnancy appears to serve the essential physiologic needs of both the mother and fetus. It ensures adequate supplies required for normal fetal growth and oxygenation even under circumstances that affect the maternal cardiac output ( inferior vena cava compression ). This increased blood volume also helps normal pregnant women to withstand hemorrhage equal to the volume of blood added to the circulation during the course of the normal pregnancy without any signs of decompensation.

**Cardiac output:**

It has been well established since the beginning of this century that the cardiac output increases an average of 50 percent during pregnancy. It is generally accepted that cardiac output begins to rise during the first trimester, probably around the tenth week of pregnancy and continues to rise until the 24th week of gestation. Once it reaches the peak, it stays rather stable.

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. The effect of maternal posture on cardiac output was demonstrated by a number of studies. A significant decrease (25 to 30 percent) in cardiac output, measured by dye dilution technique, was demonstrated in the supine position between the 38th and 40th weeks of pregnancy but not before the 24th week. These findings were confirmed recently by echocardiographic studies.

**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 from the supine position to the lateral position may cause the heart rate to begin 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 rate are increased during pregnancy as a result of increased diastolic heart volume without any change in the ventricular wall thickness.

**Blood pressure:**

A slight decrease in the systolic arterial blood pressure and a significant decrease in the diastolic pressure have been observed to occur in normal pregnancy. This decrease becomes evident in the late first trimester and continues throughout most of the second trimester. The lowest values are noted in mid pregnancy and thereafter the blood pressure returns toward non-pregnant levels before term. The degree of change in the blood pressure parameters has been found to be affected by parity, smoking, pre-existing hypertension, maternal age and ethnic background.

In the typical normal pregnancy, the mean arterial pressure (diastolic plus 1/3 of the difference between systolic and diastolic) is less than 85mm of mercury. Studies have found that when the mean arterial blood pressure in the mid second trimester is higher than 90mm of mercury, there is increased perinatal mortality and morbidity.

**Systemic vascular resistance:**

Normal pregnancy is associated with a significant fall in systemic vascular resistance. As a result, the diastolic blood pressure drops as well as the systolic. However, the diastolic blood pressure drops more than the systolic leading to a widening of the pulse pressure. The mechanism for this change is not entirely clear. It has been speculated, however, that a significant portion of this decline is caused by the development of a low resistance circulation in the pregnant uterus. Estrogens, prolactin, circulating postaglandins PGE2 and PGI2 may be responsible for the vasolilation that can cause a drop in the peripheral resistance. In addition, the profound dilation of the skin vessels as a result of the increased maternal body heat dissipation may contribute to the drop in the systemic vascular resistance.

**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 28% of the maternal cardiac output perfuses the uterine vessels (placental and non placental). 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 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.

**Cardiocirculatory changes during labor and delivery:**

During labor, significant hemodynamic changes take place. These changes can in part be explained by the effect of the uterine contractions, which may cause a significant increase of 300 – 500ml in central blood volume, and in part by the effect of pain and anxiety on the cardiovascular system. It is important to note here that in the lateral position, cardiac output between contractions is higher than in the supine position and the increase during contractions is smaller.

The effect of uterine contractions during labor on the heart rate is variable. Some investigators have reported an increase in the heart rate and others have reported a decline in the heart rate.

The difference may have to do with different position of the patient during the labor process and certainly different hemodynamic changes that can lead to the variability in the heart rate. Significant variations of individual heart rate responses to uterine contractions may also play a role.

During labor (uterine contractions), both the systolic and diastolic blood pressures increase. The elevation of the blood pressure can be as high as 35mmHg in the systolic component and as high as 25mmHg in the diastolic component. As the labor process advances and the patient enters the second stage, an increase in the diastolic blood pressure as high as 65mmHg above the baseline can be observed. It is believed that since the peripheral resistance does not change or it changes only slightly during labor, the increase in blood pressure is attributed to the rise in cardiac output. Redistribution of maternal cardiac output to the upper part of the peripheral circulation after compression of the distal aorta and the common iliac artery has also been suggested to play a role in the elevation of systemic pressures as measured in the arm. These hemodynamic changes are less pronounced in lateral recumbency than in the supine position.

The hemodynamic changes during labor are influenced to a great extent by the form of anesthesia or analgesic employed. The above – mentioned changes in the cardiac output and blood pressure do not happen on patients with caudal anesthesia. The progressive rise in the heart rate and the blood pressure that is normally observed is abolished on these patients and the stroke volume is also maintained throughout labor but rises rapidly after delivery.

In patients who undergo cesarean section, maternal hemodynamics can be significantly affected by anesthesia. A patient with heart disease may not tolerate the marked fluctuations with subarachnoid block anesthesia. Balanced anesthesia with thiopental, nitrous oxide, succinylcholine and epidural anesthesia without epinephrine are associated with smaller hemodynamic fluctuations and therefore should be preferred in patients with limited cardiac reserves.

**Hemodynamic changes in the postpartum period:**

In the postpartum period the blood volume decreases by about 10 percent on the patients who undergo vaginal delivery and 15 to 30 percent for those who undergo cesarean section. The cardiac output increases by 60 to 80 percent immediately after delivery and it rapidly decreases to a level slightly above the non-pregnant value. Complete return to normal non-pregnant values will take sometimes a few weeks. The stroke volume increases also significantly and the heart rate drops by 4 to 17 beats per minute shortly after delivery. Blood pressure is usually unchanged unless excessive blood loss has taken place in which case the blood pressure will drop or in other medical complications. The peripheral vascular resistance according to some investigators is increased and according to others is unchanged.