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QUESTION

Elucidate the physiological adaptation of the female to pregnancy

ANSWER

The physiological adaptations during [pregnancy](https://en.wikipedia.org/wiki/Pregnancy) that a woman's body undergoes to accommodate the growing [embryo](https://en.wikipedia.org/wiki/Embryo) or [fetus](https://en.wikipedia.org/wiki/Fetus). This are as follows

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.

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.

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. The cardiovascular changes are as follows;

* 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. 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 % 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". 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.
* 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 up 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 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. Systolic ejection murmurs are common in pregnancy while diastolic murmurs are less frequent. The systolic murmurs are usually the result of the hyperdynamic circulation. Electrocardiogram changes have been reported during pregnancy. Transient ST and T changes are common in pregnancy, SRQ waves and inverted T waves in lead III. Left access deviation of the QRS complex has been reported also in pregnancy.

* 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 there after 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, preexisting 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 85 mm of mercury. When the mean arterial blood pressure in the mid second trimester is higher than 90 mm 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.

RENAL PHYSIOLOGICAL CHANGES

The changes in renal function during pregnancy are profound and are surpassed only by those of the cardiovascular system. Major anatomic as well as functional changes are apparent as shown in the following

Anatomic Changes

The kidney size increases only slightly during normal pregnancy. However, the more striking in structural changes are those of the ureters, calyces, and renal pelvis. These changes are readily seen as early as the third month of gestation and remain until approximately the fourth month postpartum. Since these changes appear long before the gravid uterus is large enough to cause mechanical compression of the ureters, a hormonal effect is postulated.

Functional Changes

Of all functional renal changes that accompany pregnancy, the most striking is that of glomerular filtration rate. It begin to change early in the second trimester of pregnancy.

The factors responsible for these changes remain conjectural, but the following have been suggested;

1. The growth hormone-like effect of the hormone human placental lactogen.

2. The increased production and plasma concentration of free cortisol.

3. The increase in blood volume.

4. The hemodilution and hydremia resulting in decreased colloid osmotic pressure.

Regardless of etiology, these functional alterations force us to redefine normal values of renal function during pregnancy. The normal serum creatinine in pregnancy drops to 0.46 mg% as compared with the no pregnant value of 0.67 mg%. The BUN decreases to 8.2 mg% from a non-pregnant value of 13 mg%. Uric acid also declines to a value of 3.1 mg% from approximately 4.5 mg%. The upper-normal uric acid level in pregnancy is 5 mg% and levels higher than that should raise suspicion of preeclampsia. Creatinine clearance values increase to 150 - 200 ml/min as compared with values of 65 to 145 ml/min in the non-pregnant patient.

CHANGES IN THE REPRODUCTIVE SYSTEM

Rhythmic tightening of the uterus occur as part of preparatory changes for labor. These are called Braxton-Hicks contractions and since the advent of ultrasound, can be seen as early as eight to nine weeks. As the pregnancy advances these contractions become more frequent and they are more likely to be felt by the patient. Usually they happen every 5 to 20 minutes and sometimes they may last as long as 30 minutes. The genital organs undergo significant changes with increased vascularity of the cervix and increased mucous formation by the cervical glands due to increased levels of estrogen. Many patients experience perinea pressure pain, which may be secondary to vascular engorgement of tissues due to estrogen and stasis of blood and to pressure from fetal presenting parts. Pubic pain is also noted and may be secondary to increased joint motility that happens secondary to progesterone's relaxing effect on the pubic symphysis cartilage. Many women experience pain in the region of the round ligament, which is secondary to stretching as the uterus grows.

MUSCULAR SKELETAL AND NEUROLOGIC SYMPTOMS

A number of women may experience backache in the upper back, which is secondary to muscle tension from increasing breast size and discomfort. Most women, however, experience low back pain secondary to muscular fatigue and strain that is caused by the changes in body balance from the growing uterus. Several patients also may experience pressure on nerve roots that in turn may lead to muscular spasms and pelvic joined pains secondary to bone ligament relaxation from the sex hormones. The changes that happen on the ligaments and the cartilage of the pelvic bones secondary to the sex hormones may also lead some women to present with gait alterations. Finally, a number of women may experience paresthesia (numbness and tingling of fingers and toes). A number of theories are suggested for the explanation of these symptoms. The fingers and upper extremities are effected if lordotic posture is extreme; the head and neck are flexed, putting strain on the brachial nerves and causing tingling of hands and arms. Toes and lower extremities are affected if gravid uterus presses on femoral veins and nerves supplying lower extremities, thus interfering with circulation and causing paresthesia. Edema may cause pressure and tingling of hands or feet, especially in hands when rising in the morning. Sometimes excessive edema of the hands may lead to carpal tunnel syndrome. Finally, Vitamin B deficiency, hypoglycemia and hyperventilate have been suggested as causes of these symptoms.