DOI: https://doi.org/10.36811/ijrmsh.2019.110006 **IJRMSH: October-2019: Page No: 45-51**

International Journal of Reproductive Medicine and Sexual Health

Research Article **Open Access**

The Physiological Changes During Pregnancy

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***Received Date:** Sep 30, 2019 / **Accepted Date:** Oct 07, 2019/ **Published Date:** Oct 09, 2019*

Abstract

Every adult woman is responsible for their body, and the decisions they make have an impact on their life and their health. However, there are times in life, pregnancy, when a person is deeply responsible for a new life in development. Safe signs of pregnancy are the presence of a fetus seen by ultrasound, listening to heart tones, touching parts of the fetal body and the presence of pregnancy hormones in the urine. After fertilization, measurable concentrations of hCG begin to emerge in the body after 7-10 days, which can be evidenced from the urine or blood of the woman. The immunological tests used today are mostly based on the use of latex particles. The presence of Human chorionic gonadotropin, the polypeptide beta subunit of which is used to prove pregnancy (abbreviated b-hCG) at a concentration of 25 mIU in the urine of a woman, equivalent to a period between the fourth and fifth weeks of pregnancy, can be demonstrated. A planned pregnancy presupposes a series of procedures that will contribute to the proper and complete development of the embryo. Each stage of pregnancy brings certain biological changes in the body of the woman. Pregnancy should last a minimum of 37 weeks, but it can take up to 42 weeks.

Keywords: Menstruation; Oocytes; Ovary

Cite this article as: Siniša Franjić. 2019. The Physiological Changes During Pregnancy. Int J Reprod Med Sex Health. 1: 45-51.

Introduction

The uterus undergoes spectacular growth during pregnancy, increasing in weight 20-fold from two ounces to two pounds and increasing from 10 milliliters to between 2 and 10 liters [1]. Growth of the uterine muscle is concentrated in the upper part or fundus of the uterus, which prepares for the downward pressure on the fetus during labor. The uterus rises in the pelvis and rotates to the right after the twelfth week of pregnancy, while maintaining a longitudinal lie relative to the pelvic axis. The wall of the abdomen supports the uterus. Hormonal changes induce a relaxation of the joints, which helps the body manage the shifting center of gravity as the uterus grows. The uterus will tip towards the spine if the woman lies on her back, which compresses the vena cava and aorta. This decreases blood flow to the brain and uterus, inducing supine hypotensive syndrome.

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Blood flow increases to the cervix and vagina. The cervix extrudes a thick mucus that fills the cervical canal and serves as a barrier to infection (often called the mucus plug). The vaginal canal becomes increasingly acidic, which also has an antimicrobial function. In response to the secretion of progesterone, prolactin and adrenal steroids, the breasts change in size, sensitivity and structure in preparation for lactation. Colostrum production begins in the second half of pregnancy.

There are major changes in the cardiovascular system that have vital consequences for maternal health. The heart increases in size, rate and output; cardiac output will increase 40 percent to 60 percent over the non-pregnant state. Blood volume increases, including a 50 percent increase in plasma and 15-20 percent increase in red cell volume. Production of red ceils accelerates. Systolic and diastolic pressure decrease slightly during the first half of pregnancy and then rise to pre-pregnancy levels. Peripheral circulatory resistance decreases. Blood flow to the uterus increases markedly. Anemia, hypertension and hypotension serve to decrease blood flow to the uterus.

Respiration is deeper during pregnancy as women take in more oxygen to accommodate the needs of the fetus. The lower ribsflare to accommodate the diaphragm, which rises as the uterus grows. Kidney function changes to filter the increase in maternal blood volume and fetal waste. The bladder is pushed upwards and forwards. Decreased blood flow and swelling of the bladder render it more susceptible to injury and infection. Fluid retention increases, with characteristic swelling of the ankles and fingers. This normal pregnancy induced edema must be distinguished from swelling of the face and arms that signals pre-eclampsia.

Major changes in hormone production accompany pregnancy. There is a very large increase in the secretion of estrogen and progesterone, which accomplishes a wide range of essential functions, including uterine growth and maintenance, preparing the breasts for lactation, relaxation of smooth muscle and stimulation of the respiratory system. The placenta secretes the proteinhormones HCG, which is critical to estrogen production and sex differentiation in the fetus, and HPL, which helps regulate the availability of nutrients for the fetus. Prostaglandins stimulate the cardiovascularchanges needed to sustain pregnancy. Thyroid hormone levels also change in response to the increased presence of estrogen.

Menstruation

The menstrual cycle is the result of an orchestra of hormones [2]. It involves the interaction of many endocrine glands as well as a responsive uterus. The menstrual cycle remains a complex process where many aspects are still not well understood. The key hormones that play a role in the control of the menstrual cycle include gonadotropin- releasing hormone (GnRH), follicle- stimulating hormone (FSH), luteinizing hormone (LH), estradiol, and progesterone. In addition to these key hormones, there are other peptide and non-peptide hormones that play a role in the menstrual cycle.

The menstrual cycle can be divided into three phases: proliferative (follicular), ovulation, and secretory (luteal). The menstrual cycle is also described based on its length (number of days between onset of menstrual bleeding in one cycle and the onset of bleeding of the next cycle). The median duration of a menstrual cycle is 28 days. Most individuals will describe a cycle length between 25 and 30 days. The variability in length of a menstrual cycle is based on the variable length of the follicular phase. The luteal phase is constant in most women and is 14 days in length. Polymenorrhea is described as menstrual cycles that occur at intervals less than 21 days. Conversely, oligomenorrhea is described as menstrual cycles that occur at intervals more than 35 days. During menstruation, blood loss is typically 30 mL, and amounts greater than 80 mL (menorrhagia) are considered abnormal.

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The proliferative phase begins at the onset of menses until ovulation takes place. Folliculogenesis takes place during this phase of the menstrual cycle. A dominant follicle is selected from a pool of growing follicles that will be destined to ovulate. The growth of follicles in this stage will depend on pituitary hormones such as FSH. The growth of the follicle also leads to production of estradiol from the layers of granulosa cells surrounding it. Estradiol is responsible for the proliferation of the endometrial lining of the uterus.

Ovulation happens at the peak of follicular growth in response to an LH surge. Prior to ovulation, follicles grow to sizes greater than 20 mm in average diameter. LH is then released in a positive-feedback manner from the anterior pituitary due to prolonged exposure to estradiol. For this positive feedback to take place, levels of estradiol above 200 pg/mL for approximately 50 h are necessary. Approximately 12 h after the LH peak, the oocyte is released. In order for the oocyte to release from the follicle, several proteolytic enzymes and prostaglandins are activated, leading to the digestion of the follicle wall collagen. Once an oocyte is released, the fallopian tube is responsible for picking it up where it will await fertilization.

The secretory phase starts after ovulation. During this phase, the remaining granulosa cells that are not released with the oocyte during the ovulation process enlarge and acquire lutein (carotenoids), which is yellow in color. These granulosa cells are now called the corpus luteum and predominantly secrete progesterone. Peak progesterone production is noted 1 week after ovulation takes place. Progesterone is required to convert the endometrial lining of the uterus from a proliferative one into a secretory endometrium in preparation for embryo implantation. The life span of the corpus luteum and, hence, progesterone production will depend on continued LH support from the anterior pituitary. If a pregnancy takes place, hCG (human chorionic gonadotropin) of pregnancy will maintain the corpus luteum. However, if a pregnancy fails to happen, luteolysis takes place and the corpus luteum is converted to a white scar called the corpus albicans. The loss of the corpus luteum and the subsequent loss of progesterone lead to the instability of the endometrium and the sloughing of the endometrium, signaling a new menstrual cycle.

Oocytes

During a women's reproductive life span only 300-400 of the nearly 1-2 million oocytes present in her ovaries at birth are ovulated [3]. The process of oogenesis begins with migratory primordial germ cells (PGCs). It results in the production of meiotically competent oocytes containing the correct genetic material, proteins, mRNA transcripts, and organelles that are necessary to create a viable embryo. This is a tightly controlled process involving not only ovarian paracrine factors but also signaling from gonadotropins secreted by the pituitary.

The contribution of the male to the biology of reproduction is to produce a genetically intact spermatozoa that will fertilize an oocyte. The end product of male gametogenesis, the mature spermatozoa, is designed for one purpose: to deliver the male contribution of the genetic makeup to the embryo. The biology of gamete production is different in males compared to females. Gamete production in females is intimately part of the endocrine responsibility of the ovary. If there are no gametes, then hormone production is drastically curtailed. Depletion of oocytes implies depletion of the major hormones of the ovary. In the male this is not the case. Androgen production will proceed normally without a single spermatozoa in the testes.

Ovary

The ovary, which contains the germ cells, is the main reproductive organ in the female [3]. It also functions as an endocrine organ, secreting estrogen and progesterone in response to gonadotropin and paracrine signaling. Ovaries exist as a pair of glands, approximately the size

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of almonds, on either side of the uterus. Within the abdominal cavity, ovaries are found closest to the lateral wall of the pelvis, attached to the back portion of the broad ligament of the uterus. This area is known as the ovarian fossa and is surrounded by the external iliac vessels, the umbilical artery, and the ureter.

The ovary comprises several different layers and types of tissues. The innermost layer is the medulla, which houses the blood vessels essential to supporting the ovary. To the outside of this is the ovarian cortex, which is made up of follicles and stromal tissue. The outermost layer of the ovary consists of a thin layer of epithelial cells. Known as the germinal epithelium, this layer produces thousands of primordial follicles during fetal growth. Underlying the germinal epithelium is a strong connective tissue layer known as the tunica albuginea (TA). Ovum production and oocyte maturation occur within the cortex of the ovary. As primordial follicles are recruited and develop, they move closer to the outer edge of the ovary, eventually bursting through the surface during ovulation.

The ovum, expelled from the follicle at ovulation, is surrounded by a thin layer of acellular material called the zona pellucida to which are attached clusters of granulosa cells from the follicle [4]. The layers of granulosa cells form a crownlike structure called the corona radiata. The ovary is positioned adjacent to the open funnellike end of the fallopian tube (the infundibulum). Projections from the infundibulum, termed fimbriae, guide the released ovum into the fallopian tube. The ovum is swept into and along the fallopian tube by the beating of the cilia covering the tubal epithelium and is propelled down the tube by the peristaltic contractions of the smooth muscle in the tubal wall. Fertilization is possible when intercourse occurs reasonably close to the time of ovulation. However, the likelihood of a successful conception is related primarily to the survival time of the ovum, about twelve to twenty-four hours, rather than the sperm, which can survive in the genital tract and fertilize an ovum for as long as six days. The likelihood of a successful conception increases as intercourse occurs closer to the time of ovulation, but no conceptions occur the day after ovulation because of the ova's short life. In many successful conceptions, the sperm were already "lying in wait" for the ovum in the fallopian tube. The sperm "waiting" in the fallopian tube undergo a process called capacitation, which is mediated by tubal secretions. During this process the surface properties of the sperm are altered, and components of semen adhering to the sperm surface are removed. Only capacitated sperm are active in fertilization. The ovum spends four days in the fallopian tube moving toward the upper third of the tube where fertilization usually occurs by waiting capacitated sperm. After fertilization, the ovum moves into the uterus, implants, and develops further. If the ovum is not fertilized, it degenerates in the uterus.

The ovaries host oocytes and produce sex hormones [5]. In the young woman, the ovary is an oval-shaped glandular body, pinkish white in color, measuring about 3-4 cm long, 1.5-2 cm wide, and 1-1.5 cm thick. Before puberty, the surface of the ovary is smooth and homogeneous: However, with age, repeated ovulations make it increasingly rough and irregular. The ovary has two surfaces, medial and lateral; two borders, mesovarian and free; and two extremities, uterine and tubal.

Changes in ovarian function, dominated by the gradual decline of both oocyt quantity and quality, are major contributors to the reproductive aging process [6]. The latter becomes apparent both in increasing rates of infertility observed at older age as well as increased aneuploidy rates, responsible for a higher risk of miscarriage and trisomic births with increasing age.

The size of a woman's follicle and oocyte stock is already determined during early stages of fetal development. At birth, this primordial follicle pool consists of around 1-2 million oocytes. Due to a continuous process of apoptosis, follicle numbers are reduced to

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approximately 300,000–400,000 at menarche. When follicle numbers fall below a critical threshold of a few thousand, the perimenopausal transition commences, which is characterized by overt cycle irregularity and altered cycle length. Finally, prolonged menstrual cycles proceed to cycle arrest, a milestone referred to as menopause, which coincides with a near absence of primordial follicles in the ovaries.

The normal process of ovarian aging varies considerably among women, with peak fertility in the mid- to late 20s. The profound age-related decline in female fecundity, however, remains largely unnoticed until clinical signs of the perimenopausal transition are present. The loss of the capacity to create an ongoing pregnancy leading to a live birth is accompanied by an increase in early follicular folliclestimulating hormone (FSH) levels, which cannot be easily recognized by an individual. The onset of the menopausal transition, expressed by lengthened cycles due to deficiency of antral follicles capable of growing into dominance, is usually a woman's first notification of advanced ovarian aging.

Changes

Sexual development involves a complex series of events that, if orchestrated in an appropriate sequence, results in the normal transition from childhood to young adulthood [7]. Although from an evolutionary perspective, the ultimate goal is propagation of a species, this pivotal time in the life of an adolescent often represents one of physical and emotional challenges, potentially heightened even when subtle variances to societal norms occur. Written for an overview of the subject, this segment will detail how pubertal development has been categorized and the neuro-physiological changes that ensue. The focus will then shift towards processes that result in precocious (central and GnRH-independent causes) and delayed development, highlighting more common etiologies and disease states. How and when to evaluate abnormal presentations of development and how to ideally treat them is discussed. This period of change allows for a pivotal entry point towards establishing longitudinal care with the clinician. However, a thorough understanding of the appropriate timing of events and an awareness of the stressors that frequently complement these changes is then essential for a wide range of specialists who can bring a unique perspective when caring for such young patients when normal puberty drifts awry.

The menstrual cycle begins with the first day of menstruation but follicular growth is initiated during the last few days of the luteal phase of the preceding menstrual cycle [8]. Near the end of the previous luteal phase, plasma progesterone, estrogen and inhibin A levels decline because of the demise of the corpus luteum, and a rise of FSH occurs (days 1-4). FSH initiates the recruitment of a follicular cohort (of antral follicles). These follicles start developing and secreting steroid hormones as well as acquiring FSH and LH receptors. From the middle of the follicular phase onward, estrogen levels rise steadily, leading to an estradiol surge. In parallel with this increase, there is an increase in the levels of 17-α-hydroxyprogesterone, testosterone, androstenedione and inhibin. FSH levels begin to decline because of the negative feedback of estrogens and particularly inhibin B secreted by the developing follicle. In response to the decline of the FSH, the development of adjacent follicles is inhibited (days 5-7). This leads to the preovulatory phase (days 8-12) during which FSH starts rising again. At the end of that phase LH surges, triggering ovulation. After the surge, LH, FSH and estradiol levels fall precipitously and progesterone and inhibin A levels start to rise. The first half of the cycle is complete. The length of the follicular phase varies and depends on the rate of maturation of the principal preantral follicle(s).

Reproduction

At its most basic biological level, sexual reproduction means that a new individual organism is a mix of the genetic variations from two parent organisms [9]. In humans that means

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that (about) half of one's genome comes from the mother and (about) half from the father. This seems deeply natural to us, but it is a minority approach in the biological world.

The world of living things is now divided into the "domains" of bacteria, archaea, and eukarya. Bacteria and archaea are lumped together as prokaryotes. When we think of living things, we tend to think of our fellow mammals, with, perhaps, a few birds, reptiles, fish, and (maybe) amphibians. Those animals, the other main branches of the vertebrate subphylum, (almost) all reproduce sexually. So do most, but not all, other eukaryotes. But although most eukaryotes reproduce sexually, the vast majority of living organisms— and living species—on this planet do not use sex at all. All bacteria, all archaebacteria, and a significant number of eukaryotes reproduce by cloning. Each off spring has exactly the same set of genetic variations, the same DNA sequence, as its parent. When a microbe reproduces, it normally splits into two copies, each genetically identical to its parent. (Some bacteria do engage occasionally in something called "conjugation" that is vaguely like sex, but it is not an even split of the daughter organism's genetic variations and is not limited to genetic exchanges within the same species).

Pregnancy

Pregnancy is central to human life and sexual health, whether or not it is a first-hand experience [10]. Like other reproductive experiences, pregnancy has psychological and cultural meaning, and it occurs within the context of particular social and material circumstances. A pregnancy may be longed for, planned and wanted, unplanned and accepted or unplanned and unwanted. It may be undertaken joyfully as an active choice or result from physical or social coercion. It may end in the birth of one or more children, or prematurely, through miscarriage or induced abortion. It can be a joyful experience, a great adventure, a traumatic and nerve-wracking roller coaster or an unmitigated personal disaster.

Pregnancy is usually a happy time, associated with considerable physical, social and psychological changes. Serious health problems, such as hypertension and pre-eclampsia, toxaemia, gestational diabetes or obstetric cholestasis, can occur but they are relatively uncommon. Nonetheless, in industrialised cultures the most common view is that pregnancy and childbirth are biological and medical events, or potentially problematic 'health states'. In other words, pregnancy has been medicalised. The implication of this view for women is that they are assigned simultaneously passive and active roles. They are passive containers for their growing babies, but they are expected to actively monitor their own health and behaviour and to ensure their child's future health. The implication of this view for psychological research is a tendency to focus on the problems that can occur, rather than on pregnancy as a developmental transition or biopsychosocial process. Descriptions of psychological well-being during pregnancy need to be considered with this in mind.

Abortion

Abortion has always been a debated topic within society and at the heart of the debate lies the issues of competing rights, those of the pregnant woman and those of the unborn child [11]. Some members of society believe that abortion amounts to the murder of the unborn child whilst others consider that abortion is the right of women and it is her alone who should make the decision regarding her pregnancy. Abortion is the termination of a pregnancy which may have been unplanned resulting from contraception failure or as the result of unprotected sexual intercourse. Occasionally, abortion is requested after a planned pregnancy but where the circumstances have changed dramatically for the woman, making the continuation of the pregnancy very diffi cult for her and her existing family.

Abortion is also available to women who discover that their unborn child is suffering from severe abnormalities. In such cases, the

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pregnancy may be beyond 24 weeks and this can be very distressing for all concerned. Such cases are generally cared for within the midwifery services and will not be addressed here. Women with a wanted and planned pregnancy who are having their pregnancy terminated because of foetal abnormality should not be cared for with women who are seeking an abortion because of an unintended/unplanned pregnancy.

Conclusion

During and after pregnancy, the body of a woman undergoes major changes - physical and mental. This can result in great concern, indecision or some other emotion. At that time, people from her vicinity should have an understanding for new mother and help her get through the period.

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