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NURSING

PHYSIOLOGY

ASSIGNMENT

IMPLANTATION

The term "implantation" is used to describe process of attachment and invasion of the uterus endometrium by the blastocyst (conceptus) in placental animals. Implantation is the time when the fertilized egg successfully attaches and implants into the lining of the uterine wall. Although the egg may have been fertilized over a week before, it's only after implantation that your body starts producing hCG—human chorionic gonadotropin, also known as the hormone that's picked up by pregnancy test. In humans, this process begins at the end of week 1, with most successful human pregnancies the conceptus implants 8 to 10 days after ovulation, and early pregnancy loss increases with later implantation. The implantation process continues through the second week of development. The initial phase of the implantation process is "adplantation". This first phase requires the newly hatched blastocyst to loosely adhere to the endometrial epithelium, often "rolling" to the eventual site of implantation where it is firmly adhered. This process requires both

the blastocyst adhesion interaction with the endometrium during the "receptive window". Subsequent development of the placenta allows maternal support of embryonic and fetal development. If implantation has not proceeded sufficiently during the menstrual cycle to allow hormonal feedback to the ovary, then the next cycle may commence leading to conceptus loss. There is also evidence, from animal models, that a conceptus with major genetic does not develop or implant correctly leading to their loss during the first and second weeks of development.

Implantation, in reproduction physiology, the adherence of a fertilized egg to a surface in the reproductive tract, usually to the uterine wall (see uterus), so that the egg may have a suitable environment for growth and development into a new offspring. Fertilization of the egg usually occurs after the egg has left the ovary and is being transported through the fallopian tubes. Male sperm cells deposited in the female reproductive tract travel up to the fallopian tubes to unite with the egg. Once fertilized, the egg begins to undergo a series of cell divisions. The egg takes up to seven days to reach the uterus; by this time the single-celled egg has divided numerous times, so that it is a ball of approximately 200 cells.

The uterus has thick walls suitable for egg attachment and growth. A female hormone known as progesterone, secreted by the corpus luteum in the ovary, influences the readiness of the uterine wall for egg implantation. It increases the blood supply in the wall, water content, and secretion of glycogen, a nutrient for the surrounding tissue and developing egg. If the uterus is not first prepared by progesterone, the egg will not attach itself. Progesterone also inhibits muscular contractions in the uterine wall that would tend to reject the adhering egg.

When the egg reaches the uterus, it usually remains free in the uterine cavity for about a day. It then attaches to the uterine lining (the endometrium). Cells in the outer surface of the egg grow rapidly once contact is made with the uterine wall. The egg disrupts the surface of the endometrium and actively burrows into the deeper tissue. By the 11th day after fertilization, the egg has completely embedded itself into the endometrium. The product of conception—first the fertilized egg and then the developing child and the placenta—normally remains implanted in the human uterus for nine months.

Process of implantation

Implantation is a process in which a developing embryo, moving as a blastocyst through a uterus, makes contact with the uterine wall and remains attached to it until birth. The lining of the uterus (endometrium) prepares for the developing blastocyst to attach to it via many internal changes. Without these changes implantation will not occur, and the embryo sloughs off during menstruation. Such implantation is unique to mammals, but not all mammals exhibit it. Furthermore, of those mammals that exhibit implantation, the process differs in many respects between those mammals in which the females have estrous cycles, and those mammals in which the females have menstrual cycles. Females in the different species of primates, including humans, have menstrual cycles, and thus similar processes of implantation. Before embryogenesis begins, the ovary releases an unfertilized egg cell, called an oocyte, which then travels down the fallopian tube. The egg is enveloped in an extracellular matrix called the zona pellucida. Sperm can fertilize the egg in the zona pellucida (ZP), which prevents the fertilized egg, called a zygote, from adhering to the wall of the fallopian tube. If the zygote implants in any area besides the uterus, the result is an ectopic pregnancy. This condition prevents the complete development of the embryo, and it can cause fatal hemorrhaging in the pregnant female.

As the zygote moves through the fallopian tube it undergoes several rounds of cell division, a process called cleavage. These cell divisions produce the inner cell mass (ICM), which will become the embryo, and the trophoblast, which surrounds the ICM and interacts with maternal tissues. Together, the ICM and the trophoblast are called the blastocyst. A blastocyst successfully implants in the uterus when, as the ZP exits the fallopian tube, the blastocyst leaves the ZP and binds to the endometrium. The endometrium is one of the few uterine surfaces to which a blastocyst cannot always implant. The properties of the endometrium change, and only in a brief window can the blastocyst implant on the tissue. In humans, that window includes days six through ten after ovulation. Just prior to ovulation, the endometrium begins to thicken and to expand in response to the release of estrogen from the ovaries. As the embryo moves through the fallopian tubes, the endometrium proliferates, changes in shape, becomes receptive to implantation, and produces a hospitable environment for the embryo. Signaled by the release of progesterone from

the ovaries, a series of changes called decidualization occurs. Decidualization includes the gathering of white blood cells around endometrial arterioles, or blood vessels leading from arteries to capillary beds. As that vasculature forms, a molecule that stores energy, called glycogen, accumulates in the expanding connective tissues of the uterus. Furthermore, the endometrium swells as interstitial fluid accumulates in it. The endometrium, swollen with interstitial fluid, vasculature, and nutrients, provides a hospitable environment for embryogenesis. As the blastocyst moves through the uterus it realigns itself so that the inner cell mass is adjacent to the uterine wall, and the trophoblast contacts the endometrium. The position of the ICM in relation to the endometrium establishes the head to tail, or dorsal-ventral, axis of the embryo, with the dorsal side of the embryo facing the uterine wall. This is the first embryonic event that dictates the organization of the future body. Successful implantation depends on the blastocyst binding to the endometrium. There are many molecules that are thought to dictate this interaction, but integrins, a type of cell-adhesion molecule, have been identified as a primary component. Integrins extend from the lining of the uterus and from the surface of the blastula. Integrins have many functions in nearly all tissue types, and they have a role in cell adhesion, conveying information about the extracellular environment to the nucleus, and modulating the local immune response. Immediately following implantation, integrins help regulate gene expression in the embryo. Doctors also look for high concentrations of integrins when they look for areas of uterus receptive to implantation in assisted reproductive therapy (ART), and they use the lack of such concentrations to identify women who may be infertile.

Despite the contact between the blastocyst and the endometrium, implantation can fail. There are many potential causes of errors. If implantation does not occur, the endometrium breaks down and sheds, along with the blastocyst, as part of the menstrual cycle. However, if a blastocyst does implant, then the endometrium remains in the uterus, and together with uterine tissue, becomes the maternal portion of the placenta, called the deciduas. Once the blastocyst adheres to the uterine wall, the trophoblast secretes enzymes that digest the extracellular matrix of endometrial tissue. The trophoblast cells then begin to intrude between the endometrial cells, attaching the blastocyst to the uterine surface. Further secretions of enzymes allow the blastocyst to bury itself deeply among the uterine stromal cells that form the structural components of the uterus. Subsequently, trophoblast cells continue to divide and form two extraembryonic membranes. These membranes form the fetal

portion of the placenta called the chorion. Additional enzymes and signaling factors secreted by these membranes remodel the uterine vasculature to bathe the fetal or embryonic blood vessels in maternal blood. Chorionic villi are the folds of tissue and blood vessels that connect maternal and fetal blood pools. Maternal blood diffuses into the villi, and it travels through them into the fetus's vasculature. Similarly, fetal blood diffuses from the villi and into the maternal vasculature. Normally fetal and maternal blood do not mix, but the relationship between the two circulatory systems enables the transfer of nutrients and oxygen to the fetus or embryo, and carbon dioxide and urea from the fetus to the mother.

While unique to mammals as a reproductive process, implantation is not unique to the uterus and the trophoblast. In the 1980s, researchers found similarities between the invasive abilities of blastocysts and those of cancer cells. The same trophoblast enzymes that digest the endometrium are also used by tumor cells to burrow into tissues throughout body. Tumor cells use the same growth factors as the trophoblast to attract maternal blood vessels, which then interact with the chorion, and to provide nutrients to the expanding mass. In addition, the changes in the endometrium during decidualization such as swelling, the accumulation of white blood cells, and the general activation of the maternal immune system, are consistent with a response to the presence of pathogens or tumors.

When does implantation occur?

Sperm meets egg, and 40 weeks later, boom—it's baby time! Sounds simple, right? Let's back things up a bit, Biology 101 diagram-style.

implantation-graphic

Your ovary will release an egg into your fallopian tube, and if you had sex up to about a week prior to ovulation, sperm will be waiting in your fallopian tube. If fertilization is successful, the egg will begin to divide and travel down your tube toward your uterus. This process usually takes about a week; after that, implantation happens. On average, implantation occurs about 8-10 days after ovulation, but it can happen as early as six and as late as 12. This means that for some women,

implantation can occur around cycle day 20, while for others, it can be as late as day 26. This is part of the reason why counting your pregnancy weeks can be confusing.

How long does implantation last?

Although most pregnancies are 40 weeks, the process of implantation represents only a fraction of that time. Implantation typically lasts only a few days. Once it's complete and the fertilized egg—now called an embryo—is burrowed snugly inside your uterine wall, it will begin to produce hCG. Your body's progesterone levels will also begin to rise, nourishing your uterine lining and preventing your period from beginning.

What does implantation feel like?

For most people, implantation feels like nothing at all. Some report feeling implantation symptoms like mild cramping right around the time of implantation, but doctors aren't certain if there's even an association between the two. Do your best to stay cool, calm and collected during that two-week wait—just because you're not feeling any implantation symptoms doesn't mean it's not happening.

Implantation symptoms

Since there's no real correlation between when implantation happens and actual implantation symptoms, it's best to think instead about implantation symptoms and how they relate to early pregnancy.

The most common implantation symptoms of early pregnancy include:

Implantation cramps. Some women may notice some minor cramping right around the time implantation is taking place. Though there's no way to know for sure what's actually going on, what we do know is that this cramping is due to the rise in progesterone that occurs during the second half of your cycle, whether you're pregnant or not.

Implantation bleeding. Defined as a small amount of bleeding or spotting that can occur after conception and a few days before your menstrual cycle, implantation bleeding is light, stops on its own and doesn't require treatment. It's experienced by about a third of all pregnant women, although there's no scientific data that proves the correlation between implantation and bleeding.

Nausea. Often some of the first tip-offs that something might be up, nausea and vomiting are popular—and unpleasant—implantation symptoms in early pregnancy. You may also start noticing changes in your appetite or that you're getting grossed out by foods you previously loved.

Tender breasts. As your hormones change, you may start to notice your breasts starting to swell and feeling a lot more sensitive than usual.

Constipation and bloating. Things feeling like they're starting to slow down? You can thank those pregnancy hormones yet again for constipation, a common implantation symptom. You may also notice you're looking extra bloated during this time, so it might be time to break out the leggings.

Fatigue. Growing a baby is hard work! If you're feeling more tired than usual, that's often a sign of early pregnancy, caused by a rise in progesterone and increased blood volume.

Headaches. Another side effect of your increased blood volume during pregnancy, headaches are a common implantation symptom.

Mood swings. Notice yourself getting extra bothered by even the smallest of things? Mood swings are a common implantation sign during early pregnancy.