

# AnesthesiaDotCalm Newsletter



News You Can Use

July 21, 2007

## The Maternal Lake

When estimating the blood loss resulting from a cesarean section do you include the blood retained within the placenta? You may think this to be a ludicrous question, arguing that you don't consider the amount of blood retained in an appendage as part of your estimated blood loss when it is amputated. Beside, you may assert it is impossible to know how much blood is in the placenta. That is not quite so. That is why today's *AnesthesiaDotCalm Newsletter* revisits the development of the placenta.

The formation of the placenta, or placentation, involves two major processes: *implantation* and *chorionic villi* formation. Implantation is when the blastocyst sinks completely into the uterine wall, and chorionic villi formation refers to the development of the baby's blood vessels into the uterine wall, thereby establishing the main site of gas and nutrients exchange. Within a week after fertilization, the zygote (a cell resulting from the joining of sperm and ovum and is only 0.1-0.15 mm in diameter )(1), undergoes mitosis and forms a bubble-like structure called a *blastocyst*. The outer surface of this bubble consist of a single layer of cells known as the *trophoblast*. The cells of this layer have a special ability to attach to and invade the uterine wall. Soon after the blastocyst makes contact with the uterine wall the endometrium begins to disintegrate allowing the blastocyst to sink into the uterine lining.

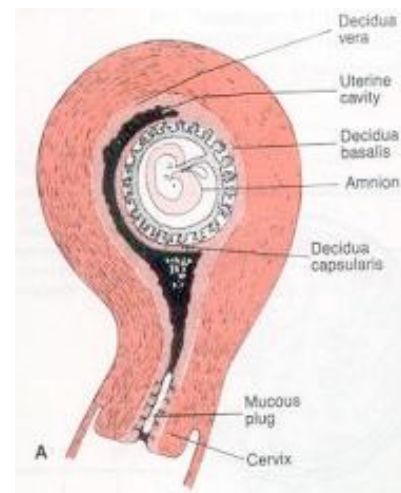
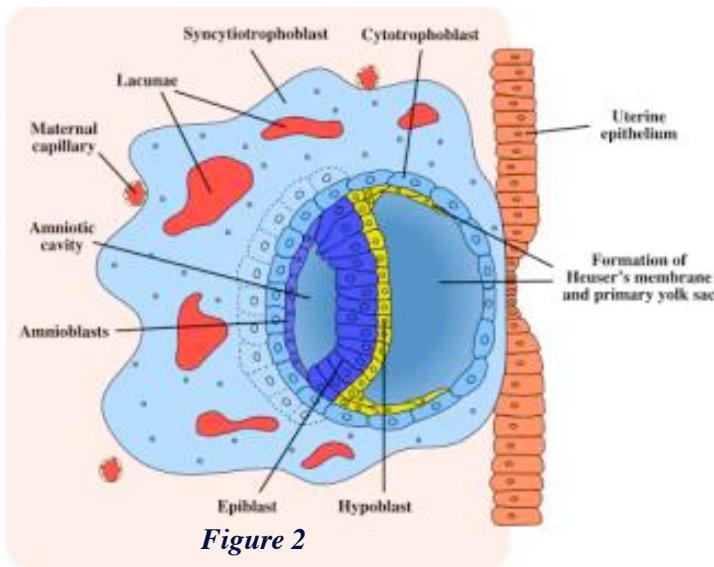


Figure 1

Once the blastocyst becomes buried within the endometrium, it undergoes cellular proliferation dividing into three distinct layers:

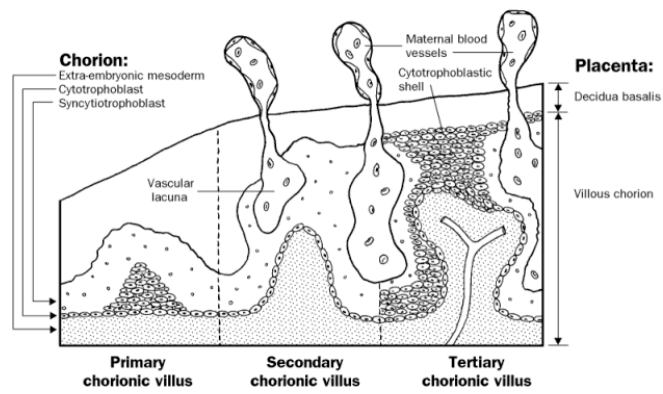
The side lying in contact with the blastocyst at the site of implantation is the *decidua basalis*; the decidua lining over the surface of the implanted blastocyst is the *decidua capsularis*; the remainder of the decidua lining the inside of the uterus is the *decidua vera* (Fig. 1). About 10 days after implantation, the chorion (the part of the placenta that will surround the embryo) begins to develop, and during this time the chorionic villi, the essential structures of the definitive placenta, are established (2). The trophoblast cells continue to proliferate and form two types of cells: syncytiotrophoblast (cells without boundaries) and cytotrophoblast (cells with boundaries) (Fig. 2).



As the trophoblast proliferates, finger-like growths comprised primarily of syncytiotrophoblasts and cytotrophoblasts push out from the surface of blastocyst into the decidua, forming numbers of branching villi (Fig. 3). As the syncytiotrophoblasts proliferate and grow into the decidua, they breach the uterine blood vessels. Consequently, maternal blood escapes from the vessels and surrounds the syncytiotrophoblasts, bathing the villi in a *maternal blood lake or lacunae*. This intervillous space will eventually occupy 55.6% of the placenta (2).

When the fetal blood vessels grow into the chorionic villi (tertiary villi stage), maternal-fetal interactions such as the exchange of nutrients and water supply begin. The chorionic villi initially develop all over the surface of the blastocyst; however, by the third and fourth month, they cease to be produced and degenerate completely everywhere except at the side attached to the decidua basalis, leaving the surface of the chorion in contact with the decidua capsularis smooth (3). On the other hand, the villi towards the decidua basalis continue to grow and become much more complicated. The placenta completes its development at this stage.

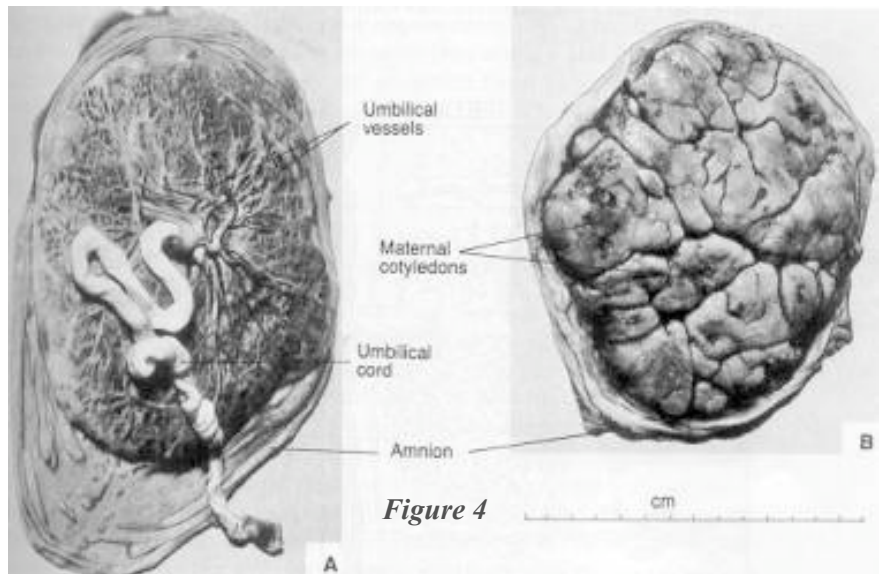
A mature placenta consists of two parts: the uterine, or maternal, part and the fetal part. We can easily distinguish the fetal from the maternal side of the placenta by their different physical appearances (Fig. 4).



**Figure 3**

The fetal side is smooth and slick, with the umbilical cord projecting from its surface. On the other hand, the maternal side of the placenta is red and more “bumpy,” showing the shape of the chorionic villi masses (cotyledons). The bumpy shape of the placenta is caused by some chorionic villi attaching directly to the decidua basalis and acting as anchoring villi. The anchoring villi divide the placenta into seven to ten villous masses called cotyledons (Fig. 4). Most of the villi hang floating freely in the blood spaces, providing the major site of maternal-fetal exchange.

Despite the small size of a placenta, the surface area of the villi for maternal-fetal exchange is remarkably large. Each primary chorionic villus divides at least five times, forming villous trees. This results in 700,000 terminal villi with a surface area of 12 m<sup>2</sup>, and all are happily bathed in the maternal blood lake. The branches of



**Figure 4**

uterine arteries empty into the center of each cotyledon. When fully developed, each gram of placenta (wet weight) contains about 0.2 ml of plasma, or about 0.36 ml of whole blood and 25% of this blood is maternally derived while 75% is fetal in origin. Therefore a 400-g placenta occupying 312 ml in volume contains about 36 ml of maternal blood and 108 ml of fetal blood (total of 144 ml)(4-6).

So in the total scheme of things, the amount of maternal blood retained within the placenta is probably not significant. But at the very least you now know a little about the maternal lake.

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