



## EXPLORING THE ROLE OF YOLK SAC IN GARBHAPOSHANA: A TINY MIRACLE

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## ABSTRACT

Nutrition is an integral part of development. In India, the prevalence of low birth weight has been reported as 26%, which is associated with perinatal morbidity and mortality<sup>1</sup>. Not only adults but also a growing fetus requires a good source of nutrition right from fertilization till birth. A sufficient amount of nutrition is necessary for the growth of a healthy fetus and to reduce the risk of congenital abnormalities. *Ayurveda* has explained the pre-conceptional care for getting a healthy progeny<sup>2</sup>. The process of *Garbha poshana* before the formation of *Apara*, that is in *Asanjatavastha*, the *Garbha* gets nourishment from *Upasneha*, *Upasweda*, and *Tiryagatadhamani*<sup>3</sup>. This period can be taken as the first trimester of pregnancy as the *Vyaktata* of *Anga* takes place from the 4<sup>th</sup> month onwards. During this period the fetus gets nourishment by the secretions of fallopian tube and uterine glands in the form of histotroph. The anatomical structure which is involved during this period i.e. before the formation of placenta, for the transfer of nutrition is the yolk sac. The semi permeable membrane of yolk sac helps in transport of nutrition through diffusion during this period. The present paper helps to understand the role of yolk sac during *Asanjatavastha* of *Garbhaposhana*.

**Keywords:** *Garbahaposhana*, *Upasneha*, *Upasweda*, *Asanjatavastha*, *Tiryagatadhamani*, histotroph, yolk sac.

## INTRODUCTION

The growing fetus is entirely dependent on the mother for its nutritional needs. *Acharya Charaka* explains that the fetus is devoid of hunger and thirst. It is dependent on mother for every need and when the *Angavayava* are in *Avyakta* form it gets its nourishment through *Upasneha* and *Upasweda* of *Garbhashaya*<sup>4</sup>. For the *Garbhavridhhi* to occur along with *Upasneha* and *Upasweda*, *Swabhava*, *Parinama* and *Kala* are the important factors<sup>5</sup>.

As the *Shareera* is made up of *Panchamahabhuta*, *Acharya Sushruta* tells that, *Garbhavridhhi* occurs through the *Rasa* which is predominantly made up of *Jala Mahabhuta* and the *Maruta* which helps in the *Vivardhana* of *Garbha*<sup>6</sup>. The *Ahara* which is being consumed by the mother is converted into the *Ahararasa*, is divided into three parts. One part for the nourishment of the mother, one part for the formation of *Stanya* and the remaining part does the *Grabhaposhana*<sup>7</sup>. The process of *Garbhaposhana* has been explained in two stages. They are before the formation of *Apara*, i.e, in *Asanjatavastha* and after the formation of *Apara*, i.e in *Sanjatavastha*. During *Asanjatavastha* as the *Angapratyanga* are not formed, the fetus gets nourishment through *Upasneha* and *Upasweda*. *Acharya Dalhana* explains how a tree situated on a bank of river gets nourishment by drawing the water from the river, similarly the fetus gets nourishment through the process of *Upasneha*. Before the formation of placenta, the embryo gets nutrition from the uterine secretions, endometrium which is called histotrophic nutrition. Histotrophic nutrition refers to nutritive material derived from maternal tissue at cellular levels other than blood<sup>8</sup>. During this period as the cardiovascular system is not yet developed, the nutrition reaches the fetus through a structure called the yolk sac.

### YOLK SAC

A yolk sac is a membranous sac attached ventrally to the developing embryo via the yolk stalk<sup>9</sup>. During cell division, after fertilization, the morula has an inner cell mass and outer trophoblast. The inner cell mass further gives rise to flattened cells called the hypoblast and columnar cells called the epiblast. The

primary yolk sac forms from proliferating hypoblast cells<sup>10</sup>.

### Time of origin

The yolk sac is the first extraembryonic membranes to develop, starts forming during second week of embryonic development. Late blastocyst stage, prior to embryo implantation, coincides with the formation of extra embryonic mesoderm. The yolk sac and amnion develop simultaneously during 8 to 14 days of embryogenesis<sup>11</sup>.

### Fate of yolk sac

At ten weeks, the yolk sac lies in the chorionic cavity between the amniotic and chorionic sacs. It atrophies as the pregnancy advances. In rare cases, it persists throughout pregnancy and appears under the amnion as a small structure on the fetal surface of the placenta near the attachment of the umbilical cord. The persistence of the umbilical vesicle is of no significance.

### YOLK SAC AND HISTOTROPHIC NUTRITION

Until the contact between mother and embryo is established, the embryo gets nourishment from the oviductal and endometrial secretion. These secretions contain carbohydrates, lipids, cytokines, hormones, and growth factors. This uterine fluid enters into the morula to form blastocyst and blastocoele. This fluid nourishes the embryo till implantation.

The syncytiotrophoblast erodes the endometrial stroma and come in contact with uterine secretions. Cytotrophoblasts grow into syncytiotrophoblasts as finger-like projections, which are called villi. Uterine secretions and maternal plasma are delivered freely into the intervillous space. Nutrients from these secretions are diffused into the villi. From these villi, the secretions enter into the extraembryonic coelom.

To reach the embryo, these nutrients must cross the yolk sac membrane. The epithelial layer of the yolk sac selectively absorbs glucose, fats, and protein. The yolk sac membrane expresses genes like GLUT, SGLT-1, and Calcium transporter TRPV 6<sup>12</sup>. The nutrients from the yolk sac are carried to the embryo through the vitelline circulation.

## DISCUSSION

During *Asanjatavastha*, the *Garbha* gets nourishment through the *Upasneha* and *Upasweda* of *Rasavaha Dhamani* of mother. This *Asanjata* period can be compared to the first three months of gestation, as *Acharya* has mentioned that, from the fourth month onwards, *Vyaktata* of *Anga* takes place<sup>13</sup>.

The mother is called as *Douhrida*, at fourth month, which is nothing but *Hridaya* of the fetus and the mother. So, the circulatory system starts functioning after the third month. Before this period, as there is no establishment of haemopoetic form of nutrition, the fetus gets nourishment from the histotroph, which is nothing but the secretions of the fallopian tube and uterine glands and the maternal plasma.

*Upasneha*, *Upasweda*, and histotrophic nutrition:

The word meaning of *Upa* is *Sameepa* or nearby. *Sneha* refers to attachment or affection. According to *Jyothishyashatra*, *Sneha* means *Ardrata* or liquid substance. *Acharya Sushruta* has mentioned the concept of only *Upasneha* in the context of *Garbhaposhana*. This can be taken as the *Garbha* gets nourished by absorbing the nutrition from the extraembryonic coelom.

*Acharya Dalhana's* explanation of *Upasneha* can be compared to the diffusion process where the nutrients move from the region of higher concentration to lower concentration across a semipermeable membrane. The visceral yolk sac consists of a layer of endodermal epithelial cells facing the yolk sac cavity and an underlying mesodermal layer containing the vascular system. The yolk sac membrane expresses genes for nutrient digestion and nutrient transporters, like oligopeptide transporter Pept 1, cationic transporter CAT 1, sodium-glucose transporter SGLT 1, etc. which help in the transport of selective nutrients for the embryo.

As the explanation of *Acharya Chakrapani*, on *Upasweda* tells that *Upasweda* refers to *Shareera Ushmata*, which helps in the development of *Andaja* i.e., bird that develops from the *Anda* or egg, which can be compared to the transformation of one form to another.

The yolk sac membrane secretes digestive or catalytic enzymes to complete the metabolism. The chorion, which develops from the yolk sac, secretes chorionic fluid.

The secretory function of the yolk sac can be compared to *Upasneha*, and metabolic function can be taken as *Upasweda*. The yolk sac secretes transthyretin, retinol-binding protein, transferrin, and fetoprotein, which are required for the nutrient transfer to the fetus<sup>14</sup>. Glucose transporter gene, GLUT-1 protein, is also expressed in the yolk sac. Factors required for the transfer and metabolism of glucose, like insulin and IGF2, are present in the yolk sac. As the explanation of *Acharya Chakrapani* on *Upasweda* mentioned that, *Upasweda* is nothing but the transformation of one form to another. This metabolic function of the yolk sac can be compared to *Upasweda*.

The process of *Upasweda* is also one among the *Garbhavriddhikara Bhava*. The yolk sac helps in the development of various structures, the erythromyeloid progenitors (EMPs) are present in the yolk sac, which give rise to macrophages. The biochemical process of haematopoiesis begins in the yolk sac. This is how a developing embryo can produce red and white blood cells and platelets, which helps further nourish the embryo. The chorion also develops from the yolk sac and functions to nourish the developing embryo. Produces chorionic fluid, which gives a cushioning effect and protects the embryo. The chorion is involved in gas and nutrient exchange. Its villi can extend and contact maternal blood vessels. It also contributes to the formation of the placenta. The yolk sac gives rise to primordial germ cells, which develop in the embryo and eventually become ovaries or testes in the fetus<sup>15</sup>. Thus, the yolk sac helps differentiate various structures in the developing fetus.

## CONCLUSION

The semi-permeable membrane of the yolk sac helps in the absorption of nutrients during the *Asanjatavastha* of *Garbhaposhana*. The endodermal layer of the yolk sac is lined by epithelium, which helps absorb nutrients and transports it to the fetus via vitelline circulation before the cardiovascular

system starts functioning. The yolk sac is accountable for biological functions like blood cell formation and regulation of metabolism. The secretory and metabolic processes of yolk sac can be compared to the *Upasneha* and *Upasweda* in the *Asanjatavastha* of *Garbhposhana*.

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