ISSN: 2322 - 0902 (P)
ISSN: 2322 - 0910 (O)

International Journal of Ayurveda and Pharma Research

Review Article

AN ENUMERATIVE STUDY ON *GARBHA-AVKRANTI* FROM SUSRUTA-SHARIRA WSR TO LANGMAN'S MEDICAL EMBRYOLOGY

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ABSTRACT

The *Garbhaavkarnti* is the stage that describes the process of the growth of cell from intra-uterine life to post natal stage. The *Garbhaavkranti* mainly deals with the pre-natal life i.e. the foetal period and other related processes. This period is minutely envisioned by Langman's medical embryology, and in *Susurta Sharira* we have got more detailed version of pre-natal period. The *Garbha-avkranti* word signifies the *Garbh* i.e. zygote and *Avkranti* or *Avatarana* i.e. different stages of development of zygote. *Garbhaavkranti* is a process in which different stages of formation of *Garbha* is mentioned. *Garbha* (zygote) is formed from the uniparental inherent cells known as sperm and ovum. There are some special characteristics that combine or fuse together along with 24 other *Gunas* like *Avyakta*, *Mahana*, *Ahankara*, *Prakriti Tatva* and *Bhava* i.e. gene and chromosomes. There is no single way that may lead to the formation of *Garbha*. *Matraja Bhava* (maternal inheritance factor) is present in *Aartava* which further shows the quality of *Aagnaya* feature i.e. the mitochondria of ovum. The importance of embryology at that time was known by *Susruta* and the criteria for good progeny and the process by which embryo develops was all known to them in subtle level. It is fascinating to conclude that they knew about all this without the technological advances which are available today. The importance of healthy mother and father in phase of conception is shown in this *Garbhavkranti*. This gives the idea of unhealthy reasons and gives broad scale treatment for infertility cases. The *Garbhaavkranti* (embryology) is always a matter of ample concern to medical field. So, in this article the *Susurta Sharira Grabhavkranti* is discussed precisely thereby referring to Langman's medical embryology for testimonial based study.

KEYWORDS: *Avtarana, Artava, Atianu Veshashan,* fertilization, *Garbha, Panchmahabhuta, Samyoga*, *Sukra.*

INTRODUCTION

As one cell leads to a foetus after a gestational age of 11 weeks i.e. 9 weeks after fertilization, its growth and development shows an amazing multifarious phenomenon. Similarly in *Garbha-avkranti Acharya Susruta* explains the formation of growth in all levels starting from coitus time to conception time. So, for better understanding of embryology, *Garbhaavkranti* can play a key role as it gives a vast knowledge of cell growth. This has formed new pathway for pre-natal criteria and therapeutic ideas to overcome the problems related with conception or with fertilization and in this way we may improve infant mortality rate.

Garbha Sharira explains the study of embryo in detail and more extensively it lays focus on foetus tissue growth from physical structure to psychological development in prenatal phase. *Susruta* gives the point of *Garbha Utapti*, *Nirmana* and *Poshana* in detail. This mutual link gives detail of good reproductive health and pre-natal health care. *Acharya* has mentioned some great untouched areas which need to be studied minutely for long term effects i.e. after post natal phase. In this article we have tried to brief about the material needed in formation of *Garbha* before conception like sperm and ovum and other areas related with gametes and the material after conception which are disclosed as per *Susruta* in his textbook. For better understanding we may refer to Langman's medical embryology book written by T.W.Sadler to form an opinion more clearly.

AIM & OBJECTIVE

To understand basic concept that were mentioned in *Susruta Sharira*, chapter-3 *Garbhaavkranti* and to clarify more, we have taken Langman's medical embryology for testimonial based study.

MATERIAL and METHODS

S*usurta Sharira* and Langman's medical embryology books are used. Other embryology books are studied for topic understanding.

***Garbha- Avkranti* with Embryology**

It is the process of fertilization and development of the foetus starting from the basic unit, their union, implantation, successive growth and finally the full term delivery. It comprises of two words- *Garbha* and *Avakranti* that gives an idea about descent of a dormant embodied life principle.[1] *Avakranti* is defined as *Upagamanam* and *Avataranam* which shows descent of anything.[2] It shows that two cell structures when unite in different form in different location gives embodied life.[3] It is considered as a state of formation and attainment of a shape by certain mechanical and environmental factors for some time period resulting into the formation of *Garbha* as a structural unit.[4]

Avtarana in *Garbha* shows the process of fertilization of gametes to form a single cell i.e. zygote.[5] It gives ray of initial phase of prenatal life, its subdivision into blastomeres and their arrangement into hollow blastocyst. Whereas *Upagamanam* shows development and growth of embryo and foetus in stages.

Sperm and Ovum[6]

The formation of *Garbha* is a perfect union of two different cells i.e. the sperm and the ovum particularly unite[7] in the uterus part of mother. The union that takes place is mainly due to the potential part of sperm and ovum i.e. nucleus part known as *Sukra jeev* and *Shonita Jeeva.*[8] *Sukra* i.e. sperm is *Soumyam* and *Artva* i.e. ovum possesses qualities of both *Soumyam* and *Aagnayam.* It shows that both sperm and ovum have *Soumyam* feature and therefore *Soumyam* is the nucleus part of both cell bodies (sperm and ovum). And *Agnayam* quality is energy body of the cell i.e. mitochondria of cell the power activity holder of the ovum cell.[9-12] It shows the wide ranging properties of gametes which are mentioned by *Susurta.*[13] *Agnayam* feature of *Shonita bhag* i.e. ovum, is the power activity of the ovum cell. So, *Acharya* mentioned the *Shointa* as *Agnaya Tatva Pradhana*. The *Agnaya Aartava* is originated from *Matraj Bhava Janita* [14-15]. *Ati–anu Bhuttanaam* was described as nucleus of gametes that are joined together with the physical and spiritual, *Materaj* and *Petraj Bhava* of the *Sukra* and *Shonita.*[16] The process of fertilization are mentioned in three phases as [17-18]

Paraspar-Upkarata: Penetration of corona radiate.

Paraspar- Anugrahata: Penetration of Zona pellucid.

Paraspar- Anupravesha: Fusion of the gametes plasma membrane.

These three phases occur in *Garbhashaya* i.e. in uterus. Fertilization phases in *Ayurveda* were mentioned as same as in modern science but the difference is in words and deep understanding. These three phases are as –

a) **Phase I: *Paraspar Upkarata*:** The word *Paraspar Upkarata* describes the interaction between *Shonita* and *Sukra Bhraya Avarna* of the *Anu Bhaga* of gamates. *Shonita* part strongly indulges with *Sukra* part tearing the shield of *Shonita*. In terms of modern this word shows that the corona radiata is innermost layer and it's adjacent to zona pellucida and so it is outer protective layer that tears or is penetrated by *Sukra* (spermatoza). It gives the idea of mutual meeting of both gametes at first outer surface [19-20] .

b) **Phase II: *Paraspar- Anugrahata:*** In this stage mutual interaction occurs within the middle layer of *Sukra–Shonita*. In terms of modern it is mentioned as- zona pellucida is penetrated by the spermatozoa. And this initiation is necessary for fertilization by the help of acrosome released enzyme i.e. acrosin and tryosin. This enzyme helps to penetrate zona making it more permeable surface.[21-22]

c) **Phase III:*Paraspar-Anupravesha:*** Amalgamation of both *Shonita* and *Sukra* to give the shape of *Garbha*. In terms of modern it is mentioned as the fusion of plasma membrane of oocyte and spermatozoa which results in breakdown at the time of fusion. It takes place in three forms- Second Meiotic Division, Zona Reactions, and Early Embryogenesi.[23-24]

As soon as the spermatozoa enter the occyte, the egg responds in these three steps.

Aspect of Fertilization [25-26]

Setri-Pursha Samyoga: It is the starting phase from where the physical union of female and male genitalia complemented by rhythmic movement leads to gametes fusion by the result of coitus.

***Tej Sharira Vayu Uderyata- Tej* and *Vayu* factors:** In ejaculation process *Agni* and *Vayu* are the factors that play essential role in emission of *Sukra* in vagina. It shows that semen contains *Sukra* /sperm having Tej in it and this energy part in *Sukra* gives influencing stamina to *Sukra. Vayu* helps *Sukra* to move further to the *Mukha* of *Garbhasya*. As more

than 500 million sperms are accumulated to the surroundings of the external os of uterus and also in the fornix part of vagina after emission of seminal fluid.[27] The movement of sperms that are present in fluid is all due to the effect of energy that sperms carry with itself i.e. *Teja* part mentioned by *Susruta*. It clearly shows the functions of fructose that sperms contain as energy provider.[28] This clearly denotes the idea that the *Teja* is the energy source of *Sukra*/sperm and the mobility of sperm is by the factor of *Vayu* by the *Guna* of *Chala Pravarti* in it. So, *Vayu* helps the *Sukra* to become mobile and the sperm contains the *Teja* as bioenergy i.e. fructose. The researchers also show the same that sperm cell takes fructose over glucose as main energy provider and therefore, no ATP is required.[29-30]

Tato Teja- Anila Saanepata Sukra Chautama

Transportation of sperm at the time of emission- passage of sperm in the vagina to the external os of uterus by the action potential of *Teja* and *Anil gunas* combined form. *Teja* is aggravating factor and i.e. fructose present in it and *Anila* gives motility to the *Sukra Bhaga*. Both these help the ejaculation of sperm in the seminal fluid. [31]

***Yonimarga Pratipadhate-* Capacitation**

Now the sperm stays for some couple of hours in reproductive tract for becoming more fertilized, and then it penetrates the ovum so as to form zygote because soon after the entry of sperm in vagina, it is incapable to fertilize the ovum. So, staying in *Yoni Marga* i.e. in vaginal tract gives the *Sukra* the time to enhance the capacity before reaching to ampulla part of uterus. Therefore, spermatozoa stay in vaginal region and integrate with the epithelial surface of reproductive tube for some time and in this period removal of plasma proteins occurs from the surface of spermatozoa. Once the *Sukra bhaga* has attained enhancement for further actions [32-34], capacitation of sperm cell can pass through the corona cells and undergo the acrosome reaction.

***Samsrejayate ch Artavye-* Process of fertilization**

It also contains three phases as mentioned above *Paraspar-Upkarata* (Penetration of corona radiata), *Paraspar- Anugrahata* (Penetration of zona pellucida), *Paraspar- Anupravesha* (fusion of the gametes plasma membrane) [35-36].

Tato Agni Soma Samyogata- Samsrjaya mano Garbha-Garbhashya Anu Pratipadhate- Fraternizing of nucleus part of sperm i.e. Soma part and ovum i.e. Agni part with mitochondria leads to the development of new zygote cell structure in the ampulla part of fallopian tube extension of uterus.[37-38]

Prayavachaenaam Abhraabhihiyate Bhava

These all features give the genetic information from both the nucleus that form zygote. These are the causative agents from mother and father i.e. genes and chromosomes that built individual characteristics. [39-41]

***Vayuna Abhipremaano*[42]-** Here it shown by *Susruta* **that *Panchmahabhuta*[43]**- Five primordial factors which help in the development of new cell in uterus includes. [44]

Cleavage: It gives the splitting of complex molecular cell division into simpler ones as segmentation occurs. This factor gives the idea of *Vayu*/air that mention– *Vayu Vebhajati* it clearly shows cell division. Division occurs on the level of *Doshas, Dhatus* and *Malas* and *Anga- Prantangaare,* these all divided by *Vayu Mahabhota.*

Migration: It provides the movement to cell from one place to another. It shows the function of *Vayu* Primordial feature.

Compaction: The process of combining of cells together as a pack gives the view of *Prithivi Samhanti* or compaction process.

Differentiation: In this phase the cell acquainted with functions that are different from those of the original type. It clears the idea of *Teja Mahabhuta-* ***Teja Pachati:*** Mutation occurrence resulting into transformation of energy. It may lead to permanent changes which in turn lead to the characters that are different from parents. It shows that genetic changes occur by the action of this *Mahabhoota*. So, mutation occurs in two ways- one is natural/ *Prakretika* i.e. variation in primary factors due to environmental reasons. And second one- Somatic mutation i.e. changes that occur in somatic cells.[45]

Accretonory/Growth: The continuous and accelerating growth of a zygote by the help of proper nutritional level by the synthesis of new protoplasm and then multiplication of cell gives the idea of *Jala Mahabhuta* which gives the nutrition to embryo. This increases the matrix/ protoplasm of cell.

Enlargement: Auxesis of cells so that the cell increases in size but the quantity remains constant. Auxetic growth occurs in certain tissues such as in muscles (it is found in some higher animals as well as in organisms e.g. in nematodes, tunicates and rotifers). It shows the increase in intercellular spaces. It gives the idea of *Akash Mahabhuta* that gives *Vevardhyati* and *Vivardhyat*. So, this results in the increase in size of the embryo, space of amniotic cavity, yolk sac, coelom and in intercellular space.

***Garbhashya Anu:*[46]** *Praveshyta Avtisthate-* Capture mechanism in uterine cavity. These two words shows the activity that takes place in uterine cavity.

i) *Anupreveshate-* the entry of zygote into the uterine linens at the end of first week

ii). *Avtishate-* Implantation- The implant in uterus wall of zygote gives the clear understanding of *Avtishate*. It occurs at the end of first week in the uterus. At the time of implantation, the uterus is in secretary phase and the blastocyst implants in the uterine cavity. It is covered by the functional layer of endometrium (decidua) after capture mechanism of zygote and endometrium. The blastocyst is more deeply embedded in the endometrium and the penetration defect in the surface epithelium is closed by a fibrin coagulum called as closed plug. The process of implantation starts in first week (Five & half days) and ends in the second week (about ninth day). At the time of the morulla entry into the cavity of uterine the zona pellucida has disappeared allowing implantation to begin. In the human beings the trophoblastic pole begins to penetrate between the epithelial cells of the uterine mucosa on about the sixth day.[47]

New studies suggest that the L-section on trophoblast cell and its carbohydrate receptors on the uterine epithelium mediate initial attachment of the blastocyst to uterus. Selections take place due to carbohydrate binding proteins involved in interaction between leukocyte and endothelial cells. That allow Leukocyte to 'capture form' followed by blood.

DISCUSSION

As per Susruta the word *Yonimarga Pratipadhate*, *Garbhashya Anupratipadhate- Anupreveshate- Avtishate*– This gives the illustrative knowledge of reproductive system at subtle level as in modern it is discussed in a very gross view. At that time Ayurvedic scientists had brief idea about how *Garbhasya* has the quality to undergo this cyclic process and how *Sukra* enters and settles in the uterus lining. It shows in depth knowledge of *Acharya Susruta* in the field of embryology as compared with the Modern Science. As primordial work of *Akash Mahabhoota* i.e. *Vevardhyati* and *Vivardhyat,* corresponds to the growth of cell. *Susruta* mentioned this in the last of the five *Mahabhoota* functional areas because he knew that if the size of fallopian tube increases prior to other elemental functions than, it will lead to rupture of tube. So, in very scientific manner he has shown the sequence of *Panchmahabhoot* in the growth process from zygote to embryo. And *Akash Mahabhoota* creates division of *Srotasa Bhaga/* channels of body into three parts viz., upward, downward and lateral.

In the systemic information *Susruta* here mentioned - *Kshteryo, Vedeyata, Saparsta , Gratha, Daresta, Srota, Raseyta, Pursha, Satrsta, Ganta, sakshi, Dhata, Vakta* as *Bhava* concept i.e. genetic information unit. This is a matter of more research to prove which genetic factor influences the process at different stages, as mentioned by Acharya here. For example– *Saprsta* shows the genetic character for skin receptors, *Gratha* for nose receptors, *Drastha* for visual receptors, *Srota* for auditory receptor, *Rasyata* for tongue receptors and so on. So, this gives vast information on how a mentally and physically healthy *Garbha*/embryo is formed. So, a lot of work has to be done to establish evidence based detailed study to prove these scientific and mind blowing theories provided by *Susurta*. This will surely help in the study of infertility cases for both the sexes.

CONCLUSION

Garbhavkranti is the word used in *Ayurvedic* text to symbolize modern embryology but with a more detailed vision according to current era. *Garbhavkranti* contains both qualitative and quantitative analysis to provide an answer to a lot of questions in today's world. In this article it is tried to prove on the ground level that how *Susruta* Samhita *Sharira Sathana* chapter three had given wonderful explanation with phases of formation of new cell/ *Garbha* from mother and father cells meeting after coitus. In Langman's medical embryology the context is mentioned in the same way as *Acharya Susruta* said years before the modern science had developed. Physiological and anatomical growth of new cell starting from *Garbha* or Zygote to embryo are mentioned and any malformation if occurs like- infertility then it can be cured. In *Susruta Garbhavranti* detailed information has been provided from the starting period of conception with different phases from penetration of corona to the penetration of zona pellucida to the fusion of plasma membrane, different aspect of fertilization have been explained. So, it is an interesting research work for the research scholars working in the field of embryology to consider *Susruta Samhita* as basic medical book for embryology research as it will surely give some mind blowing results.

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Cite this article as:
Sharma Giriraj, Sharma Pooja. An Enumerative Study on Garbha-Avkranti from Susruta-Sharira wsr to Langman's Medical Embryology. International Journal of Ayurveda and Pharma Research. 2019;7(6):57-62.
Source of support: Nil, Conflict of interest: None Declared

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