REVIEW ARTICLE

A CRITICAL APPRAISAL OF GARBHA AVKRANTI VIS-A-VIS MODERN EMBRYOLOGY

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ABSTRACT

With the latest advancement in the field of medical science, each aspect of human embryology has been studied in detail and still more and more is being explored. This has been made possible with the help of different tools and techniques. But in the present era of scientific world one cannot put aside the thousand years old literature of ayurveda, where Acharyas have beautifully described human embryology in terms of Garbhadhan Vidhi (method of conception), maasanumasik Garbha vriddhi and other aspects of Garbha shareera (embryology) with their deep insight of knowledge even in the absence of present diagnostic tools/aids. Detailed description is available in Samhitas regarding Garbhavkranti (fertilization) and monthly development of Garbha. The present article aims to put forth the relevance of ayurveda concept of human embryology explained by Harita and by reviewing the available literature it is concluded that description given at that time holds quite true even today.

Keywords: ayurveda, Garbhadhana vidhi, human embryology

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INTRODUCTION:
Mother nature has provided the bestow of reproduction to all living beings enabling them to preserve their species. Starting from the ancient period to the contemporary era embryology is a matter of great curiosity for the ancient sages as well as the modern embryologist so as to solve the mystery of reproduction and explore the secrets of embryonic development. Ancient sages have explained the concepts of conception, formation of zygote and foetus, the inheritance of various qualities, formation of different organs and system and monthly development of foetus in a subtle, detailed and interesting way.

Garbha Shareera (embryology) is a proof of the unparalleled knowledge, the Acharyas had regarding the embryology irrespective of the fact that era, thousands of years ago lacks such modern scientific parameters and techniques to carry out researches to discover new facts and figures. Various ancient Acharyas and scholars belonging to the brihatyee and Laghutrayee had very well observed and documented the concept of Garbhavkranti and various stages of development of Garbha. In Ayurvedic Texts Charaka has described Garbha as combination of three factors i.e. artava(ovum), sukra(sperm) and jiva(atma). Garbha is a product of akasha, vayu, jala, agni and prithvi five mahabhutas(five great elements) and cetana\(^1\) (consciousness).

Sushruta is also of the view that of Charaka but instead of using the word jiva, he has mentioned prakriti(nature) and vikara(change) words along with atma(soul). He has termed Garbha as agni-soma-samyoga(union) which along with all the panchamahabhutas, sattva(harmonious), raja(confused), tama(destructive) and other bhavas with stimulation of vayu that takes part in the formation of Garbha\(^2\).

REVIEW OF LITERATURE:
Starting from the Vedas and Brahmana one of the Brahmana Granthas are of the opinion that all the body parts of the Garbha do not develop simultaneously, rather develop one after the other. During upanishad period the concept of various stages of fetal development has been mentioned very systematically. Garbha upanishad is one of the milestones having the description of fetal development.

Buddhist texts like Samyuttanikaya, Jataka, Milindapanho, Visuddhimagga etc have gross description of embryology. As per Samyuttanikaya embryo is called ‘kalala’(zygote) after fertilization. It is the first stage. Second stage is ‘abbuda’(morula). This abbuda in due course gets elongated and attains the shape of ‘pesi’. Later pesi(gastrula) becomes ‘ghana(Blastula)’. Now from this stage differentiation of both the extremities
along with head, hairs, body hairs and nails etc grow\[^3\].

In puranas a brief description of embryology can also be traced in Garuda Purana. Its description is based on certain philosophical concepts and says that there exists two germ cells stages in the uterus during the course of development, first it passes through the stage of ‘kalala’ super imposed by ‘budbuda’. Then blood like fluid, muscles and finally a round shaped germinating seed like structure is obtained. The other body parts like digits, nose, etc having little movement come in view.

But the most elaborate and accurate description of the initial stages of development of Garbha which resembles the most to the modern embryological concepts is mentioned in Harita samhita which has been taken as the study matter in this article along with the view of other Acharyas as well as its modern perspective.

**Ayurvedic Perspective of Organogenesis:**

Charaka opines that in the first month, atma gets mixed up or vitiated by all the dhatus(tissues) and attains a mucoid appearance. Previously due to prithvi ttatva, the shape is solid, which later on becomes blastocyst due to predominance of jala tattva. He believes that at this stage all the body parts are present in this mucoid structure but in subtle form\[^4\].

Sushruta and Vaghbata are of the opinion that during the first month, the embryo is in the shape of kalala\[^5\]. As per Garbhopanishad, the fertilised egg becomes Kalala in one night, budbuda in 7 nights, pinda in 15 days and solid in one month\[^6\].

Yajnavalkya Smriti has described that after union of sukra and shonita(ovum) carrying pancamahabhutas as well as descent of atma all these get mixed up and are moistened in the first month\[^7\].

Harita has elaborated the views of Yajnavalkya and said that after union of sukra and sonita on the first day, it attains the form of kalala. On 10\(^{th}\) day, it becomes becomes budbuda, on 15\(^{th}\) day a solid and on 20\(^{th}\) day a mass of flesh. The mahabhutas get associated with it on 25\(^{th}\) day and by the end of one month all the tattvas become conspicuous\[^8\].

**Modern Embryological Concept:**

- Fertilization of the ovum takes place in the ampulla of the uterine tube. The fertilised ovum is a large cell. It undergoes a series of divisions i.e cleavage\[^9\].
- When there are 16 cells, the ovum is called a morula\[^9\]. It has an inner cell mass covered by an outer layer of cells, the trophoblast.
- Fluid partially separates the inner cell mass from trophoblast. The morula now becomes a blastocyst\[^9\].
The cells of the inner cell mass multiply and are rearranged to form an embryonic disc having two layers. These layers are the epiblast and the hypoblast [9]. Later the epiblast differentiates into three germ layers the ectoderm, endoderm and mesoderm. Cells of the hypoblast become flattened and line the yolk sac.

A cavity appears on the ectodermal side of the disc. This is the amniotic cavity. Another cavity appears on the endodermal side. This is the yolk sac.

At first the walls of the amniotic cavity and yolk sac are in contact with trophoblast. They are soon separated from the latter by extra embryonic mesoderm [9].

A cavity the extra embryonic coelom appears and splits the extra embryonic mesoderm into a somatopleuric layer [9] (in contact with trophoblast) and a splanchnopleuric layer [9] (in contact with yolk sac).

The trophoblast and underlying somatopleuric mesoderm form a membrane called the chorion [9].

The cells forming the wall of the amniotic cavity form the amnion.

The amniotic cavity is now attached to the trophoblast by some mesoderm into which the extra embryonic coelom has not extended. This mesoderm forms the connecting stalk [9].

On viewing the embryonic disc from the ectodermal side we see that near one edge it has a rounded area called the prochordal plate [9]. Here ectoderm and endoderm are not separated by mesoderm.

An elevation the primitive streak is also seen on the embryonic disc [9]. A line drawn through the prochordal plate and the primitive streak divides the embryonic disc into right and left halves.

Cells multiplying in the primitive streak move into the interval between ectoderm and endoderm and form the mesoderm.

Caudal to the primitive disc we see a round area called the cloacal membrane [9]. It is made up only of ectoderm and endoderm.

Table 1. Stages of Initial Development of Garbha [10] (According to various ancient literatures):

<table>
<thead>
<tr>
<th>SAMHITA</th>
<th>1st MONTH</th>
<th>2nd MONTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Garbha upanishat</strong></td>
<td>1st night <em>kalala</em>; 7th night <em>budbuda</em>; 15th night <em>pinda</em></td>
<td>Buds of various body parts</td>
</tr>
<tr>
<td>2. <strong>Charaka Samhita</strong></td>
<td>Mucoid than <em>kalala</em></td>
<td><em>Ghana/Pinda/pesi/arbuda</em></td>
</tr>
</tbody>
</table>
DISCUSSION:

Table 2. Comparative analysis of development of fetus

<table>
<thead>
<tr>
<th>S.no</th>
<th>STAGE</th>
<th>DAYS ACCORDING TO TEXT</th>
<th>MODERN CONCEPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Kalala</td>
<td>1st 30th 30th 1st</td>
<td>Morula (1-3 day)</td>
</tr>
<tr>
<td>2.</td>
<td>Budbuda</td>
<td>7th - - 10th</td>
<td>Blastocyst (4th day)</td>
</tr>
<tr>
<td>3.</td>
<td>Pinda</td>
<td>15th - - -</td>
<td>Implantation of embryo in uterus complete by the 12th day and embryo appears rounded in shape</td>
</tr>
<tr>
<td>4.</td>
<td>Ghana(solidification)</td>
<td>30th - - 15th</td>
<td>Embryo becomes more solid due to rapid division of cells and the formation of primitive streak and neural groove.</td>
</tr>
<tr>
<td>5.</td>
<td>Pesi</td>
<td>- - - 20th</td>
<td>In the last 3rd week the embryo becomes 1.5 to 2mm long and apparently may resemble with pesi as described in ayurveda</td>
</tr>
</tbody>
</table>

GU-Garbha Upanishad CS-Charaka Samhita SS-Sushruta Samhita HS-Harita Samhita
The above table describes the various stages of initial embryonic development described by Acharyas in various Samhitas corresponding to their days in contrast to the various stages described by the modern embryologist. If we thoroughly go through the literature described in four thousand years old treatise Garbha upanishad we will find a very minute and explicit description of each and every stage of embryonic development and that to in its initial stages which are unveiled by the present day embryologist by means of highly sophisticated and ultra modern techniques and equipments available nowadays and our Acharyas had acquired this truthful knowledge by their divine insight, observation and intellect. After Garbha upanishad Acharya Harita has described these stages minutely. In this study an effort has been made so as extract out the observations and facts in support of the insight of the Acharyas those are even up to date to the present scenario of Garbha shareer given in ayurveda. For instance if we take the word kalala its word derivation means that the product of fusion of virya and raja on the first day in the form of sukshma pinda is kalala [11]. On the modern counterparts it could be correlated to zygote. The word zygote is derived from the greek word meaning yoked or joined or junction and the consistency and texture of of zygote was found to be similar as a sukshma pinda like structure i.e. kalala. It can further justified by the study done on “Stages of normal development in the medaka Oryzias latipes” [12]. If we think about the word derivation of the word budabuda [13] it means bulbula in hindi or in English its bubble. Bubble is a small globule in a transparent solid something that is hemispherical or semicylindrical .In the modern embryology it has been said that morula is an early stage embryo consisting of cells called blastomeres in a solid ball contained within the zona pellucida. It is produced by a series of cleavage divisions of the early embryo starting with the single celled zygote. Once the embryo has divided into 16 cells, it begins to resemble a mulberry hence the name morula [14]. The structure morula and budabuda bears a strict resemblance with each other. This fact is further supported by the evidence provided by the study entitled “Time sequence of early events in fertilization in the medaka egg” [15] in which each stage of initial embryonic development has been studied with light microscopy. The next stage of development of Garbha is that of pindaakara [16]. The word pinda in Sanskrit means to gather and pile up materials like mud or any other mass etc. The next developmental stage post morula is that
of blastula and blastocoele. The word blastos in Latin means to sprout i.e to grow. The blastula is a hollow sphere of cells referred to as blastomeres surrounding an inner fluid filled cavity called the blastocoele formed during an early stage of embryonic development. This structure blastula bears a quite similar appearance to because there is a common property of collection of matter in both these structures. In blastula there is a collection and arrangement of layer of cells in one layer filled with a fluid filled cavity. The evidences are provided by the study mentioned in above where it has been observed in light microscopy. The next stage in development is Ghana akara garbha. This word Ghana means a structure undergoing the process of gradual solidification, the structure undergoing nirantara sandrata (gradual solidification) and attaining murtarupa \textsuperscript{[17]} (Stability). The next stage in the process of development is that of gastrulation or the formation of trilaminar germ disc. The word germ means a living substance capable of developing into an organ, part or organism as a whole or primordium and disc means a circular or rounded flat plate. The change in structure from blastula to gastrula is that a simply connected sphere like surface is converted into a non simply connected surface torus like. The torus means a surface or solid formed by rotating a closed curve especially a circle about a line which lies in the same plane but does not intersect it \textsuperscript{[18]}. This structure gastrula and blastula at the stage of implantation shows a close resemblance to the structure Ghana because at this stage it is undergoing the process of stability by means of implantation and solidification by the formation of germ disc, neural groove and primitive streak which will result in the formation of vertebral column thus resulting in solidification. The last stage before the beginning of organogenesis is the formation of peshi akara Garbha. The word peshi in Sanskrit means mansa pinda means collection of muscle like tissue. The process of neurulation has the complete resemblance with that of peshi akara because here the trilaminar germ disc now completely develops into primitive streak and notochord and peshi has a longer and horizontal appearance just like primitive streak. Further studies mentioned above also supports this fact.

**CONCLUSION:**

The conclusion which has been extracted out from the present study that the deep insight, observation and valuable knowledge described in our Samhit\textsuperscript{as} holds quite truth and accuracy as is discovered and explored by the modern day embryologists that to with the help of latest tools and aids. In this study only a tiny sphere of Ayurvedic concept of Garbha shareer had been tried to explore. So an effort
should be made by the Ayurvedic physicians for more and more exploration and extract out the beautiful ideology of Acharyas into its practical significance.

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