
THE FACTS AND DOUBTS ABOUT BEGINNING OF THE HUMAN LIFE AND PERSONALITY

Asim Kurjak, Ana Tripalo

"What a piece of work is a man!" William Shakespeare, Hamlet

"To those of average curiosity about the wonders of nature, it is likely that two great mysteries have stirred the imagination; and each concerns a birth. Who has not gazed into the heavens on the starlit night and wondered about the birth of the universe? And who has not been stimulated by the sight of the newly born baby to the marvel at the unseen events within the mother's uterus that have led to the birth of such a perfect creation?" (1) These words written by the Professor Sir Graham (Mont) Liggins open Pandora's box of questions, dilemmas, doubts and controversies about human life and its beginning offering everybody lifelong challenge to solve mystery of life.

Entering this field scientists have been remiss in failing to translate science into the terms that allow mankind to share their excitement of discovering life before birth. Regardless to remarkable scientific development, curiosity, and speculations dating back to Hippocrates, life before birth still remains a big secret. Different kinds of intellectuals involved themselves trying to contribute to the solution of human life puzzle. They are led by the idea that each newborn child will only reach its full potential if its development in uterus is free from any adverse influence, providing the best possible environment for the *embryo/foetus*. Considering *embryo/foetus*, it should be always kept in mind amazing aspect of these parts of human life in which the mother and the *embryo/foetus*, although locked in the most intimate relationships, are at ALL TIMES two separate people. Accepting *embryo/foetus* as the person opened new set of questions about its personality and human rights. Today, synthesis between scientific data and hypotheses, philosophical thought, and issues in the humanities, has become pressing necessity in order to deal with ethical, juridical and social problems arising from man's interference in many aspects and stages of life. (2)

DEFINITION OF THE LIFE

Proper answer to the question "How to define human life?" is complicated. Nowadays dilemmas consider the respect of human life from the birth to death involving not just biology but other sciences also. Philosophy, theology, psychology, sociology, law and politics evaluate this topic from different point of views. Integration of all would result proper definition.

Some authors say that that life as such does not exist- no one has ever seen it. Szent-Gyorgy says that noun "life" has no significance because there is no such thing as "life". Le Dantez holds that the expression "to live" is too general and that it is better to say a dog "dogs" or a fish "fishes" than a dog or a fish lives. (3)

When defining life it should be considered not just life as it is today but as it might have been in its primordial form and as it will be in the future. All present forms of life appear as something completely new. Life, than, is transferred and not conceived in each new generation. Furthermore, the phenomenon of life has existed on Earth for approximately 3.5 billion years. Consequently, although the genome of a new embryo is unique, the make-up of embryo is not new. If life is observed through the cell than every life (and human also) is considered as a continuum. Human cells and the mankind have been existing on the Earth continuously since the appearance of the first man. However, if definition refers to the single human being or present population, the statement "human life is a continuum" is not acceptable. (4)

Life, in a true sense of word, begins when the chemical matter gives rise, in a specific way to an autonomous, self-regulating, and self-reproducing system. Life is connected with a living being, and it created its own system as an indivisible whole - forms its individuality. One of the most important characteristics of living beings is reproduction. Reproduction is a mean of creating new life by transferring forms of old one into newly formed human being. Therefore, variability, individual development and harmony characterize human beings. Individuality is the most essential characteristic of human being consisting new life but also all human life forms through the evolution, characterized by phenotype, behaviour and the capability to recognize and adapt. Human embryo and foetus gradually develop into these characteristics.

Although we should not forget that in the same way today's research is tomorrow's benefit (1), concerning human life conclusions should not be treated one-sidedly, from one perspective. This reality should be regarded in all its richness: embryo gives biologist, geneticist substance for consideration, but since we are talking about the beginning of a human life, it requires philosophical-

anthropological consideration, theology and social sciences as well. In its protection, we have to include ethics and law. This approach leads to conclusion that it is necessary to reject reductionism as well as integrism and to find "golden middle" in between these two methodologies.

SCIENTIFIC APPROACH

Biology characterizes human being by dynamics of the system and its self-control (homeostasis), excitability (response to stimuli of different nature and origins) self-reproducibility, the heredity of the characters, and the evolutionary trend.

For biologists it is important to specify which form of life phenomena, we are referring to: cell, organism population or species. The basic level of organization and the simplest form of life is the cell. Biologically speaking human cellular life never stops - or if it did, the extinction of the human species would result -and is passed on from one generation to another. Human individual organism life is defined within its life cycle, which is temporary limited; i.e. it has a beginning and the end. (5) It is obvious that life is a highly dynamic phenomenon, which could be described and explained through the careful study of life processes and interactions by interdisciplinary approach. In human spermatozoa and the oocyte are two essential cells involved in creating human life. It is clear that biologists are most qualified to render judgement on this matter. Understanding of beginning of human life and development of the *embryo/foetus* could provide definitive resolution. However, with a recent possibility of visualizing early human development virtually from conception. Perinatologists should be those who by study, training, practice and research are singularly qualified. (6)

The science enables us data about physical development of the human being but does not provide information about its personality and personal-hood.

HUMAN EMBRYOGENESIS

Only proper understanding of the process of human embryogenesis enables answering scientifically the question when the life cycle of human individual starts. Therefore, in the following text the main steps of the human developmental process are going to be briefly described, primarily during the first 15 days after fertilization.

A human being originates from two living cells: the oocyte and the spermatozoon transmitting the torch of life to the next generation. The oocyte is a cell approxi-

mately 120 μ m in diameter with thick membrane, known as the zona pellucida. The spermatozoon moves, using the flagellum or tail, and the total length of the spermatozoon including the tail is 60 μ m. (7)

After singamy, the zygote undergoes mitotic cell division as it moves down the fallopian tube toward the uterus. A series of mitotic divisions then leads to the development of the preembryo. The newly divided cells are called blastomeres. From 1 to 3 days after singamy, there is a division into two cells, then four cells. Blastomeres form cellular aggregates of distinct, totipotent, undifferentiated cells that, during several early cell divisions, retain the capacity to develop independently into normal preembryos. As the blastocyst is in the process of attaching to the uterine wall, the cells increase in number and organize into two layers of cells. Implantation progresses as the outer cell-layer of the blastocyst, the trophoblast, invades the uterine wall and erodes blood vessels and glands. Having begun five or more days after fertilization with the attachment of the blastocyst to the endometrium of the uterus, implantation is completed when the blastocyst is fully embedded in the endometrium several days later. Even during these 5-6 days, modern medicine introduces the possibility of making preimplantation genetic diagnosis.

However, at this time, these cells are not yet totally differentiated in terms of their determination to specific cells or organs of the embryo. The term preembryo, then, includes the developmental stages from the first cell division of the zygote through the morula and the blastocyst. By approximately the 14th day after the end of the process of fertilization, all cells, depending on their position, will have become parts of the placenta and membranes or the embryo. The "embryo" stage, therefore, begins approximately 16 days after the beginning of the fertilization process and continues until the end of 8 weeks after fertilization, when organogenesis is complete. (8)

Pre-embryo is the structure that exists from the end of the process of fertilization until the appearance of a single primitive streak. Until the completion of implantation pre-embryo is capable of dividing into multiple entities, but does not contain enough genetic information to develop into an embryo: it lacks of genetic material from maternal mitochondria and of maternal and parental genetic messages in the form of messenger RNA or proteins. So, during the preembryonic period has not yet been determined with certainty that a biological individual will result or would it be one or more (identical twins forming), so that the assignment of full rights of a human person is inconsistent with biological reality.

A conclusion is that the pre-embryo requires the estab-

ishment of special rules in the society: it cannot claim absolute protection based on claims of personhood; although meriting respect, it does not have the same moral value that a human person has. Today, one largely accepted opinion is that until the 14th day from fertilization or at least, until implantation -the human embryo may not be considered, from the ontological point of view, as an individual.

Genetic uniqueness and singleness coincide only after implantation and restriction have completed, which is about 3 weeks after fertilization. Until that period, the zygote and its sequelae are in a fluid process, are not physical individual, and therefore cannot be a person.

It is well known that high percentages of oocytes, which have been penetrated never, proceed on to further development, and that many oocytes which do, are thwarted 50 early in their development that their presence is not even recognized. It is suggested that 30% of conceptions detected by positive reactions to human chorionic gonadotropin (HCG) tests abort spontaneously before these pregnancies are clinically verified.

The newly conceived presents itself as a biologically defined reality. However, the status of the pre-embryo as an individual remains a great mystery. In the present scientific scene especially with the progress of ultrasound technologies, prenatal psychology and therapeutics opened a window into prenatal-life of embryo and foetus confirming the evidence that the embryo/foetus is a true subject itself.

PERSONALITY

Defining personality is very complex. There is still no clear definition of personality. One dictionary offers, "what constitutes an individual as distinct person", but does not define what the "what" is. Another dictionary asserts "the state of existing as a thinking intelligent being". This definition might lead to the inference that personality increases pro rata with intelligence, or that some people may not have a personality at all if we followed Bertrand Russell's dictum that "most people would rather die than think and many, in fact, do!" Ken Stallworthy's Manual of Psychiatry is more help with the definition that "personality is the individual as a whole with everything about him which makes him different from other people" because we can certainly distinguish foetuses from each other and from other people. With the next sentence - "personality is determined by what is born in the individual in the first place and by everything which subsequently happens to him in the second" -we are really in the field.

Led by truism "No insignificant person was ever born"¹⁰ human being should be valued from the birth to natural death. But as always, in nowadays world when truism is turned on its head when a person is selectively devalued, made insignificant on the basis, for example, of skin colour, religious belief etc. Therefore, it is hard to establish proper values and exact definitions. This comes especially to sight when prenatal-life is considered. Above stated truism opens important question: "Is the person -unborn a person in the first place and, if so, is the person -unborn a "significant" person?" (6)

Let us evaluate further present controversies. There is no doubt that the embryo and foetus *in utero* are human individuals prior to birth. The child that is born is the same developing human individual that was in the mother's womb. Birth alone cannot confer natural personhood or human individuality. This is confirmed by preterm deliveries of babies who are as truly human and almost as viable as those whose gestation goes to full term. All the known evidence support the human foetus being a true ontological human individual and consequently a human person in fact if not in law. A human being cannot begin before the appropriate brain structures are developed that are capable of sustaining awareness. The same applies to a grossly malformed foetus. It would still be a human individual even if its human nature was not perfect nor its functions quite normal. Nobody questions the humanity of a Down's syndrome foetus or child. A foetus or child with severe open *spina bifida* is none the less a human being. The same should be said for the live an encephalic foetus or infant with only brain stem functions. It is a human individual even if it lacks a complete brain and usually survives birth by only a few hours or a day. Human society created several standards in defining "person", "human being" based on what is familiar and easy recognizable. For example: a human speaks, understands, and laughs. Absence of these characteristics (mutism, autism, and stoicism) does not disqualify. To the contrary, conclusion is that the characteristics we have come to associate with being a person may not be applicable to each individual person. Therefore, it is necessary to establish criteria for definition of "person" in society and in time. Italian Professors committed themselves to care for embryo in such a way, the same dignity to every patient and the human conditions to grow and develop, to educate others inside and outside the speciality and carry out researches involving all the components of society.

BIOETHICAL ASPECTS

The idea of embryo/foetus as the miniaturized infant or adult is true in extent that the embryonic /foetal physiologist must be able to apply knowledge of every system obtained in born, yet quite untrue in failing to recognize

the many ways in which life before birth differs fundamentally from life after birth. The newly conceived form presents itself as the biologically defined reality: it is an individual that is completely human in development that autonomously, moment by moment without any discontinuity, actualizes its proper form in order to realize through intrinsic activity, a design present in its own genome. Embryo as a patient is best understood as the subset of the concept of the foetus as the patient. These two concepts opened whole set of questions regarding ethical problems. The embryo as the patient is indivisible from its mother. However, balance is needed in protection interests of embryo/foetus and the mother. One prominent approach to understanding the concept of the embryo/foetus as a patient has involved attempts to show whether the embryo/foetus has independent moral status or personhood. (11), (12) Independent moral status for the foetus would mean that one or more of characteristics possessed either in, or of the *embryo/foetus* itself and, therefore, independently of the pregnant woman or any other factor, generate and therefore ground obligations to the embryo/foetus on the part of the pregnant woman and her physician.

A wide range of intrinsic characteristics has been considered for this role, e.g., moment of conception, implantation, central nervous system development, quickening, and the moment of birth. (13) Given the variability of proposed characteristics, there are many views about when the embryo/foetus does or does not acquire independent moral status. Some take the view that the *embryo/foetus* possesses independent moral status from the moment of conception or implantation. Others believe that the *embryo/foetus* acquires independent moral status in degrees, thus resulting in "graded" moral status. Still others hold, at least implicitly, that the embryo/foetus never has independent moral status 50 long as it is *in utero*. (14) Being a patient does not require that one possesses independent moral status. (15) Being a patient means that one can benefit from the application of the clinical skills of the physician. (16) Put more precisely, a human being without independent moral status is properly regarded as a patient when the following conditions are met: that a human being is presented to the physician for the purpose of applying clinical interventions that are reliably expected to be efficacious, in that they are reliably expected to result in a greater balance of goods over harms in the future of the human being in question. In other words, an individual is considered a patient when a physician has beneficence-based ethical obligations to that individual.

To clarify the concept the *embryo/foetus* as the patient, beneficence-based obligation is necessary to be provided. Beneficence-based obligations to the foetus and embryo exist when the foetus can later achieve inde-

pendent moral status. This leads to conclusion that ethical significance of unborn child is in direct link with the child to be born -the child it can become.

LEGAL STATUS OF THE EMBRYO

When discussing law, it should be always kept in mind that medicine is international, but law is not.

The status of the human embryo is not juridical defined and relies on the political, social, and religious influences in each country. It is hard to answer the question when human life should be legally protected. At the time of conception? At the time of implantation? At the time of birth? In all countries (except Ireland and Liechtenstein) juridical considerations are based on Roman law. Roman civil law says that the foetus has right when it is born or if it is born-nasciturus.

Few countries agree with definition of beginning of human personality the time of conception. The majority does not grant legal status to the human embryo *in vitro* (i.e., during the 14 days after fertilization). Thus, even in the absence of legal rights, there is no denying that the embryo constitutes the beginning of human life, a member of the human family. Therefore, whatever the attitude, every country has to examine which practices are compatible with the respect of that dignity and the security of human genetic material.

ARGUMENTS FOR BEGINNING OF HUMAN LIFE AND HUMAN PERSON AT FERTILIZATION

The fundamental approaches of biomedical and social practice must begin with the understanding that the subject before birth is a person and that "personhood" is conferred by successful fertilization of the egg. To hide from this in silence or ignorance should be unacceptable to all as stressed by Scarpelli. (6)

View that human life begins when sperm and eggs fuse to give rise to a single cell human zygote whose genetic individuality and uniqueness remain unchanged during normal development is widely supported. Because the zygote has the capacity to become an adult human individual, it is thought it must be one already. The same zygote organizes itself into an embryo, a foetus, a child and an adult. By this account, the zygote is an actual human individual and not simple a potential one in much the same way as an infant is on actual human person with potential to develop to maturity and not just a potential person. As Scarpelli pointed out recently outside the realm of religious dogma, there has been no one, whose existence can be traced back to any entity other than the

fertilized egg. The biological line of existence of each individual, without exception begins precisely when fertilization of the egg is successful.

The process of fertilization actually begins with conditioning of the spermatozoon in the male and female reproductive tracts. Thereafter, fertilization involves not only the egg itself but also the various investments, which surround the egg at the time it is released from the ovary follicle. Fertilization, therefore, is not an event, but a complex biochemical process requiring a minimum of 24 hours to complete singamy, that is the formation of a diploid set of chromosomes. During this process, there is no commingling of maternal and paternal chromosomes within a single nuclear membrane (pre-zygote); after this process the parental chromosomes material is commingled (zygote).

Among the many other activities of this new cell, most important is the recognition of the new genome, which represents the principal information centre for the development of the new human being and for all its further activities. For the better understanding of the very nature of the zygote, two main features are to be at least mentioned here. The first feature is that the zygote exists and operates from singly on as a being, ontologically one, and with a precise identity. The second feature is that the zygote is intrinsically oriented and determined to a definite development. Both identity and orientation are due essentially to the genetic information with which it is endowed. That is why many do believe that this cell represents the exact point in time and space where a new human individual organism initiates its own life cycle.

ARGUMENTS AGAINST BEGINNING OF HUMAN LIFE AT FERTILIZATION

Today, one largely accepted opinion is that until the 14th day from fertilization

or at least, until implantation -the human embryo may not be considered, from the ontological point of view, as an individual. There are at least five main reasons in favour of this opinion:

1. Before formation of embryonic disk embryo is "a mass of cells genetically human", "a cluster of distinct individual cells" which are each one "distinct ontological entities in simple contact with the others" (18)

2. Until approximately the 14th day after fertilization, all that happens is simply a preparation of the protective and nutritional systems required for the future needs of the embryo. Only when entity called embryonic disc is formed can develop into a foetus and thence into a foetus. (19)

3. Monozygotic twins phenomenon or chimeras can occur. In fact, this seems to be the strongest reason why the embryo is denied the quality of individuality and as a proof that the zygote cannot be an ontologically human being. In approximately one third of cases the embryo divides at about the two cells stage and in the other two thirds the inner cell mass divides within the blastocyst from day 38. Occasionally, the division takes place from day 8-12 but usually it is not complete thereby forming conjoined identical twins on two-headed individuals.

4. Co-existence of the embryo with its mother is a necessary condition for an embryo belonging to the human species and this condition can be obtained only at implantation (13). However, there is evidence that development of human embryo in vitro can continue well beyond the stage of implantation, and that mouse embryos implanted under the male renal capsule can reach the foetal stage. It is also argued, or at least implied, that 50 many human embryos die before or after implantation that is would be lacking in realism to accept that the human individual begins before implantation.

It is well known that high percentages of oocytes, which have been penetrated never, proceed on to further development, and that many oocytes which do, are thwarted 50 early in their development that their presence is not even recognized. Up to 50% of ovulated eggs and zygotes recovered after operations were found 50 grossly, abnormal that it would be very unlikely that they would result in viable pregnancies. It is also suggested that 30% of conceptions detected by positive reactions to human chorionic gonadotropin (HCG) tests abort spontaneously before these pregnancies are clinically verified. The scientific literature is not unanimous on the incidence of natural wastage prior to, and during, implantation in humans, varying from 15% to as much as 50%. The vast majority of these losses are due to chromosomal defects caused during gametogenesis and fertilization. (20)

Genetic uniqueness and singleness coincide only after implantation and restriction have completed, which is about 3 weeks after fertilization. Until that period, the zygote and its sequelae are in a fluid process and are not physical individual and therefore cannot be a person.

5. The product of fertilization may be a tumour, an hydatidiform mole or chorioepithelioma. Though the mole is alive and of human origin, it is definitely not a human individual or human being. It lacks a true human nature from the start and has no natural potential to begin human development.

A teratoma is another clear instance of cells developing abnormally that results from the product of fertilization, but which could not be considered to be a true human

individual with a human nature. It has no potential to develop into an entire foetus or infant. Clearly, the foetus with the teratoma would be a human individual, but not the attached teratoma itself. Obviously, not all the living cells that develop from the concept, the early embryo or the foetus form an integral part of a developing human individual.

DIFFERENT RELIGIOUS TEACHINGS AND HISTORICAL ASPECTS

Catholic Church's teachings are clearly described in the Introduction *Donum Vitae*: "A human creature is to be respected and treated as a person from conception and therefore from that same time his (her) rights as a person must be recognized, among which in the first place is the invaluable right to life of each innocent human creature".

In 1997, the third Assembly of the pontifical Academy for life was held in Vatican City. It has been concluded that "at the fusion of two gametes, a new real human individual initiates its own existence, or life cycle, during which -given all the necessary and sufficient conditions - it will autonomously realize all the potentialities with which he is intrinsically endowed. The embryo, therefore, from the time of gametes fuse, is a real human individual, not a potential human individual. It was even added that recent findings of human biological science recognize that in zygote resulting from fertilization the biological identity of a new human individual is already constituted. (21),(22)

In Western Europe and in the North and South America these opinions are mostly based on Judeo-Christian theology, in Arabian Countries, in Africa and in Asia prevail the influences of the Islamic and Budish religions. Although their approach to the beginning of human life is impressively similar, each of these religions has different attitudes to the problem of embryo research, infertility and its therapy. In a fact, while the Jewish attitude towards infertility is expressed in the Talmud sayings and in the Bible (synthesized in the first commandment of God to Adam "Be fruitful and multiply"), the Christian point of view establishes no absolute right to parenthood. According to the Islamic views, attempts to cure infertility are not only permissible, but also a duty. Buddhism has imposed strict ethics on priests, but it has relatively lenient attitudes toward lay people, so if medical treatment for infertility is available, people should make use of it.

For about two thousand years the opinions of Aristotle, the great Greek philosopher and naturalist, on the beginning of the human being were commonly held. He argued

that the male semen had a special power residing in it, *pneuma*, to transform the menstrual blood, first into a living being with a vegetative soul after seven days and subsequently into one with a sensitive soul 40 days after contact with the male semen. (23)

Aquinas adopted Aristotle's theory but specified that rational ensolement took place through the creative act of God to transform the living creature into a human being once it had acquired a sensitive soul. The first conception took place over seven days while the second conception or complete formation of the living individual with a complete human nature lasted 40 days. (24) Hippocrates believed that entrance of the soul into the male embryo occurred on the thirtieth day of intrauterine life. It entered into the female embryo on the fortieth day. Actually, this idea was a considerable improvement on the scheme found in the Book of Leviticus, where it is suggested that the soul does not enter the female until forty days after the conception. (25) In short, the rational soul enables the matter to become a human being, an animated body, an embodied soul, a human person. Harvey's experiments with deer in 1633 proved Aristotle's theory of human reproduction wrong, without himself finding a satisfactory explanation of human conception. After modern scientists discovered the process of fertilization most people took for granted that human being, complete with a rational soul, began once fertilization had taken place.

It is clear that the answer to the question "When has the human being actually come to life?" could only be given by combining the cognition of different religions, philosophy and various biological scientific disciplines. There is a very fine line between the competence of science and the one of metaphysics, and it greatly depends on the individual's philosophical principles. Those two, more or less autonomous intellectual disciplines have very often tried dominating one another, or ignoring each other. It is only recently that the majority of scientists and some theologians have come to realize that the separate meanings of scientific and religious "truths" complement themselves thus representing methodologically independent entities. Current science is not interested in what Nature is, but in the facts that could be started regarding it, thus trying to explain the term, rather than inventing it. The main difference between science and religion can be seen in the fact that scientific "truths", unlike religious postulates, can and must be experimentally verified and the methods of scientific cognition can be easily explained and learnt. While religion favours irrationality, science prefers an entirely rational approach to matters of importance. Intellectual cognition when scientifically expressed usually is in a form of mathematical formulas and presented quantitatively. On the contrary, religion tends to keep its truths in a form of metaphoric expres-

sions, preferring qualitative. Today, there is a tendency, on a higher level, to reopen the dialogue between the science and religion, which was present at the very beginning of our culture. Religion had existed long before science came to life, but science is not to be thought of as a continuation of the religion. Each discipline should preserve its principles, its separate interpretations and its own conclusions. In the end, both of them represent different components of the one and indivisible culture of mankind.

VISUALIZATION OF EARLY HUMAN DEVELOPMENT

Significant advances have been made in recent years in visualizing and analyzing the earliest human development. Most of them have been done by introduction of three-dimensional colour Doppler sonography.

Many new parameters about early human development are now studied by Doppler ultrasound. Considerable number of biochemical, morphological and vascular changes occur within the follicle during the process of ovulation and luteinization and most of them can be studied by transvaginal ultrasound with colour Doppler and 3D facilities. (26) If the oocyte is fertilized the embryo is transported into the uterus where under a favourable hormonal and environmental conditions, it will implant and develop into a new and unique individual. The introduction of transvaginal colour Doppler improved the recognition of blood vessels enabling detailed examination of small vessels such as arteries supplying preovulation follicle, corpus luteum and endometrium.

Perifollicular vascularization can help in identification of follicles containing high quality oocytes, with a high probability of recuperating, fertilizing, cleaving and implanting, while 3D ultrasound enables accurate morphological inspection and detection of cumulus oophorus. Follicles without visualization of the cumulus by multiplanar imaging are not likely to contain fertilizable oocytes. This information is especially useful in patients undergoing ovulation induction.

Following ovulation, the corpus luteum is formed as the result of many structural, functional and vascular changes in the former follicular wall. Colour Doppler studies of the luteal blood flow velocities enable evaluation of the corpus luteum function in second phase of menstrual cycle and early pregnancy. When the placenta takes over the role of production of progesterone, the corpus luteum starts regressing. After ovulation there is a short period during which the endometrial receptivity is maximal. During these few days a blastocyst can attach the endometrium and provoke increased vascular permeability and vasodilatation at the implantation site.

Trophoblast produced proteolytic enzymes cause the penetration of the uterine mucosa and erode adjacent maternal capillaries. This results in formation of the intercommunicating lacunar network -the intervillous space of the placenta. A small intradecidual gestational sac can be visualized by transvaginal sonography between 32 and 34 days. (27)

The secondary yolk sac is the earliest extraembryonic structure normally seen within the gestational sac in the beginning of the 5th gestational week. The yolk sac volume was found to increase from 5 to 10 weeks of gestation. When the yolk sac reaches its maximum volume at around 10 weeks it has already started to degenerate, which can be indirectly proved by a significant reduction in visualization rates of the yolk sac vascularity. Therefore, a combination of functional and volumetric studies by 3D power Doppler helps to identify some of the most important moments in early human development.

The embryonic heart begins beating on about day 22-23, accepting blood components from the yolk sac and pushing blood into the circulation. The embryonic blood begins circulating at the end of the 4th week of development.

The start of the embryo-chorionic circulation changes the source of nourishment to all intraembryonic tissues. The survival and further development of the embryo become dependent on the circulation of embryonic/foetal blood. If the embryo-chorionic circulation does not develop, or fails, the concept is aborted. The embryo cannot survive without the chorion (placenta) and the chorion will not survive without the embryo. A vascular degenerated chorionic villi constitute the hydatidiform mole.

Within the embryo, there are three distinct blood circulatory systems:

1. Vitelline circulation (from yolk sac to embryo)
2. Intraembryonic circulation
3. Two umbilical arteries (from embryo to placenta - foetoplacental circulation)

It is possible to visualize and assess them virtually from conception. (28),(29),(30),(31),(32)

At five weeks from the maternal side of placenta, it is possible to obtain simultaneously three-dimensional imaging of the developing intervillous circulation during the first trimester of pregnancy. Three-dimensional power Doppler reveals intensive vascular activity surrounding the chorionic shell starting from the first sonographic evidence of the developing pregnancy during the 5th week of gestation.

At seven weeks, three-dimensional power Doppler images depict aortic and umbilical blood flow. Initial branches of umbilical vessels are visible at the placental umbilical insertion.

During the 8th and 9th week, developing intestine is being herniated into the proximal umbilical cord.

At nine to ten weeks, herniation of the mid-gut is present. The arms with elbow and legs with knee are clearly visible, while feet can be seen approaching the midline.

At eleven weeks, three-dimensional power Doppler imaging allows visualization of the entire foetal and placental circulation.

During the 11th-12th week of pregnancy development of the head and neck continues. Facial details as nose, orbits, maxilla and mandibles are often visible. Herniated mid-gut returns into the abdominal cavity.

NEW POSSIBILITIES FOR STUDYING EMBRYONIC MOVEMENTS AND BEHAVIOUR

The latest development of 3D and 4D sonography enables precise study of embryonic and foetal activity and behaviour. (33) With four-dimensional ultrasound movements of head, body and all four limbs and extremities can be seen simultaneously in three dimensions. (34) Therefore, the earliest phases of the human anatomical and motor development can be visualized and studied simultaneously. It is clear that neurological development -early foetal motor activity and behaviour needs to be re-evaluated by this new technique. (35),(36) Recently, our group studied the development of the complexity of spontaneous embryonic and foetal movements. (37) With advancing of the gestational age the movements become more and more complex. The increase in the number of axodendritic and axosomatic synapses between 8 and 10 and again between 12 and 15 weeks (38) correlates with

the periods of foetal movement differentiation and of the onset of general movements and complex activity patterns such as swallowing, stretching and yawning, seen easily by 4D technique. Seven to eight weeks of pregnancy gross body movements appear. They consist of changing the position of head towards the body. Nine to ten weeks of pregnancy limb movements appear. They consist of changing of position of extremities towards the body without the extension or flexion in elbow and knee. Ten to twelve weeks of pregnancy, complex limb movements appear. They consist of changes in position of limb segments towards each other, such as extension and flexion in elbow and knee.

Twelve to fifteen weeks of pregnancy, swallowing, stretching, and yawning activities appear. In addition to these activities, it is now feasible to study by 4D ultrasound a full range of facial expression including smiling, crying and eyelid movement.

It is hoped that new 4D technique will help us for better understanding of both somatic and motor development of early embryo. It will also enable reliable study of foetal and even parental behaviour.

CONCLUSION

“Self-awareness is, one of the fundamental possibility, the most fundamental characteristic of the human species. This characteristic is an evaluation novelty; the biological species form which mankind has descended had only rudiments of self-awareness has however, brought in its train somber companions- fear, anxiety and death awareness” T. Dobzhansky

The question when a human life begins and how to define it could be answered only through the inner-connecting pathways of history, philosophy and medical science. It has not been easy to determine where to draw the fine line between the competence of science and metaphysics in this delicate philosophical field. To a large extent, the drawing of this line depends on one's fundamental philosophical outlook.

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