

APPROACH TO THE FETAL MOVEMENTS

A pilot study of six cases

Theodolinda Mestriner Stocche¹, Carolina Araújo Rodrigues Funayama²

ABSTRACT - The aim of this study was to verify developmental aspects of fetal movements through 2D ultrasonic recordings of normal fetuses, product of low risk pregnancies. A qualitative analysis of the several types of movements was performed in a sample of six fetuses, each four weeks, from 12th to 40th gestational week. In the close period to 20th gestational week it was registered the largest prevalence of movements. It was observed that certain movements disappear, and others stay or appear through period. Complex movements (breathing, deglutition and suction) were more frequent after the 20th week than before. In spite of the fetuses have presented a general motor pattern, individual variations were observed. These findings are in consonance with literature, toward the existence of certain motor pattern, with emergence and disappearance of the several types of movements according to the gestational age, and individual variations that suggest specificity.

KEY WORDS: human fetus, development, movement.

Abordagem sobre movimentos fetais: estudo piloto de seis casos

RESUMO - O objetivo deste estudo foi verificar aspectos do desenvolvimento de movimentos fetais por gravações de ultra-sonografia 2D de fetos normais, produto de gravidez de baixo risco. Análise qualitativa dos vários tipos de movimentos foi realizada em uma amostra de seis fetos registrados a cada quatro semanas, de 12 a 40 semanas gestacionais. No período da 20^a semana gestacional ocorreu a maior prevalência de movimentos, considerando toda a amostra. Observou-se que certos movimentos desaparecem, outros permanecem e outros surgem durante o período analisado. Movimentos complexos foram menos detectados no princípio da gestação, aumentando depois da 20^a semana. Apesar dos fetos apresentarem um padrão motor comum, foram observadas variações individuais. Tais achados estão de acordo com a literatura, apontam para um padrão motor com aparecimento e desaparecimento dos vários tipos de movimentos de acordo com a idade gestacional e com variações individuais que sugerem especificidade.

PALAVRAS-CHAVE: feto humano, desenvolvimento, movimento.

The study of the evolution and complexity of the fetal movements presents special importance for larger knowledge of the human development. To study the evolution of the fetal motor development we should consider the periods before and after the coming of the ultrasonic scan in the decade of 1960. The visual exploration in real time of the fetal activity propitiated great knowledge of this period until then mystified.

Studying fetuses that maintained excellent physical, neurological and mental development to child at school age, we believed to be contributing with items truly normal of the fetal development.

The aim of this work was to verify and discuss some developmental aspects of the fetal movements through ultrasound recordings of normal fetuses, products of pregnancies of low risk.

METHOD

This study was approved by the Committee of Ethics in Research of the Hospital of the Clinics (School of Medicine at Ribeirão Preto, São Paulo University), where the analysis of the present material was accomplished.

Constitution of the multidisciplinary equip and their functions - The team was constituted by a coordinator (author of this work), a gynecologist ultrasonographer, who

School of Medicine at Ribeirão Preto, São Paulo University, Ribeirão Preto SP, Brazil: ¹Psychoanalyst, Master in Neuroscience; ²Pediatric Neurologist, PhD.

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Dra. Carolina Araujo Rodrigues Funayama - Departamento de Neurologia, Hospital das Clínicas USPRP - 14048-900 Ribeirão Preto SP - Brasil. E-mail: carfunay@fmrp.usp.br

Table 1. Characterization of pregnant.

Pregnant	Age (years)	Profession	Color	Gestation	Marital status
1	32	academical teacher	white	1	married
2	28	secretary	white	1	married
3	30	teacher	white	1	married
4	31	Nurse	white	2	married
5	32	secretary	white	2	married
6	31	academical teacher	white	1	marital

Table 2. Conditions of the childbirth.

Fetus	Gestational age (weeks)	Weight	Height	Apgar at 5 min	Childbirth	Sex
F1	39	2950 g	49 cm	10	Cesarean	M
F2	41	3450 g	51 cm	10	Cesarean	M
F3	39	2900 g	49 cm	10	Cesarean	M
F4	39	3000 g	50 cm	10	Vaginal	F
F5	39	3000 g	49 cm	10	Cesarean	M
F6	40	3400 g	50 cm	10	Vaginal	F

performed the selection of the health pregnant, and five observers previously prepared for the first author of this work to exercise their functions: readings of the main subject to be treated; initial contact with each pregnant selected, to the consent for the accomplishment of the study. The observers accompanied the sessions of ultrasound of the fetus writing down in the research protocol: a) the fetal movements; b) the parents' behavior during the accomplishment of the ultrasound, focus of another search; c) weekly meetings of study and revision of the images of the ultrasound recorded in video cassette.

Selection criteria – The criteria for the pregnant inclusion and newborn in the research were quite meticulous (Tables 1 and 2), and of the 31 women, only six were included for the protocol.

Characterization of the fetal movements – An ultrasound with 2D images was used, and the movements were characterized based on the observations described by Prechtl¹, collected each four weeks, from 12th to 40th gestational week. It was observed the presence or absence of the several types of movements without registering the number of times that each movement was accomplished. The observers also wrote down the individual behaviors of the fetuses in relation to his/her uterine environment.

Characterization of the postpartum sample – The observer, whenever possible, was present during the childbirth and obtained concrete information of newborn vitality through the pediatric record. Soon afterwards, each observer went to attend the couple's mother-son for the first sucking.

During the first year of life, the observer visited the family that had accompanied during the pregnancy, once a week, during one hour. In these sessions, all were written down of the baby's manifestations and of his/her relationship with mother or substitute, being used of the technique of Bick². The observations continued for the second year every fifteen days. After second year, the coordinator maintained the annual periodic evaluations with the families, obtaining information on the development and the children's motor to the eight year-old age.

There were only included in the study the fetuses that gave origin children with normal neuropsychomotor development and behavior. For evaluation and characterization of the development children's normality, the patterns were used according to Illingworth³.

RESULTS

Analysis in groups of the movements – We observed that the several types of movements presented larger prevalence in the fetus, at the beginning of the gestation, among them the shocks, widespread movements and movements of the trunk. Other types of movements stayed with stable prevalence, while others increased (Table 3). The ocular movements and bladder emptying were difficult to identify with the resolution of the image.

Other types of movements as somersaults and pedaling only happened in the half of the pregnancy, therefore they were not classified in the Table 3.

Specificity – Among the fetuses (named F1 to F6)

Table 3. Tendencies of the several types of movements during the gestation.

Decreased	Stable	Increased
Shocks	Flexing and extending members	Suckling
Widespread movements	Rotation and lateral balance of the head	Breathing
Movements of the trunk	Opening and closing mouth	Lateral gaze and blinking
	Yawning	Resting
	Bladder emptying	Swallowing
		Hiccup

it was observed predilection for certain movements. The F4 presented the movement of lateral rotation of the head in all of the sessions, while F1 only presented in the 20th and 24th weeks. Similar results were observed in the lateral balance of the head, in which F4 presented the movement in five of the six sessions and F2 in none. In other types of movements, suction, yawn, hiccup, pedaling, somersaults, also individual patterns were observed.

Some behaviors got the parents' attention and/or of the observers that spontaneously described them. While F2 manipulated the umbilical cord seeming "to play" to climb it, F4 gave pirouettes, F1 kicked the placenta, sometimes with such intensity that got to deform it, F6 "played", preferentially, with their hands, going them lazy by the body or sucking them, and F5 whenever wanted to rest, it reduced his/her activity and "it sought" to accommodate in certain place where the pulsation of the abdominal aorta printed him/her right movement, that we called lulling.

These behaviors described for each fetus repeated in more than one session, characterizing a certain predilection of behaviors.

DISCUSSION

In the present study the observers concentrated on the quality of the executed movements of the normal fetus, not including in the analysis its frequency during the session. With the beginning of the study in the 12th week it was not possible to observe the first fetal movements. In agreement with the literature happen in the 7th and half post-menstrual week¹. Since the beginning of the observations, the fetuses showed a great variety of movements, observed to every four weeks of gestation.

Fetal motor activity – In the present study, a number relatively small of movements was observed in the beginning of the observations (12th week). The movements increased in types, reaching the period of larger movement in the 20th post-menstrual week. They stayed relatively stable in the 24th and 28th weeks and decreased progressively until delivery from 36

to 40 weeks. In the second ultrasonic session, at 16 weeks, a great evolution was observed in the quality of the movements. The breathing movements were more evident, the suction and the deglutition, clearer and the motor repertoire appeared entirely. The differences in the behavioral characteristics of each fetus became more evident. In the 20th week, the segmental movements developed and they still came more diversified. They performed somersaults, kicked the uterine wall, caught the umbilical cord, swallowed amniotic liquid, presented sob, and the breathing movements were stronger. All that combination of movements seems private for each fetus. In the 24th week, the fetuses no longer floated, their volumes crossed the one of the amniotic liquid. As they were more contained could have larger contact with the uterine environment. The patterns of the movements were changed; the free flotation from the beginning was substituted by the contact of the inferior members with the uterine wall, appearing the denominated movement of stepping. This can be the beginning of the walking reflex.

As the fetuses went growing, the autonomous movements became vigorous, probably getting ready for the childbirth. The fetuses presented significant increase of the movements of to open and to close the mouth, to swallow, suction of the hands or of the fists, producing perioral stimulation. Besides, they showed rest periods more frequently. In this period, the variables that constitute and determine the behavioral states, heart frequency, eyes and body movements settle down⁴.

Respected the individual differences, it seems that a pattern of consequent motor activity comes from ontogenetic characteristics and modified by the atmosphere that involves the fetus.

Primitive movements – In the present observation the shocks were just detected in the first half of the gestation. There was difference inter fetuses, since shocks were present in all registered weeks in one, occasional in three and always absentees in two, suggesting an individual motor behavior.

Like shocks, general and trunk movements decreased with progress of the weeks. The general movements disappear at the 24th week and the shocks in the 28th week. The decrease of these types of movements could express only the relative decrease of the consequent intra-uterine space to the corporal growth of the fetus. However, other types of movements stay unaffected and others increase the prevalence. Therefore, the fall in the prevalence of the primitive movements is indicative of the good fetal neurological development, according to Prechtl¹.

Visser et al.⁵ described behavior motor quite altered in anencephalic fetuses, which present abrupt movements with great width and that causes wide position changes in the uterus. In these fetuses, the most apparent alteration was in the quality of the general movements, indicating strong organizing influence of the supra-spinal structures in the normal fetal activity. The demonstration that an incipient neural structure makes possible the presence of general movements helps in the understanding of the production of the normal motor patterns⁶.

Flexing-Extension – According to Brandt⁷, just as it happens in the intra-uterine life, the child born preterm demonstrates spontaneous movements and position changes, and no posture of the body typical of the age happens before the tonus of the extending muscles has increased; then, the extremities stay flexed.

Comparing the flexing movements and extension of the inferior and superior members, in the present study both are present along the gestational period. They appear isolated or maintaining the “flexing-extension” pattern. As for the head’s movement in flexing (nodding), a distribution is observed with two picks, one among to 16th and 20th weeks and the other in the 36th week. The first pick can be related to the “exercise” of the subsequent tonic-cervical control, counterbalanced soon afterwards, for the previous, but with new reinforcement in the 36th week.

Complex movements – The complex movements increased in prevalence, starting from 24 post-menstrual weeks. The opening and closing the mouth is a type of movement that can appear as simple movement or to be associated to the deglutition. The movements of opening the mouth and deglutition are present since the beginning of the observations to the end of the gestation, having a significant increase of the deglutition after 28th gestational week. The probable reason of that is the increase of the liquid ingestion, that varies from 210 to 760 milliliters a day⁸.

The deglutition presents functions of volume regulation of the amniotic liquid, the fetal nutrition and the gustatory chemical-sensorial stimulation of the fetus⁹. The gustatory papillae appear in the fetus in the 8th or 9th weeks of gestation, and about to 12th week are well developed and can receive information of the external taste stimuli. A significant increase of the ingestion occurs when saccharin is injected in the amnion, and the opposite is detected on iodized oil, a bitter flavor. Therefore, the fetus has preference for sweet flavor and displeasure with the bitter flavor^{10,11}.

Similar to deglutition, the suction and breathing movements became more frequent, more vigorous with developing of the gestation. It could be considered as a preparation for the birth. Casaer et al.¹² demonstrated that among preterm babies with good coordination between suction and breathing, only 12% showed poor cardiopulmonary control, while it happened in 79% of those that were unable to coordinate those two activities. It concluded that the observation of the coordination between suction and breathing could be a good method to evaluate the neurological activity in the preterm babies.

The autonomous nervous system seems to become functional in variable apprenticeships of the prenatal life¹³. Although the mechanisms that control the cardiovascular and breathing system appear early in the prenatal life, the coordination of that system grows in subsequent months of the prenatal and postnatal period¹⁴. The chemoreceptors are less influential in the control of the breathing during the neonatal period than later in the childhood¹⁵.

Roodenburget al.¹⁶ pointed that the yawns happened along the gestation in an occasional way, with variable presence, frequently during the active sleep; yawn combines with breathing and general movements and the hiccup happened rarely, presenting a rhythmic way.

In spite of low quality of ultrasonic image, it was possible detect eye movements and that of bladder emptying. The movements of the eyelids, happened in larger prevalence at the 36th week and the horizontal movement of the eyeball from 20th to 36th week. Kozuma et al.¹⁷ found similar result more frequently of movement among to 20th and 32nd weeks. Recent study from Korjak et al.¹⁸ presented results on facial movements. According to these authors the quality of ultrasonic 4D depiction of fetal facial expressions increases with gestational age. The frequency of yawning, tongue expulsion, mouth and eye squeezing, scowling, and isolated blinking ranged

from 1 to 12 per 30-min observation period, and this study showed the ability of 4D sonography to depict different facial expressions and movements, which, according to the authors might represent fetal awareness.

In relation to the bladder emptying, the fetuses ingest and they excrete amniotic liquid maintaining its volume and altering its composition and the action of emptying of the bladder is a good indicator of the normality of the development of the urinary apparatus^{19,20}. For being an activity that regulates the homeostasis, we suppose that the urination should be observed with high frequency.

As the gestational age increases, complex movements that involve superior members, particularly hands, head, mouth and perioral area increase. This fact is indicative of a larger ripening of central nervous system, as demonstrated by D'Elia et al.²¹ and Pretchtl²² in their experiences in the field of the evolutionary neurology.

Among to 16th and 28th week, whenever the feet find the uterine wall, the alternate movements of the inferior members give the impression of they pedal for the space. That movement was denominated by us of "Pedaling", stepping in the English literature²³. DeVries et al.²³ classified the movements of the fetus in "rude movements of the body", that included the three movements for us described (flexing, extension and rotation), besides scaring, to give steps and to contort. In our results we put the movements of giving steps and contortions in the movements that we denominated sophisticated, observed among to 16th and 28th week. The superior members sometimes find the umbilical cord, they seem to catch and climb it, or still to put the hands or the fist in the mouth and to suck them. These last ones become more frequent with the progress of the gestation while the first ones decrease. These movements do not seem to happen at random, but they are addressed for a specific objective²⁴. When there is synchrony in the movements of the superior and inferior members, the movement resembles each other to that of a quadruped, or when crawling of the human baby, according to Kozuma et al.²⁵.

In relation to the other movements of the head, they rarely come isolated. In general the head's movements accompany the one of the trunk, as they happen in the calls sophisticated movements (pirouettes). Pirouettes were described by DeVries et al.²³. Another association of movements of the head and trunk was observed from the 36th week to the end of the gestation, with lateral rotation of the head and propul-

sion of the trunk giving the movement impression similar to that of the bag-cork.

In the present observation it was verified periods of fetal rest. The casuistry increased of the 12th to 16th week and it reached the maximum in the 20th week and stayed like this until the end of the gestation. Sometimes the rest happened with absolute quiet of movements while in other occasions they presented frequent movements that resembled stretching. We also have observed, that as the gestation developed, the duration of the rest increased while the amount of movements decreased, similar to the found in the child soon after the birth.

Does specificity exist in the motor behavior of the fetus? – If we consider the amount and quality of specific movements for normal fetus, inside of a "pat-tem" found in most, there is a great individual variability (specificity). If we consider that each fetus carries own genetic load, that he/she grows in a private uterine atmosphere, and it is subject to the maternal influences as stress, biochemical and hormonal alterations, we can suppose that each one will have a private performance.

The results here presented suggest the presence of fetal movement specificity. Among the movements that presented larger individual differences are the movement of lateral rotation of the head, of lateral balance of the head, suction, yawn, hiccup, pedaling and somersault. The presence of different behaviors was also observed in our study. Among them we found the fetuses playing with the umbilical cord or to climb it, to kick the placenta and to pass the hand for the body or to suck it. Some seemed more active and whenever they approximated of the umbilical cord played it with the hands, while others stayed suitable presenting movements more contained in some space of the uterine cavity, close to the aortic balance.

In the 28th week the behavior of the fetuses is refined and he seems to be very sensitive. One of them resisted the state of maternal stress, when, during the ultrasonography, an intense noise made scaring the mother, and the fetus was anxious seeming to want to flee. Groome et al.²⁶ observed increase of the motive activity of the fetus due to the mother's stress in the 38th week; therefore, we believe that this reaction of the fetus is not characterized as an individual behavior. After each birth, the observers went to attend the first suckling, and the mothers spontaneously commented on that already knew their babies. This comment continued along the weekly visits during the first year of the baby's life

and the behavioral characteristics stayed until it finishes their interview to the 8 years of age. DiPietro et al.²⁷ established the individual differences in the fetal traits, and it correlates with the subsequent infantile temperament. In 31 fetuses, with 20 weeks of gestation, the heart frequency and the fetal movements were registered longitudinally. After the birth, they collected data regarding the temperaments of the children at the 3 and 6 months and concluded that the most active fetuses became active children, difficult to educate, unexpected and with adaptative difficulties. On the other hand, high heart frequencies were associated with low activity level, emotion and predicability. The neurological and behavioral fetal characteristics provide the base for individual differences in reactivity and regulation in the childhood.

However, Eisenberg²⁸ considers that the uterine atmosphere is relatively uniform, what results in predominance of the genetic factors, in the neurological and motor development fetal. In this context, the specificity of the motor behavior of the fetus was mentioned by several researchers^{1,28,29}.

Concluding, in the present pilot study the observation of movements in six proven health fetuses during ultrasound scan sessions between 12th and 40th gestational weeks suggests, in consonance with literature^{1,7,8,16}, that a pattern of fetal movement exists in agreement with the gestational age and that the several types of movements present characteristics at the beginning, constancy, duration and final, what allowed group them when similar. The registrations of different behaviors indicated predilection and specificity in the fetal expression. According to DiPietro³⁰, till today there is no standardized scales of prenatal evaluation of the fetal activity, due to, among other reasons, the need of the establishment of normative data and predictive validity of specific aspects of the fetal development for the child's future behavior. We think we have confirmed some normal presentation of fetal movements and we believe that the expectations of new insights in this field will sprout with the current progresses in fetal images.

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