THE BIOCHEMICAL COMPOSITION OF AMNIOTIC FLUID AND OF MATERNAL AND FETAL BLOOD AT VARIOUS PERIODS OF PREGNANCY

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 51, No. 3, pp. 64-66, March, 1961
Original article submitted March 30, 1960

Numerous investigators have occupied themsleves with studying the biochemical composition and derivation of amniotic fluid, but up until now these questions have not been definitively resolved.

The basic attention has been alotted to studying the biochemical composition of the amniotic fluid at the end of pregnancy; the question of changes in the biochemical composition of the amniotic fluid during the development of the pregnancy has not been adequately treated in the literature. Nevertheless, specific investigation of the biochemical composition of the amniotic fluid within the dynamics of the developing pregnancy is highly valuable, since it makes it possible to elucidate certain aspects of the question concerning the derivation and mechanisms of formation of the amniotic fluid. The biochemical composition of the amniotic fluid also remains poorly studied for the early periods of pregnancy (up to 3 months); single reports on this question [13, 14, 15], have been based on a small number of observations, and these have been on women suffering from one or another illness, so that they do not reflect the biochemical composition of the amniotic fluid during the normal course of pregnancy in healthy women.

We carried out a comparative study of the biochemical composition of the amniotic fluid and the maternal blood at different periods of pregnancy, as well as the fetal blood in premature and term births.

EXPERIMENTAL METHODS

We examined 136 women, in the following periods of pregnancy: 8-12 weeks (early abortions) – 38 women, 17-26 weeks (late abortions) – 23 women, 29-37 weeks (premature births) – 10 women and 40 weeks (normal childbirth) – 65 women.

In induced abortions the amniotic fluid was obtained with the aid of a rubber tube, which was introduced through the internal os following dilatation of the canal in the neck of the uterus; a long needle was passed through this tube. At later periods the amniotic fluid was obtained by puncturing the fetal membrane with a needle guided by mirrors in the presence of a sufficiently opened uterine cervix or, in association with Caeserian section, from the fetal membrane projecting from the incision. Maternal blood was sampled at the same time that the amniotic fluid was obtained, by drawing from a vein in the antecubital fossa. Fetal blood was taken from the umbilical vessels.

We investigated a centrifugate of the amniotic fluid, free of sediment. We determined the content of sugar, chlorides, urea, resting nitrogen, and the total amount of nitrogen.

The Mean Concentration (M ± m) of Sugar, Chlorides, Urea, Resting Nitrogen, and Total

Stage of pregnancy	Sugar (in mg %)			Chlorides (in mg%)		
	amniotic fluid	maternal blood	fetal blood	amniotic fluid	maternal blood	fetal blood
8—12 weeks (early abortions)	57,97 ± 1,31	96,7 ±2,97	—	621,19 ±6,25	608,62 ±3,48	—
17—26 weeks (late abortions)	35,5 ±2,49	89,3 ±3,21	—	624,48 ± 6,82	611,60 ±2,07	—
29—37 weeks (premature births)	27,2 ±3,08	90,3 ±5,85	58,1 ±4,2	625,0 ±7,16	618,7 ±10,62	609,2 ±7,27
40 weeks (full term normal deliveries)	23,4 ±1,27	86,03 ±2,18	63,5 ±3,14	622,7 ±6,3	617,7 ±2,81	617,9 ±3,77

The data obtained was treated by the method of variation statistics; the validity index (T) was calculated for each arithmetic mean (M), as well as the difference in the arithmetic means in the case of their comparison.

EXPERIMENTAL RESULTS

The results of the investigations performed are presented in the table.

From the data presented it follows that the amount of sugar in the amniotic fluid gradually decreases with the development of the pregnancy; at the end of pregnancy its level (23.4 mg%) is less than half of what it is in the early stages of pregnancy (57.97 mg%). A very wide fluctuation in the level of sugar within the amniotic fluid is noted at the end of pregnancy (from 5 to 64 mg%), which has also been pointed out by a number of authors [9, 16, 17]; in the early periods its concentration ranges within minimal bounds (47-74 mg%). According to our observations, the level of sugar in the maternal blood at the various periods of pregnancy remained almost unchanged, as did the fetal blood at premature and full-term deliveries. The concentration of sugar in the fetal blood was always lower (40 mg% and lower) than in the maternal blood. Thus, the decrease in the sugar level within the amniotic fluid with the development of pregnancy cannot be placed in relation to changes in its concentration within the maternal or fetal blood.

The concentration of chlorides in the amniotic fluid throughout the extent of the pregnancy, as well as in the fetal serum at premature and term delivery, remained unchanged. It increased in the maternal serum at the end of pregnancy as compared with the early stages. According to the data of Zangemeister [22], the level of chlorides in the amniotic fluid is lower than in the maternal serum. On the other hand, according to the data of Makepeace [14], it is higher. According to our data, the average concentration of chlorides in the amniotic fluid at all stages of pregnancy is somewhat higher than in the maternal and fetal serum. However, when the obtained data is treated by the method of variation statistics this difference is not found to be statistically valid.

The concentration of urea in the amniotic fluid gradually increases with the development of pregnancy, and decreases in the maternal blood. At early stages of pregnancy its concentration in the amniotic fluid is somewhat lower than in the maternal blood, in late abortions it is approximately the same, and in premature and term deliveries it is higher. The concentration of urea in the fetal blood at premature and term deliveries is approximately the same, and excedes the level of urea in the maternal blood.

Appoximately the same relationship was found for the concentration of resting nitrogen in the amniotic fluid, maternal blood and fetal blood as for the concentration of urea.

Unique relationships appeared in determinations of the total protein content. Its concentration in the maternal serum in the second half of pregnancy did not change in its essential form, but in comparison with

Protein in Amniotic Fluid, Maternal Blood and Fetal Blood at Various Stages of Pregnancy

Urea (in mg %)			Resting nitrogen (in mg%)			Total protein (in %)		
amniotic fluid	maternal blood	fetal blood	amniotic fluid	maternal blood	fetal blood	amniotic fluid	maternal blood	fetal blood
20,62 ±0,82	28,36 ±0,77	—	20,34 ±0,89	27,83 ±1,1	—	0,2 ±0,014	7,11 ±0,1196	—
26,04 ±1,05	25,41 ±1,03	—	25,40 ±1,71	24,52 ±1,09	—	0,25 ±0,026	6,63 ±0,15	—
27,39 ±1,84	22,00 ±0,94	26,14 ±1,03	26,51 ±1,82	20,44 ±0,99	25,96 ±0,75	0,26 ±0,02	6,50 ±0,16	4,88 ±0,12
33,88 ±2,11	20,68 ±1,28	25,88 ±0,88	31,79 ±1,69	20,27 ±0,93	26,22 ±0,97	0,31 ±0,009	6,58 ±0,09	5,65 ±0,019

the early stages it decreased. In the amniotic fluid the concentration of protein in the early periods of pregnancy was lowest – an average of 0.2%; with the development of pregnancy it gradually increased, and at the end of the pregnancy it was equal to an average of 0.31%. In the serum of the term fetuses the concentration of protein was higher than in the fetuses of earlier stages of pregnancy, and was always lower than in the maternal serum. Thus, the amount of protein in the amniotic fluid increases regardless of its concentration in the maternal serum. As far as the relationship between the concentration of protein in the fetal serum and in the amniotic fluid is concerned, here we noted its parallel elevation in the later stages of pregnancy.

Summing up the data presented, it is possible to conclude that the biochemical composition of amniotic fluid during the extent of the pregnancy undergoes significant changes, the direction of which is different for the different substances. In particular, the concentration of nitrogen-containing substances (urea, resting nitrogen, protein) increases over the course of pregnancy, while sugar, on the other hand, decreases.

The marked constancy should be noted in the composition of the amniotic waters in the early stages of pregnancy, as well as the considerably more manifest fluctuation in the concentration of the indicated substances in the second half of pregnancy. It is rather difficult to explain this fact, and at the present time only certain hypotheses can be advanced in regard to this question. Thus, for example, in the second half of pregnancy there appears a number of new factors, which can demonstrate an effect on the composition of the amniotic fluid: 1) changes in the placenta throughout the extent of its development; 2) swallowing of the amniotic waters by the fetus [1, 2, 11, 12, 19, 20]; 3) contamination with the fetal grease and scales of epidermis; 4) the entirely possible periodic contamination with fetal urine [13, 21].

It is of considerable interest to compare our data, concerning the decrease in the amount of sugar within the amniotic fluid, with the data of S. S. Kasab'yan [7], which showed a gradual decrease in the level of glycogen in the placenta with development of the pregnancy. Thus, our hypothesis on the role of the placenta in regulating the concentration of sugar within the amniotic fluid is apparently not lacking a foundation.

The biochemical investigations which we performed simultaneously on the amniotic fluid, maternal blood, and fetal blood, speak in favor of the secretory theory on the derivation of amniotic fluid. Until now this theory was based mainly on the results of histological and histochemical investigations [3-6, 8, 18]. The absence of parallel values for the concentrations of the individual substances in the amniotic fluid, maternal blood, and fetal blood, at the different periods of pregnancy contradicts the theory of a number of investigators [10, 14] which considers the amniotic fluid as a transudate or dialysate of the maternal or fetal serum.

SUMMARY

The content of sugar, chlorides, urea, nitrogen and of total proteins was studied simultaneously in amniotic fluid maternal and fetal blood. Investigations covered 136 women at various terms of pregnancy (8-40 weeks). With the progress of pregnancy the biochemical composition of amniotic fluid changed as follows: there was a rise of urea, rest nitrogen and of the total protein; sugar concentration dropped; chloride level remained unchanged.

There was no parallelism between the biochemical changes in the amniotic fluid on one hand, and the changes in the maternal and fetal blood on the other. The aforementioned biochemical investigations serve as a conclusive confirmation of the secretory theory of the amniotic fluid origin and contradict that of transudation.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
