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*Letter*

# THE EFFECTS OF IONS IN AMNIOTIC FLUID IN DEVELOPMENT OF FETUS

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## ABSTRACT

The amount of amniotic fluid increases steadily to reach a maximum of approximately 400-1200 ml at 34-38 weeks, and then subsequently starts declining. At 40 weeks, the volume of amniotic fluid is approximately 800 ml (1,2,3) and continues to decrease till the pregnancy continues.

The composition of amniotic fluid changes with time and does not remain constant throughout pregnancy (4). It comprises of not only water, which forms around 98-99% of the amniotic fluid, but also several other essential constituents

**Keywords**: amniotic fluid, ions, pregnancy

## 1. INTRODUCTION

There is not much literature available on the ionic composition of amniotic fluid. Although electrolytes are present in the amniotic fluid in trace amounts, they are considered essential for the health and well-being of the fetus. Multiple researchers have shown the correlation between amniotic fluid electrolyte concentrations and fetal development (5). The common ions found in amniotic fluid include sodium, potassium, chloride, calcium, magnesium, and bicarbonate (6). Knowledge of the role of these ions in the amniotic fluid in a normal pregnancy can aid in prevention and early diagnosis of fetal or maternal pathologies. By accurate prenatal assessment of the biochemical composition of the amniotic fluid, one

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can evaluate fetal maturity and overall health status. This paper thus aims at assessing the function of these ions in amniotic fluid on fetal growth and development, based on the current, available literature.

## 2. FORMATION OF AMNIOTIC FLUID

Almost at the same time as the implantation, an extracolemic cavity is produced that forms the amniotic space (4). During the entire pregnancy, the growing fetus and amniotic fluid are both enveloped in the amniotic sac. Initially, the maternal plasma mainly contributes to the formation of the amniotic fluid and reaches the fetus by traversing the fetal membranes. However, as the placenta is formed, the plasma from the mother's blood crosses the placenta and reaches the fetus, contributing to the amniotic fluid. As the fetal skin is not keratinized in early pregnancy, there is diffusion of amniotic fluid across the fetal skin, and it is similar in composition to the plasma of the fetus. However, post-keratinization of the fetal skin, the absorption of the fluid takes place through the fetal gut.

## 3. COMPOSITION OF AMNIOTIC FLUID

The composition of amniotic fluid changes with time and does not remain constant throughout pregnancy (4). It comprises of not only water, which forms around 98-99% of the amniotic fluid, but also several other essential constituents.

***Sodium***

Several studies have documented the decrease in amniotic fluid sodium levels with gestational age (7). Sodium is involved in the regulation of water-electrolyte balance of the amniotic fluid and is thus an important ion in the amniotic fluid. Even a small change in the sodium ion concentrations can lead to significant changes in the volume of amniotic fluid (8).

Additionally, a study carried out on sheep showed that chronic placental insufficiency led to an increase in sodium ion concentration with a decrease in amniotic fluid volume (9).

***Chloride***

Although chloride levels fall as the pregnancy progresses, the decline is minimal as compared to other ions such as sodium (10).

Since the amniotic fluid is mainly composed of fetal urine in the latter part of pregnancy, any renal pathology will affect the amniotic fluid composition. Bartter syndrome is one such

disorder that can be diagnosed prenatally by detecting high chloride levels in the amniotic fluid (11).

***Potassium***

The concentration of potassium ions in the amniotic fluid is found to be almost constant throughout pregnancy (12-14). Raised potassium levels in amniotic fluid have been reported in women suffering from preeclampsia (15). Moreover, a study compared the concentration of trace elements in amniotic fluid, with their antibacterial activity (16). This study assessed the amniotic fluids of 39 pregnant women in their second half of pregnancy and revealed that lower concentrations of potassium were associated with good antibacterial activity.

***Calcium***

Cruikshank *et al* demonstrated the change in calcium ion levels in amniotic fluid along with the levels of calcium regulating hormones, as the pregnancy progresses (17). Their study showed that though the total calcium levels fall progressively, the levels of ionized calcium remains almost constant.

Low calcium levels in amniotic fluid have found to be associated with preterm deliveries (18).

On assessment of pregnancies complicated by spina bifida, it was found that they show a high level of calcium ions in the amniotic fluid (19).

An increased level of calcium and other bivalent cations such as zinc has also been observed in women suffering from preeclampsia (20). It is hypothesized that this is possibly due to reduced maternal excretion, leading to increased fetal load.

***Magnesium***

A study was carried out in 2011 (21) with the aim to determine the level of magnesium in amniotic fluid in the second trimester of pregnancy. According to this study, the mean magnesium value in amniotic fluid was 1.65 ± 0.16 mg/dL and slightly more, at 1.97 ± 0.23 mg/dL in serum.

The role of magnesium in amniotic fluid has been highlighted in several studies. Low levels of magnesium in amniotic fluid have been associated with preeclampsia (22) and diabetes (23, 24). However, some studies point to the contrary showing raised levels of magnesium ions in the amniotic fluid of patients with preeclampsia (20).

Pregnant women need magnesium supplementation in their diet due to the reduced serum levels during pregnancy (25,26).

***Bicarbonate***

A study that evaluated the amniotic fluid composition in a pregnancy complicated with twin-twin transfusion syndrome found that in comparison with the normal pregnancies, the complicated pregnancies showed a higher bicarbonate levels in the amniotic fluid (27).

***Zinc***

Like magnesium, zinc deficiency has also been implicated in fetal growth retardation. A decrease in zinc levels in amniotic fluid has shown association with intrauterine growth retardation resulting from placental insufficiency (28).

Zinc is also associated with antibacterial activity in the amniotic fluid. Scane *et al* demonstrated that both high and low molecular-weight antibacterial activity was directly related to the concentration of bound zinc (29). This collaborates with the present evidence stating the importance of zinc in the regulation of several aspects of the immune system. (30).

## REFERENCES

1. Brace R, Wolf E. Normal amniotic fluid volume changes throughout pregnancy. Am J Obstet Gynecol. 1989;161(2):382-388.
2. Elliott PM, Inman WH. Volume of liquor amnii in normal and abnormal pregnancy. The Lancet. 1961;278(7207):835-840.
3. Queenan J, Thompson W, Whitfield C, Shah S. Amniotic fluid volumes in normal pregnancies. Am J Obstet Gynecol. 1972;114(1):34-38.
4. Underwood M, Gilbert W, Sherman M. Amniotic Fluid: Not Just Fetal Urine Anymore. J Perinatol. 2005;25(5):341-348.
5. Cassady G, Barnett R. Amniotic fluid electrolytes and perinatal outcome. Neonatology. 1968;13(3-4):155-174.
6. Lind T, Billewicz W, Cheyne G. Composition of amniotic fluid and maternal blood through pregnancy. BJOG. 1971;78(6):505-512.
7. Leela KV, Babu K. Study of biochemical parameters in amniotic fluid for assessment of foetal maturity in cases of normal pregnancy. J of Evidence Based Med & Hlthcar. 2016;3(3):8394-8399.
8. Curran M, Nijland M, Mann S, Ross M. Human amniotic fluid mathematical model: Determination and effect of intramembranous sodium flux. Am J Obstet Gynecol. 1998;178(3):484-490.
9. Gagnon R, Harding R, Brace R. Amniotic fluid and fetal urinary responses to severe placental insufficiency in sheep. Am J Obstet Gynecol. 2002;186(5):1076-1084.
10. Sieck UV, Ohlsson A. Fetal polyuria and hydramnios associated with Bartter's syndrome. Obstet Gynecol. 1984;63:22S-24S.
11. Massa G, Proesmans W, Devlieger H, Vandenberghe K, Van Assche A, Eggermont E. Electrolyte composition of the amniotic fluid in Bartter syndrome. Eur J Obstet Gynecol Reprod Biol. 1987;24(4):335-340.
12. Lind T. The biochemistry of amniotic fluid. In: Sandler M, ed. Amniotic fluid and its clinical significance. New York: Marcel Dekker Inc, 1981; pp. l-25.
13. Benzie RJ, Doran TA, Harkins JL, Owen VM, Porter CJ. Composition of the amniotic fluid and maternal serum in pregnancy. Am J Obstet Gynecol. 1974;119:798-810.

14. Gillibrand P. Changes in the electrolytes, urea and osmolality of the amniotic fluid with advancing pregnancy. J Obstet Gynaecol Br Commonw. 1969;76(10):898-905.
15. Fotiou M, Michaelidou A, Masoura S, Menexes G, Koulourida V, Biliaderis C, et al. Second trimester amniotic fluid uric acid, potassium, and cysteine to methionine ratio levels as possible signs of early preeclampsia: A case report. Taiwan J Obstet Gynecol. 2016;55(6):874-876.
16. Honkonen E, Näntö V, Hyörä H, Vuorinen K, Erkkola R. Trace elements and antibacterial activity in amniotic fluid. Neonatology. 1986;50(1):21-26.
17. Cruikshank D, Pitkin R, Williams G, Hargis G, Reynolds W. Calcium-regulating hormones and ions in amniotic fluid. Am J Obstet Gynecol. 1980;136(5):621-625.
18. Shah M, Modi U, Bhatt R, Mistry K. Amniotic fluid composition in abnormal pregnancies. Indian J Pediatr. 1983;50(3):271-274.
19. Pettit B, Baker S, King G. The composition of amniotic fluid in pregnancies complicated by fetal anencephaly or spina bifida. Br J Obstet Gynaecol. 1979;86(8):637-641.
20. Weiss M, Frenkel Y, Dolev E, Barkai G, Mashiach S, Sela B. Increased amniotic fluid divalent cation concentrations in preeclampsia. J Basic Clin Physiol Pharmacol. 1995;6(1).
21. Bocos Terraz J, Izquierdo Álvarez S, Bancalero Flores J, González López Á, Escanero Marcén J. Magnesium concentration in amniotic fluid in the early weeks of the second trimester of pregnancy. BMC Res Notes. 2011;4(1):185.
22. Dawson E, Evans D, Nosovitch J. Third-trimester amniotic fluid metal levels associated with preeclampsia. Arch Environ Health. 1999;54(6):412-415.
23. Mimouni F, Miodovnik M, Tsang RC, Caliahan J, Shaul P. Decreased amniotic fluid magnesium concentration in diabetic pregnancy. Obstet Gynecol. 1987;69:12-14.
24. Doraczynska E, Rechberger T, Wawrzycka B, Oleszczuk J. Concentration of magnesium in the amniotic fluid of a patient with diabetes. Ginekol Pol. 1995;66:653-655.
25. Gortzak-Uzan L, Mezad D, Smolin A, Friger M, Huleihel M, Hallak M. Increasing amniotic fluid magnesium concentrations with stable maternal serum levels: a prospective clinical trial. J Reprod Med 2005;50:817-820.
26. Chazan B, Kowaiska B, Pietrasik D, Jarosz I. Effect of vitamin/mineral supplementation on calcium, magnesium and iron levels in amniotic fluid and serum taken from during first half of pregnancy. Ginekol Pol. 2001;72:993-996.
27. Adama van Scheltema P, In't Anker P, Vereecken A, Vandenbussche F, Kanhai H, Devlieger R. Biochemical composition of amniotic fluid in pregnancies complicated with twin-twin transfusion syndrome. Fetal Diagn Ther. 2005;20(3):186-189.
28. Pogorelova T, Linde V, Gunko V, Selyutina S. The imbalance of metal-containing proteins and free metal ions in the amniotic fluid during fetal growth. Biomed Khim. 2016;62(1):69-72.
29. Scane T, Hawkins D. Antibacterial activity in human amniotic fluid: relationship to zinc and phosphate. Br J Obstet Gynaecol. 1984;91(4):342-348.
30. Shankar AH, Prasad AS. Zinc and immune function: the biological basis of altered resistance to infection. Am J Clin Nutr. 1998;68(2 Suppl):447S-463S.