AIN SHAMS UNIVERSITY
FACULTY OF MEDICINE
DEPARTMENT OF OBSTETRICS & GYNAECOLOGY

A REVIEW ON AMNIOTIC FLUID

A THESIS

Submitted For Partial Fulfillment
of
M. S. Degree in Obstetrics and Gynaecology

BY

MAHMOUD ABD ALLA AHMED
M. B. B. Ch. (Ain Shams)

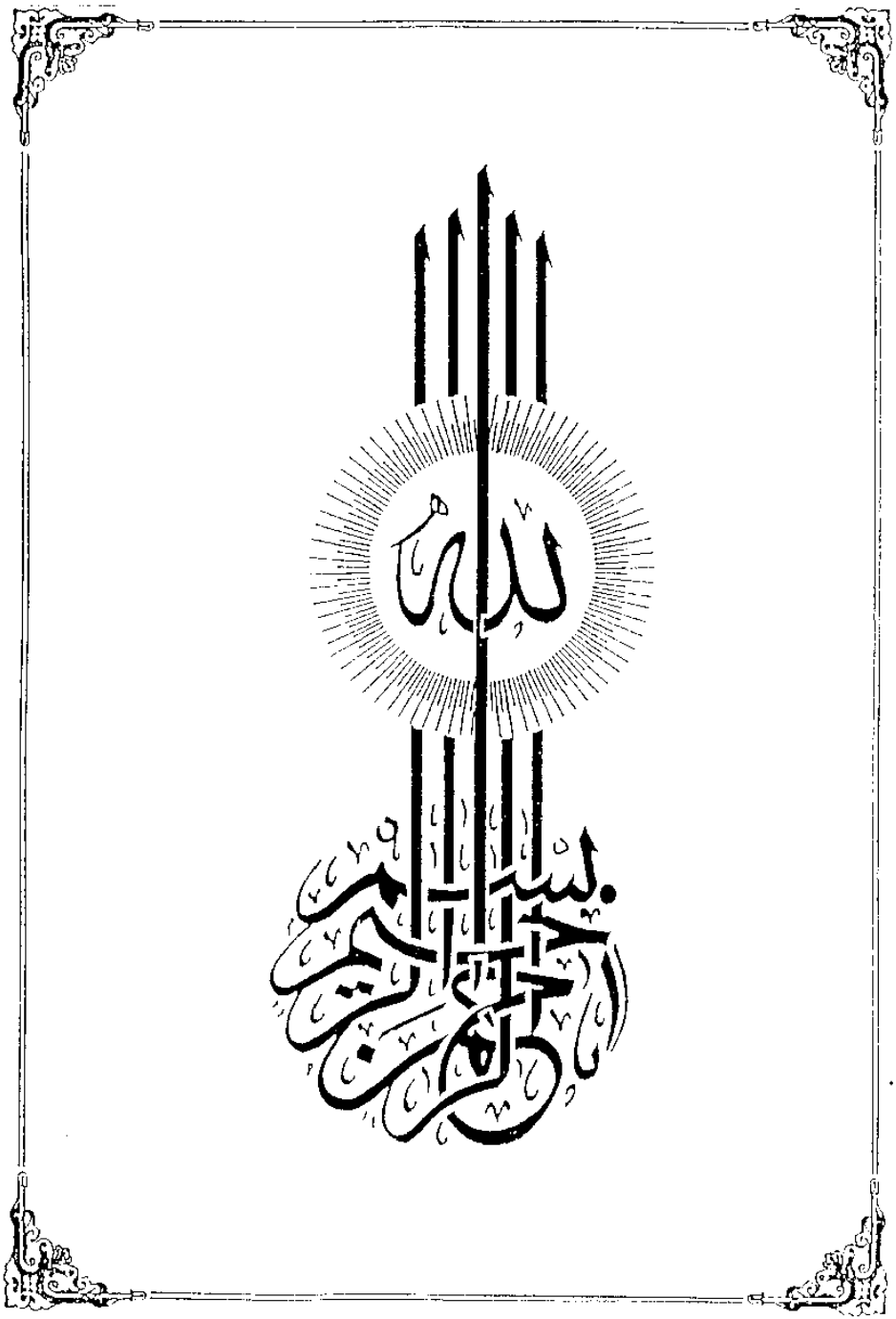
Supervised by

Prof. Dr. IBRAHIM EL MITWALLY SAMAHA
Professor of Obstetrics and Gynaecology
Ain Shams UniversitY, Cairo

Dr. FARID ABD EL AZIZ EL TEHEWY
Assistant Professor of Obstetrics and Gynaecology
Ain Shams UniversitY, Cairo

(1985)

بسم الله الرحمن الرحيم



A C K N O W L E D G E M E N T

I wish to express my sincere and deep gratitude to Professor Dr. Ibrahim El Metwally Samaha, Professor of Obst. and Gyn., Ain Shams University, for his kind supervision, his unfailing support and his wise guidance.

I would like to express my sincere gratitude to Assistant Professor Dr. Farid Abd El Aziz El Tehewy, Assistant Professor of Obst. and Gyn., Ain Shams University, for his most valuable advice, guidance, kind supervision and continuous encouragement throughout the whole work.

CONTENTS

I N T R O D U C T I O N

Hippocrates, was the first to suggest the oldest and simplest explanation that the amniotic fluid was a product of the fetal kidney (Plentl, 1966).

In modern clinical practice the study of amniotic fluid by amniocentesis antenataly considered it as a mirror reflecting the intrauterine condition of the fetus and helps the obstetrician in managing some difficult obstetric problems as Rhesus isoimmunisation, genetic diseases and estimation of fetal maturity.

Amniotic fluid could arise as a secretion or an ultrafiltrate either from the mother across the membranes, from the placenta and cord or from the fetus through the skin, gastrointestinal tract, tracheobronchial tree or kidneys. The fluid component also seems to vary in its site of origin at different periods of gestation.

Plentl (1966) likened the concept of the circulation of the amniotic fluid to a system of pumps constantly transferring the fluid from one compartment to another and back again, and adjusting to minor changes by balancing the output in one direction or another.

There are two seperate concepts which could be considered as the circulation of amniotic fluid. The first is the very rapid water turn-over and the other is the secretion and absorption through the activity of the fetal organs in utero.

The amniotic fluid serves several important functions. It provides a medium in which the fetus can readily move, cushions him against possible injury, helps him maintain an even temperature. If the presenting part of the fetus is not closely applied to the lower uterine segment during labour, the hydrostatic action of the amniotic fluid may be important in dilating the cervical canal.

THE EMBRYOLOGY AND HISTOLOGY OF FETAL MEMBRANES

The amnion or the innermost of the two human membranes is derived from the cytotrophoblast. On the seventh or the eighth day after ovulation the trophoblastic cells in this area differentiate to form amniogenic cells from which the amniotic cavity develops (Hertig et al., 1956).

This fluid-filled space, initially known as the amnioembryonic vesicle, is visible microscopically in all ova which have embedded in the decidua (Rhodes, 1969).

The growth rate of the amniotic sac soon exceeds that of the yolk sac while the allantois involutes to become the urachus. As the embryonic disc enlarges, it folds to a tubular form in cross-section and the attachment of the amnion is carried round to its ventral surface. After the third or fourth week, the yolk sac begins to elongate and the rapidly enlarged amniotic sac surrounds the developing fetus forming a sheath for the umbilical cord.

The earlier chorionic cavity is completely obliterated by the growth of the amniotic sac and the amnion is in direct contact with the surrounding chorionic layer (Moore, 1973).

This relationship is maintained until the end of gestation.

THE AMNION

In early pregnancy the amnion consists of epithelium and extraembryonic somatopleure only. As pregnancy proceeds, there is differentiation into 5 distinct layers (Bourne, 1962).

According to whitfield (1978), during early pregnancy the

epithelial cells which are columnar have secretory features, but, as progressive differentiation into five seperate layers occurs, these secretory cells disappear and the amnion become avascular when the turnover of amniotic fluid is maximal.

The five layers of the amnion consist, from within outwards, of : -

1) The Epithelium :

The epithelium is composed of a single layer of simple, non-ciliated cuboidal cells.

2) The Basement Membrane :

This is a narrow band of reticulous tissue lying along the base of the epithelial cells to which it is securely adherent by means of fine fibrils.

3) The Compact Layer :

This layer is a relatively dense, acellular layer immediately subjacent to the basement membrane. This layer shows a marked resistance to leucocytic infiltration so that it can be easily observed in membranes suffering from a severe inflamatory response.

4) The Fibroblast Layer :

This layer consists of fibroblasts and Hofbauer cells burried in a reticulin mesh. This layer would appear to play quite a considerable part in the transmission of fluid between the fetal and maternal compartments, although exactly how this transfer takes place is inadequately understood.

5) The Spongy Layer :

It is composed of the reticulum of the extraembryonic coelom. It is capable of considerable distension and it contains large quantities of mucus. So, it allows movement of the amnion upon the underlying chorion.

Bourne (1962), was unable to find blood vessels or nerves in the amnion at any stage of develompent and despite the occurance of suggestive spaces in the fibroblastic and spongy layers, he could not identify distinct lymphatic channels.

THE CHORION

The chorion is made up of four layers of cells

1) The Cellular Layer :

This is the innermost layer of the chorion, consisting of a thin layer of interlacing fibroblasts.

2) The Reticular Layer :

It consists of a reticulin network containing fibroblasts and Hofbauer cells. The blood vessels in the early embryo lie whithin this layer.

3) The Pseudo-Basement Membrane :

This is for the overlying trophoblast.

4) The Trophoblast :

This is consisting of a layer of trophoblast cells varying

in thickness from two to ten cells. It lies immediately adjacent to the maternal decidua with which it is in intimate contact.

Blood supply of the chorion :

The reticular layer of the chorion at term contains the vessels as they pass from the umbilical cord to the chorionic villi of the placenta.

The remainder of the reticular layer of the chorion also contains blood vessels in very early pregnancy, but after the end of the first trimester a capillary blood supply can not be demonstrated in the chorion (Bourne, 1962).

No actual lymphatic vessels or nerve supply have been observed whithin the layers of the chorion.

THE ELECTRONMICROSCOPIC APPEARANCE OF MATURE AMNION

The main interest during recent years has been centered upon the structure of the amniotic epithelial cell by electron microscopic studies (Bourne, 1960; Bourne & Lacy, 1960; Bourne, 1962; Leonardi et al., 1966).

The epithelial cells are cuboidal or columnar in shape. Microvilli are produced on the surface of the cell in fairly early pregnancy and as maturity advances the microvilli become more complex and numerous. Intercellular canals pass between the lateral aspects of the two membranes of adjacent cells.

In the basal region the cell membrane forms irregularly

shaped processes of varying size (Basal processes) which efficiently increase the surface area of the base of the cell, just as the intercellular canals increase the surface area of the lateral aspect of the cell and as the microvilli increase the surface area of the fetal aspects of the cell. Also, there are lateral vacuoles invaginating into the side walls of the cell and they are considered a part of the intercellular canal system.

The components of the cytoplasm vary as pregnancy advances. Mitochondria are present throughout pregnancy but tend to diminish in number towards term. Numerous vacuoles are present, some of which appear to be empty and others contain fat. Very active endoplasmic reticulum is present in some cells and a Golgi apparatus can be demonstrated in nearly all epithelial cells. The nucleus is a large, dense, relatively simple object in early pregnancy but as pregnancy advances it becomes indented and somtimes fenestrated.

THE ORIGIN OF AMNIOTIC FLUID

The physiological processes involved in the production of the amniotic fluid are still not clear.

The fluid could arise as a secretion or an ultrafiltrate either from the mother across the membranes, from the placenta and cord or from the fetus through the skin, gastrointestinal tract, tracheobronchial tree or kidneys.

The fluid component also seems to vary in its site of origin at different periods of gestation. An active secretion may occur through the amnion in the earliest embryo, later ultra-filtration through the fetal skin is a major source, while in the last half of pregnancy this route is no longer available and there is increasing fetal urinary and possibly pulmonary secretion.

The role of placenta and membranes :

Amniotic fluid is present in the early embryo when the tissues of the fetus are poorly differentiated and non functional. Moreover, the fluid is present in the sacs of some blighted ova where the fetus is rudimentary or absent (Jeffcoate and Scott, 1959). These facts strongly suggest that amniotic fluid enters via the membranes.

Further support came from Behrman et al. (1967), who showed that when the fetus was surgically removed from the monkey uterus a limited further quantity of liquor was formed.

The role of direct transport across the membranes was investigated by Danforth and Hull (1958), who examined living amniotic epithelium and demonestrated features to be typical

of secretory cells. However, these amniotic cells degenerate in late pregnancy wherethe volume of liquor is increasing most rapidly and plentl (1966) has shown that polyhydramnios may be associated with a complete absence of these cells.

In the human fetus there is evidence that there is no electrical potential difference across the membranes. Mellor et al., (1969) has suggested that only passive diffusion takes place and the rate of this will depend on molecular size and the permeability of the amnion.

Abramovich and Page (1972) believe there is a specialized area of that part of the amnion overlying the placenta which, because of its extensive vascular connections, plays a greater part in fluid exchange.

Studies of the biochemical and immunological constituents of the amniotic fluid might also suggest that liquor is derived from maternal plasma since much of the soluble protein is of maternal origin (Sutcliffe, 1975). However, larger molecules particularly the δ-globulins, have been shown to enter the fetus by direct transport across the chorionic villi (Gitlin and Gitlin, 1976) and are secreted into the liquor in fetal urine.

The Role Of The Fetus And Cord :

Lind (1975) has shown that if the more diffusible solutes are examined, the amniotic fluid closely resembles an extension of the fetal extracellular space in the first half of the pregnancy modified later by the loss of fetal skin permeability accompanied by increasing intrauterine fetal organ function.

He also calculated that the volume of liquor in early pregnancy was related most directly to the weight and, hence, to the surface area of the fetus rather than to the placental weight or length of gestation.

The fetal skin has been shown to be permeable to fluids and to some dissolved solutes up to the eighteenth week of pregnancy, after which increasing keratinization and skin thickness markedly reduce this route of access.

Abramovich and Page (1972) confirmed the permeability of skin in mid-trimester fetuses but believed that the exchange takes place through the whole fetoplacental unit of fetus, cord and placental plate and suggested that at the eighteenth week the cord takes over as the major transfer site. They were, however, unable to demonstrate any histological changes in the cord epithelium to accompany this rapid increase in function.

There is clinical and experimental evidence for intrauterine fetal urine production starting as early as the end of the first trimester (Abramovich, 1968).

Clinical evidence comes from the micturation which often accompanies birth and from fetuses between 12 and 22 weeks in which bladder aspirations were performed at the time of hysterotomy (Lind, 1975).

The increasing biochemical resemblance of liquor to fetal urine, particularly after keratinization of fetal skin, is seen by increasing concentrations of urea, uric acid and creatinine, decreasing sodium and glucose, and also by reduction in osmolarity (Lind, 1975; Young, 1976).