Postpartum adaptation of the newborn

This article has been translated from WikiSkripta; ready for the **editor's review**.

The transition from fetal (intrauterine) life to neonatal (extrauterine) life is accompanied by complex physiological changes that must take place within a relatively short period of time. The fetus, dependent on the heart and lungs of the mother, on her metabolism and thermoregulation, must independently supply oxygenated blood to the tissues immediately after birth and regulate a whole series of events.

Overview of changes at birth

- instead of fluid secretion in the lungs, it is resorbed (adrenaline, oxygen);
- spontaneous breathing (cooling) begins;
- airway resistance decreases, functional residual capacity increases, lung compliance gradually increases;
- interruption of the umbilical cord causes a decrease in venous return to the right atrium and a decrease in flow in the ductus venosus;
- increased pulmonary venous return will increase left atrial pressure;
- reduced pressure in the right atrium and increased pressure in the left atrium leads to closure of the foramen ovale;
- pulmonary vascular resistance decreases (aeration of the lungs, presence of oxygen);
- Botall's soul closes.[1]

Postpartum respiratory changes

Lung development

Lung development is a continuous process that begins in the early stage of embryonic development with the differentiation of the laryngotracheal lobe from the ventral side of the foregut and ends with the maturation of the pulmonary microvasculature and alveolarization in early adulthood.

Thus, lung development can be divided into 3 main periods: embryonic (organogenesis), fetal (pseudoglandular, canalicular and saccular stages) and postnatal (alveolarization and microvascular maturation). Because during lung development most events begin proximally and progress to the periphery, all stages of development overlap.

Main stages of lung development:

1. **embryonic** (weeks 4-7)
2. **pseudoglandular** (weeks 5-17): branching of the bronchial tree
3. **canalicular** (weeks 16-26)
4. **saccular** (terminal sac stage, weeks 24-38)
5. **alveolar** (36th week of gestation - 21st year of life).[2][1]

Lung development begins in about a 3-week-old embryo as a ventral process of the caudal end of the laryngotracheal lobe foregut. The bronchial tree is developed by the 16th week of gestation. During the canalicular stage of development, branching of the respiratory bronchioles, vascularization of the terminal tubules, and thinning of the airway epithelium continue. Arteries and veins develop along with the development of the airways. At the end of the canalicular stage (24 weeks), gas exchange in the lungs becomes theoretically possible. From the 20th - 22nd week of gestation, type I and II pneumocytes can be identified. Type I pneumocytes are flattened and make up more than 90% of the surface of the mature lung where gas exchange occurs. Type II pneumocytes are cuboidal cells that have a secretory function, and from 24 weeks lamellar bodies containing surfactant can be identified. From the 24th week until the due date, further terminal branching occurs with the development of saccules. As the septa grow, the saccules are divided into smaller units, the alveoli. A network of capillaries forms around each saccule. Alveoli begin to appear from the 32nd week of gestation, but most alveolar development occurs after the due date. Postnatally, the number of alveoli increases in particular. At 4 years, the same number of alveoli as in adults is present. A further increase in lung volume and lung surface area is due to an increase in the size of the alveoli. In the first 5 years, there is little elastin in the walls of the alveoli compared to adulthood.[1]

The pulmonary arteries of the fetus have a higher content of smooth muscle in the wall than in adults. Postnatally, in the first 2 weeks of life, there is a rapid thinning due to arterial distension, and over the course of a year, there is a slow reduction in the number of muscle fibers. If this remodeling does not occur, high pulmonary vascular resistance persists, leading to persistent pulmonary hypertension.[1]

🔎 *For more information see Development of the Respiratory System.*

Factors affecting lung growth and development

Abnormal lung growth may result from inadequate space (congenital diaphragmatic hernia, pleural effusion, cystic adenomatoid malformation), reduced fetal respiratory movements (neuromuscular disease, phrenic nerve agenesis, diaphragmatic amyoplasia)) or a reduction in the volume of amniotic fluid (the presence of fluid in the

lungs is essential for normal lung development; fluid is formed in the lungs at a rate of 2 ml/kg/h to 5 ml/kg/h, has a high chloride content and low content of bicarbonate and protein).Lung growth and development is also affected by malnutrition (especially vitamin A deficiency), maternal smoking and administration of glucocorticoids.

The period when the insult occurs determines what structures will be affected. Before the 16th week of gestation, there is permanent damage to the branching of the airways and thus a reduction in the potential number of alveoli. If the insult occurs later, it affects the number of alveoli.[1]

Changes after birth

During childbirth, the concentration of adrenaline rises, and due to this, fluid secretion ends in the lungs and its resorption begins by activating sodium channels on the apical surface of the lung epithelium. Postnatal oxygen exposure increases sodium transport. The presence of thyroid hormones and cortisol is necessary for the development of the fetal lung response to adrenaline. Part of the fluid from the lungs is squeezed out by the pressure of the vagina during the second stage of labor, but most of it is absorbed into the pulmonary lymphatic vessels and capillaries.[1]

Fetal breathing movements are interrupted during delivery. After birth, one of the strongest stimuli for the onset of breathing is cooling. The median time to onset of respiratory activity is 10 seconds. During the first breaths, a high negative pressure (typically more than 20 cmH2O) is necessary, and during the first breaths, the expirium is active (it helps clear the lungs of fluid).

After birth, airway resistance decreases and functional residual capacity (FRC) increases, most rapidly in the first 2 hours. Compliance gradually increases over the course of 24 hours along with the gradual absorption of lung fluid. During cesarean delivery, the absorption of lung fluid is slowed down.[1]

Postpartum cardiovascular changes

In the fetus, only about 12% of the right ventricular output flows into the pulmonary circulation, due to high pulmonary vascular resistance (PVR), the presence of open duct of Botall and the presence of a low-resistance placenta in the systemic circulation.

After birth, severing the umbilical cord and removing the placenta from the circulation leads to reduced venous return via the inferior vena cava to the right atrium. The foramen ovale closes due to lower pressure in the right atrium and higher pressure in the left atrium due to increased pulmonary venous return. As a result of the loss of venous return from the umbilical cord, the flow through the ductus venosus also decreases, passive closure usually appears within 3-7 days of birth.

In the first minutes after birth, pulmonary vascular resistance (PVR) decreases rapidly and continues to decrease slowly over the following days and weeks. This decrease is accompanied by structural reorganization and thinning of the vessel walls, which enables an up to 8-fold increase in blood flow through the lungs. Airing (aeration) of the lungs leads to the opening of the pulmonary capillary bed, a rapid decrease in PVR and an increase in blood flow through the lungs. Lung inflation stimulates pulmonary stretch receptors and leads to reflex vasodilation of the pulmonary vascular bed. Prostaglandins, endothelin-1 and nitric oxide (NO) are involved in the regulation of PVR.

In healthy newborns, most hemodynamic changes occur by the 8th hour of life, however, right-left shunts may partially persist until the 12th hour of life. In most babies, the duct closes by the 24th hour of life.[1]

🔎 *For more information see Development of the Cardiovascular System, Fetal Circulation.*

References

Related Articles

- Fetal circulation • Development of the cardiovascular system
- Development of the respiratory system
- Newborn (characteristics of the newborn period) • Newborn treatment after birth • Newborn care in the first days of life

External links

References

1.
2.