

## THE MODERN VIEW ON THE PROBLEM OF FETAL MACROSOMIA

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### Abstract

In recent decades, there has been a trend towards an increase in number of newborns with signs of macrosomia.

**Purpose of the study:** to study features of the course pregnancy, parturition and the postpartum period associated with fetal macrosomia and to carry out an analysis of perinatal outcomes.

**Materials and methods of research.** A retrospective analysis of 100 histories of patient deliveries giving birth to children weighing 4000.0 g and more during the 3-year study period from 2014 to 2016 at the Kyiv City Maternity Hospital №3, Ukraine.

**Results of the study.** The work demonstrates increasing frequency of parturition with fetal macrosomia over the study period, from 9% of the total number of births in 2014 to 13% in 2016. The main complications of pregnancy were threatened abortion (57%), preeclampsia of varying severity (25%). During delivery, the prevalence of such complications as premature amniotic fluid discharge (26%), failure of progress (12%) and two-fold increase in trauma of soft tissues of birth canals was established. Fetal macrosomia leads to an increase in the frequency of using surgical interventions during delivery, as well as 10 times increase in the percentage of births by caesarean section.

**Conclusions.** Our study showed that fetal macrosomia increases the frequency of complications of pregnancy and parturition. Early evaluation of the estimated fetal weight, individual approach to pregnancy and parturition; proper obstetric, gynecological and somatic anamnesis; and timely anesthesia and controlling of labor in women with fetal macrosomia all can reduce complications of labor and improve perinatal outcomes.

**Keywords:** Fetal macrosomia, frequency, course of pregnancy and parturition, perinatal outcomes, complications.

Numerous researchers studying problem of the large fetal size note an increasing trend in labor complications in the last 10 years [1, p. 84; 10, p. 476]. The frequency of large fetus delivery varies between 10-18.5% in Ukraine [4, p. 83]. According to World Health Organization (WHO), the frequency of large fetus delivery increased from 8% to 12% worldwide. The relevance of the problem of large fetal size is related to difficulties in diagnosis, delivery, complications after delivery, all of which cause a high percentage of surgical interventions, maternal and child traumas, resulting in perinatal morbidity and mortality [1, p.84].

In recent decades, there has been an increasing trend in the number of newborns with signs of macrosomia. This is associated with higher incidence of extra-genital pathologies in pregnant women (eg, diabetes

mellitus), age of primiparous and multiparous women, inappropriate nutrition during pregnancy, and so on.

The problem of fetal macrosomia is interesting to obstetrician-gynecologists due to the frequent development of various complications of pregnancy and delivery, resulting in higher percentage of maternal and fetal birth trauma, caesarean sections, perinatal morbidity and mortality. High rates of maternal trauma and unfavorable perinatal outcomes in fetal macrosomia are of great medical and social importance [4, p.139].

Two terms are applied to excessive fetal growth: large for gestational age and macrosomia. The term «large for gestational age» generally implies a birth weight equal to or greater than the 90th percentile for a given gestational age. The term «fetal macrosomia» im-

plies growth beyond an absolute birth weight, historically 4.000 g or 4.500 g, regardless of the gestational age, although establishing a universally accepted definition for macrosomia has been challenging [13, p. 22]. The diagnosis of fetal macrosomia can be established only by measuring the weight after birth; therefore, this state is confirmed only retrospectively, that is, after delivery [4, p. 139].

The global prevalence of neonatal births  $\geq 4000$  g is approximately 9% and approximately 0.1% for a weight  $\geq 5000$  g, with varying frequency in countries around the world [5, p. 110]. In the United States, 8% of all live born infants weigh  $\geq 4000$  g and 1.1% weigh more  $> 4500$  g [9, p. 2]. The prevalence of birth weight  $\geq 4000$  g in developing countries is typically 1 to 5%, but ranges from 0.5 to 14.9% [18, p. 1].

The risk of adverse outcome increases along a continuum based on the degree of macrosomia. For example, at birth weights of 4000 to 4499 g, labor abnormalities and newborn complications begin to increase. At birth weights of 4500 to 4999 g, maternal and newborn morbidity further increases. At birth weights  $\geq 5000$  g, the risk of stillbirth and neonatal mortality increases. For this reason, the presence of macrosomia is an important factor to consider in decision-making during delivery (eg, whether to use forceps or vacuum, whether to proceed to cesarean delivery) [9, p. 2].

Factors associated with fetal macrosomia include: maternal risk factors (genetics, duration of gestation, extragenital pathology in pregnant women (eg, endocrine diseases), high pre-pregnancy body mass index (BMI); excessive gestational weight gain, ethnicity, mother's age) and risk factors from the fetus (male fetus, genetic, sex, racial and ethnic factors) [18, p.2].

Genetic factors, such as parental height and weight, may also play a role in determining newborn birth weight. They include high body mass index (BMI) of a woman, the height of the mother more than 170 cm, the height of the father more than 180 cm, the large weight of the parents at birth, 3 or more pregnancies in the anamnesis, the birth of a child weighing more than 4000 g in anamnesis [10, p. 23].

Regarding endocrine diseases in the mother; the birth of a large child in a patient with diabetes mellitus is explained by hormone-metabolic disturbances. In response to hyperglycemia, the fetal pancreas synthesizes an increased amount of insulin, with an anabolic effect, and counter-insulin mechanisms are activated, which altogether lead to the development of metabolic dysfunction [11, p. 22]. In a mother with diabetes the main complications of fetal development are birth of a fetus with pronounced organic defects (diabetic embryopathy) and / or dystrophic changes of the fetus. This result in an increase or, more rarely, a decrease in its weight and height, with the formation of diabetic fetopathy [21, p. 1067]. Decreased thyroid gland function in pregnant women is associated with macrosomia - in such cases, congenital hypothyroidism develops. The cause of this pathology, in addition to thyroid gland diseases in the mother, may be a developmental defect of the thyroid gland, genetic defects of enzymes involved in the synthesis of hormones, insufficient intake of iodine

or the congenital hyperinsulinemia syndrome (Beckwith-Wiedemann or idiopathic hyperinsulinemia hypoglycemia) [4, p.140]. In spite of this, it should be noted that a large fetus is more common in women without diabetes mellitus.

Macrosomia is observed with a higher frequency in postterm pregnancy. A male fetus is more prone to macrosomia than a female fetus. Boys weights, usually, are about 150 to 200 g more than girls of the same gestational age [10, p. 23].

The risk of developing macrosomia also depends on ethnicity. Studies have shown that even in the absence of gestational diabetes Spanish women have an increased risk of fetal macrosomia compared to European, African-American and Asian women [10, p.23].

The age of the mother is also a risk factor for the development of macrosomia. V.V. Litvinchuk et al. (2000) proved that fetuses with macrosomia are much more often born in young mothers (up to 20 years) and in women of older age groups (30-34 years) [5, p. 110].

At the same time, the greatest influence of external factors, such as environmental factors, nutrition, physical activity and others, on the formation of fetal macrosomia is observed after 36 weeks of gestation [4, p. 141].

If the above factors have been excluded or seem unlikely, one of rare syndromes associated with accelerated fetal growth should be considered, especially if one or more structural fetal anomalies are present. In this case, it is necessary to recommend that a pregnant woman consult with a geneticist to help with the differential diagnosis of genetic diseases. These syndromes can include the following: Pallister-Killian, Beckwith-Wiedemann syndrome [4, p.140], Sotos syndrome, Perlman syndrome, Simpson-Golaby-Behmel syndrome, Costello, marbled skin syndrome [10, p. 23].

Despite the identification and characterization of risk factors, a combination of these factors cannot adequately predict the development of fetal macrosomia. A significant proportion of fetal macrosomia remains unclear, and most newborns with fetal macrosomia do not have identifiable risk factors [10, p. 23].

Pathophysiology of macrosomia is associated with a combination of pathological processes in mother and fetus. Such diseases as diabetes, obesity in the mother and excessive weight gain during pregnancy are associated with macrosomia and hyperglycemia. Hyperglycemia in the fetus leads to stimulation of production and secretion of insulin, insulin-like growth factor, growth hormone and other growth factors, which, in turn, stimulates fetal growth, fat and glycogen deposition. Different studies have studied the intrauterine development of fetuses with macrosomia. In the secondary analysis of data from a randomized controlled trial of treatment/no treatment of compensated gestational diabetes, Stuebe et al. evaluated the relationship between mother's BMI, impaired glucose tolerance, and risk factors for the fetus and mother. Stuebe showed that the weight of a woman's body during pregnancy (increased BMI) is associated with macrosomia and increased body weight of newborns, regardless of glucose levels [20, p. 1]. Another study, conducted by Catalano et al, further illuminates this relationship in their analysis of  $> 400$  infants

born by women with and without impaired glucose tolerance. They found that children born by women with impaired glucose tolerance had a greater body weight than children born by women with normal glucose tolerance. And this is regardless of mother's BMI [11, p. 1698].

Geragti et al. collected blood samples from 331 mothers and their children. They found that levels of maternal serum triglycerides are directly related to the weight of the fetus at birth. This study highlights the complexity of macrosomia and also shows that both maternal obesity and impaired glucose tolerance contribute not only to the increase in fetal weight at birth, but also to increases in fat levels in newborns or body fat percentage, which, in turn, increases the risk of developing fetal macrosomia and its complications – in particular, shoulder dystocia, trauma, etc. [14, p. 1].

The course of pregnancy with fetal macrosomia has its own features. As it has been noted, macrosomia can occur in association with a number of extragenital pathologies of pregnant women. For example, the frequency of preeclampsia in pregnant women with macrosomia is 13.4 - 36.5%, anemia - up to 74.1% [7, p. 36-37; 5, p. 111]. Preeclampsia occurs in 1/3 of cases of fetal macrosomia. Probably, this fact is connected with the prevalence of obesity (25-72%) among women with fetal macrosomia [14, p. 16]. Analysis of pregnancy complications showed that gestational diabetes mellitus occurred in 3.5 - 50% of pregnancies with fetal macrosomia [15, p. 476].

The prevalence of cervical incompetence and threat of abortion during fetal macrosomia is 2 times higher than average and occurs in 7.1% of cases [6, p. 3-5]. Fetal macrosomia is combined with polyhydramnios in 8,12 – 18.2% of observations [6, p. 3-5; 9, p. 1; 18, p. 2-3]. The frequency of oligohydramnios in fetal macrosomia is 3%, which is significantly lower than average [21, p. 4]. Placental abnormalities are observed in fetal macrosomia in 20 - 31.8% of cases, which does not differ significantly from normal fetuses [9, p. 1; 21, p. 4]. Disturbances in the system of uterine-fetoplacental blood flow arise due to an increase in the requirements of the growing fetus and the impossibility of adequate blood supply from the existing vascular system [7, p. 36].

Some authors suggest that the birth of a large fetus happens as the result of postterm pregnancy. The frequency of postterm pregnancies with fetal macrosomia varies from 5.8 to 19.5% [9, p. 924]. The average gestation period in pregnant women with fetal macrosomia is 6-8 days longer than in women with normal fetus [7, p. 36].

The pathological preliminary period is noted in 4.7% of women with fetal macrosomia [6, p. 3-4]. The complications of birth with a large fetus are mainly due to fetal-pelvic disproportion and disturbance of the uterine contractility due to its overstretch by the large fetus [9, p. 3].

According to the data of M. Boulvain, in case of fetal macrosomia, «immature» birth canals occur 3 times more often than in women with normal fetus size, so preliminary preparation of the birth canal is often required, as well as labor induction [23, p. 1-19]. Due to

the lack of a tight fit between a large fetus head and the pelvis of the mother, the frequency of premature amniotic fluid discharge during fetal macrosomia is 3 times higher than during physiological labor (22.4-35.6%). Premature amniotic fluid discharge, in turn, leads to a prolonged or protracted course of labor, which is not only the result of large fetal size, but also due to unpreparedness of the birth canal [23, p. 4-10].

Conservative management of labor with a functional assessment of the pelvis often leads to delayed delivery as a result of low fetal head position in a small pelvis or development of fetal distress. Methods of delivery in women with fetal macrosomia include induced and spontaneous labor and caesarean section. The choice of obstetric tactics depends directly on the woman and fetal condition.

A number of authors suggest that the first period of labor slowdown happens primarily because spatial incompatibility develops. Prolonged first period of labor in fetal macrosomia is associated with a greater frequency of labor abnormalities, in 50% of cases, it is a consequence of cephalopelvic disproportion, and progressively increases in direct ratio to fetus weight [6, p. 1, 9, p. 7].

Cephalopelvic disproportion is found 5 times more often in delivery of macrosomic fetuses in comparison with an average fetus birth. Large fetus delivery is often accompanied by the development of asynclitism. Slight asynclitism does not adversely affect the course of delivery, even sometimes facilitating head entry through the plane of a small pelvis [6, p. 1; 9, p. 7]. However, there is possibility when asynclitism is so pronounced that it hinders or impedes head passage. The pronounced variants of the off-axis head insertion are called pathological asynclitism. Pathological asynclitism is one of the signs of cephalopelvic disproportion. Pathological asynclitism in delivery through the natural birth canal can cause intradural hemorrhages, ruptures or tears of the cerebellar tegmentum [24, p. 18].

Macrosomia is associated with a higher frequency of operative delivery (twice that of patients with a normal fetus) and with trauma of the birth canal. According to the research of other doctors, a high percentage (82.7%) of surgical delivery is observed for the following emergency indications: failure of labor progress, unresponsiveness to pharmaceutical correction - 32.6%; cephalopelvic disproportion - 27.2%; acute fetal distress - 16.9%; premature detachment of the normally positioned placenta - 3%; partial placenta previa with bleeding - 3% [16, p. 1069; 9, p. 8].

Elective cesarean section in pregnant women with fetal macrosomia prevents trauma to newborns; perinatal disorders of the nervous system are found less often than during vaginal delivery. Delivery of large fetuses, both spontaneous and induced, in primiparous women more often end up with cesarean section, and anesthesia, episiotomy and vacuum extraction are consistently more often used. Indications for elective caesarean section in pregnant women with fetal macrosomia according to the literature are: fetus weight 4500 g or more, scar on the uterus after cesarean section, multiple uterine fibroids, anatomically narrow pelvis, history of miscarriage, death or disability of a child during previous

births, pelvic presentation, incorrect fetal position and severe extragenital pathology in mother [3, p. 34].

Fetal trauma that is most often associated with macrosomia is shoulder dystocia during spontaneous labor, including clavicle fracture and injury of the brachial plexus (especially C 5 and C 6) which can lead to Duchenne-Erb's paralysis. Clavicle fracture accompanies 0.4–0.6% of all deliveries and typically heals without serious consequences [7, p. 36]. For fetuses with macrosomia, the risk of clavicle fracture is 10 times increased. The risk of brachial plexus injury is low, occurring in approximately 1.5% of all vaginal deliveries in the United States. A case-control study indicates that the risk of brachial plexus injury among infants born by vaginal delivery increases 18–21 times if the fetal weight exceeds 4,500 g [9, p. 7]. For fetuses with macrosomia born by vaginal delivery, the frequency of brachial plexus injury is noted between 2.6% and 7% [9, p. 8].

The frequency of vertebral column and spinal cord injuries in fetal macrosomia are also significantly higher than in the case of normal weight fetuses [24, p. 11]. Vertebral injury can occur during the head ejection of a large fetus caused by structural issues and axial loading of the vertebrae in combination with excessive flexion and rotation. Vertebral bodies have predominantly cartilaginous structure, and the vertebrae themselves are rarely injured. The above factors often lead to tearing and rupture of ligaments, vertebral dislocations, rupture of radial branches of vertebral arteries and the vertebral arteries themselves, resulting in spinal cord injuries and hematomas of the spinal canal [24, p. 12].

In the first days of life in newborns with macrosomia the phenomenon of «imaginary well-being» can arise, manifesting as both delayed appearance of and progressive development of neurological symptoms [6, p. 6; 7, p. 37]. The prevalence of perinatal encephalopathy in fetal macrosomia is 4.7–76%, and in 40% of cases it is seen in combination with spinal trauma, manifesting as motor disorders and / or cerebrospinal fluid hypertension [24, p. 11].

In children born with a weight of 4,000 grams or more, in early childhood (up to 3 years) there is also a higher incidence of diabetes mellitus, respiratory diseases, allergic dermatitis and obesity [6, p. 6; 19, p. 923]. Considering morbidity, respiratory viral infections take first place. Often children in this group have

a protracted disease course, which, apparently, is associated with an allergic-prone constitution [7, p. 41].

**Purpose of the study:** to study features of the course of pregnancy, parturition and the postpartum period associated with fetal macrosomia, and to carry out an analysis of perinatal outcomes.

**Materials and methods of research.** A retrospective analysis of 100 histories of patient deliveries giving birth to children weighing 4000.0 g and more during the 3-year study period from 2014 to 2016 at the Kyiv City Maternity Hospital №3 (the study group) was conducted. The control group consisted of 100 women giving birth to full-term children with a weight of 2800.0 - 3999.0 g. Occurrence of complications, the percentage of caesarean section and perinatal morbidity were analyzed in each case.

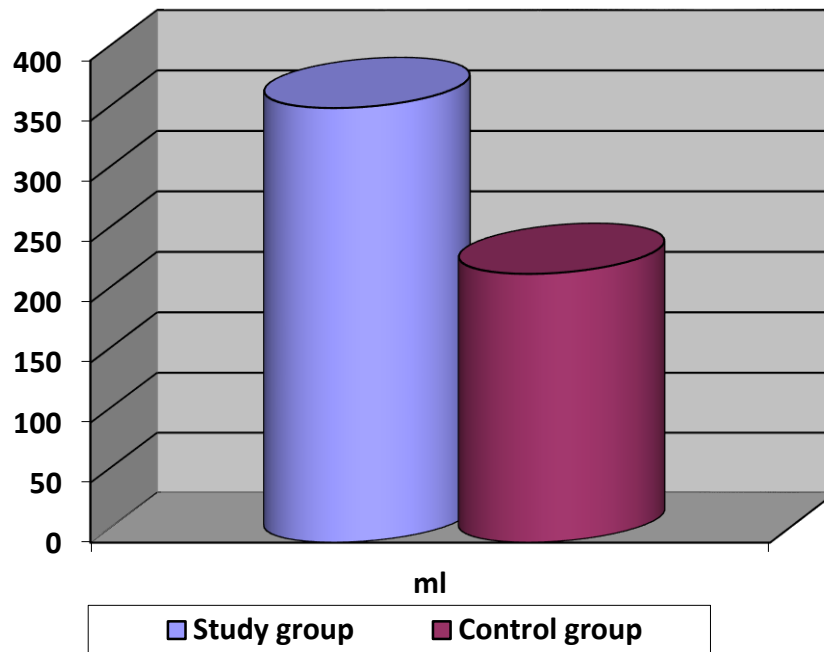
**Results of the study.** The frequency of delivering a large fetus in the maternity hospital № 3 in Kyiv, Ukraine during the study period was: 2014 - 9%; 2015 - 11% and 2016 - 13% of the total number of deliveries.

We found a 1.6-fold increase in the frequency of complications during the first half of pregnancy in women with fetal macrosomia (in 57% of women with fetal macrosomia and in 35% of women in the control group). Among them, the main complication was threatened abortion, the frequency of which was 26%, twice as much as in the control group (13%).

In the second half of pregnancy, patients with fetal macrosomia were twice as likely to develop preeclampsia of varying severity (in 25% of the main and 12% in the control group).

In women with fetal macrosomia, there were 1.2 times fewer vaginal deliveries in the study group (68%) than in control group (87%). Among the most frequent complications in delivery with macrosomia, a premature discharge of amniotic fluid was (26% of cases) and failure to progress (12% of cases).

Total blood loss during delivery, as well as the frequency of hypotonic bleeding in the postpartum period in women with fetal macrosomia was almost 2 times higher than in women in the control group. The average blood loss during vaginal delivery of women in the study group was  $360.5 \pm 156.2$  ml, compared to  $223.4 \pm 154.8$  ml. in the control group (Pic. 1). Such data can be explained by a decrease in uterine contractile activity due to overstretching of the muscular layer, as well as by increased internal wound surface area.

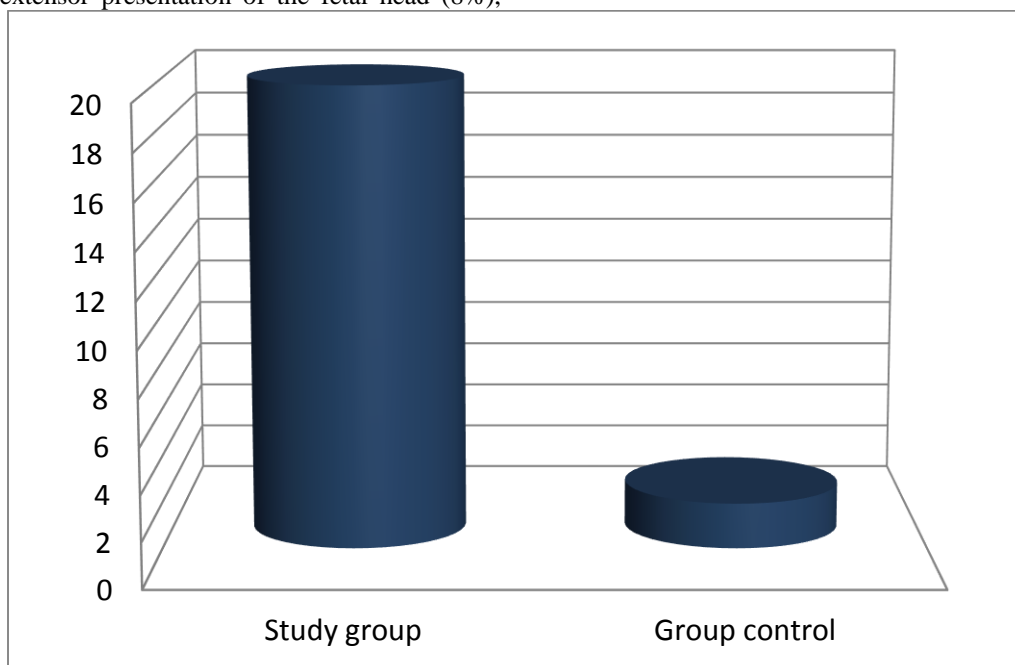


*Pic.1. Blood loss during delivery (ml).*

We found a significant increase in the frequency of surgical deliveries associated with fetal macrosomia. Caesarean section was performed 10 times more often in the study group (32%), compared with the control group (13%). The most frequent indications for surgical delivery among women in the study group were: cephalopelvic disproportion (30%), abnormalities of labor (15%), threat of uterine rupture (10%), severe forms of preeclampsia (15%), pelvic presentation of the fetus (14%), extensor presentation of the fetal head (8%),

significant varicose veins of the cervix and vagina (4%), fetal distress during delivery (4%).

Regarding labor trauma, when giving birth to a large fetus, we noted an increase in the frequency of soft tissue trauma by a factor of 2, compared with the control group. Episiotomy and perineotomy were performed 10 times more often (20% of births with fetal macrosomia and only 2% of cases of births with normal fetal weight) (Pic. 2).

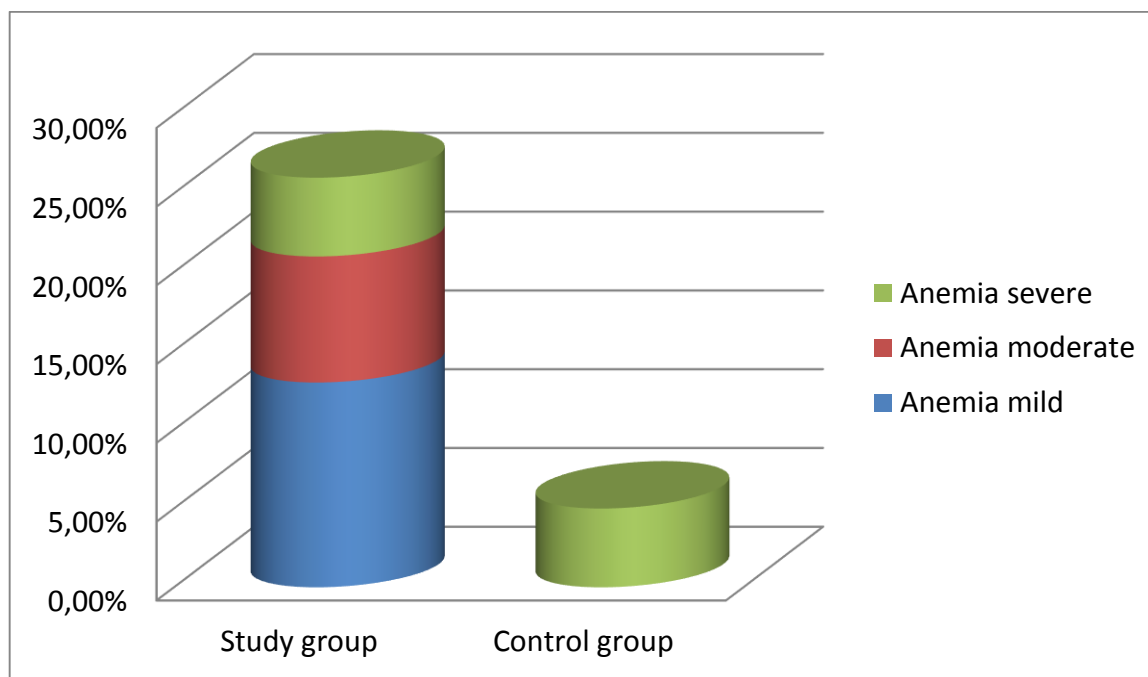


*Pic. 2. Use of episiotomy and perineotomies in examined women (%).*

Symphysitis after birth occurred in the study group in 6% of cases, whereas it was not observed in the control group.

In the postpartum period, anemia of varying severity in females with fetal macrosomia was noted in 26%

of cases in the study group: 13% with mild anemia, 8% with moderate anemia and 5% with severe anemia (Pic. 3).

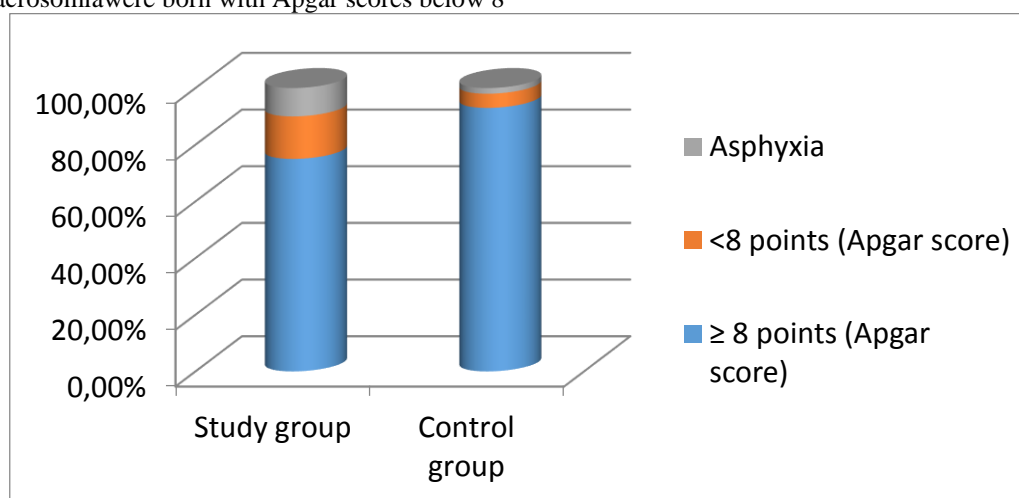


Pic. 3. The frequency of postpartum anemia in examined women (%).

In order to prevent subinvolution of the uterus, as well as hematometra, 26% of women in the study group received oxytocin in the late postpartum period of vaginal delivery.

Analysis of newborns showed that 15 babies with fetal macrosomia were born with Apgar scores below 8

points, whereas only 5 with normal weight had scores below 8 (Pic. 4). Asphyxia at birth was observed in 10% of children in study group and in only 2% in the control group.



Pic. 4. Evaluation of newborns by Apgar scale (%).

The course of the early neonatal period in children born by vaginal delivery and by elective cesarean section was practically the same.

The perinatal morbidity rates of children from the study group were 2 times higher than those of the control group (10% and 5%, respectively). Morbidity was related to birth trauma, mostly injuries to the central and peripheral nervous systems. The frequency of cephalohematoma after delivery with fetal macrosomia was also 2 times higher than in the control group.

We determined that the perinatal mortality rates of both groups were not significantly different, although this index was slightly higher in the study group with

fetal macrosomia. During the period 2014 - 2016 perinatal mortality rates were 1% in the study group and 0.7% in the control group.

**Conclusions** .Our study indicates that the frequency of births with fetal macrosomia is increasing by 2% per year, therefore the problem of fetal macrosomia has medical and social importance, for the health and life of both mother and child.

Fetal macrosomia increases the frequency of complications pregnancy and delivery, leading to an increased frequency of surgical interventions, as well as a 10 fold increase in the percentage of births by caesarean section.

Labor with fetal macrosomia adversely affects the newborn period, as reflected by increases in the asphyxia of newborns by 5 times and the perinatal morbidity rate by 2 times.

Timely diagnosis of the estimated fetal weight, an individualized approach to pregnancy and parturition, proper complete obstetric, gynecological and medical history-taking, timely anesthesia and controlling of labor in women with fetal macrosomia can reduce complications of labor and improve perinatal outcomes.

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