INTRODUCTION

Introduction of modern neonatal technologies into clinical practice allowed for the detection of newborns with low body weight (Bombardirova et al., 2001). The most widely used definition of intrauterine growth retardation (IUGR) is a fetus whose estimated weight is below the 10th percentile for its gestational age. Asymmetric growth intrauterine retardation implies a fetus with inhibited development of internal organs and low body weight retaining longitudinal length matching the gestational age (Kruick et al., 2011). This type of growth restriction is usually the result of placental insufficiency. Body weight of full-term infants is not greater than 3000 g. Intrauterine growth retardation has a prevalence of 10.8% for all pregnancies globally (IDECG seminar, 1998). Infants with IUGR have greater morbidity rate and are often diagnosed with infection and cerebral pathologies associated with genetic conditions (Markestad et al., 1997; Li et al. 2003; Peleg et al., 1998).

Maternal factors (age, body weight and height, parity) have been found to have a great impact on anthropometric parameters of newborns (Zhelokhovtseva, 1971). Different coexistent maternal diseases have been linked to the development of IUGR (Polyansky and Parusov, 1997).

Low birth weight infants account for considerable health care costs (Bombardirova et al., 2001; Petrov, 2003). Social importance of issues for IUGR infants is determined by postnatal adaptation length and an assistance that would be needed for the children in the next years.

IUGR newborns can compensate for delayed body growth with good nutrition (IDECG seminar, 1998; Markestad et al., 1997). Questions of complete compensation of mental retardation in the children, correlation between quality of family life, maternal occupation and extent of growth restriction, hereditary pattern of the condition remain still controversial.

The reason for our assessment of correlations between quality of family life and fetus development has deteriorated socioeconomic conditions in several regions of Russia after 1991, in Kurgan, Russia, in particular, that led to constitutional growth delay. With economic situation stabilized constitutional growth delay was not shown to compensate with further restriction in definitive anthropometric fetus size (Shchurov et al., 2008).

The purpose of the study is to analyze dynamics in body growth of children with IUGR, possibilities with compensation of delayed physical and mental development at pre-school age.

MATERIAL AND METHODS OF STUDY

Clinical findings of normal patients at SBI Kurgan Municipal Hospital № 2 and their full-term male and female newborns...
comprising a control group (n=848) were compared with parturient patients and 886 infants with IUGR (major group) whose birth weight was 2000 to 2980 g at 39 to 42 weeks gestation. Male-female ratio among newborns was 1.5. Anthropometric differences in female and male subgroups did not exceed 0.6%. In addition to anthropometric measurements (weight and body length, head circumference) Apgar-1 and Apgar-2 scores were used for assessment of all babies. A half-century experience has shown the Apgar score tests being a most simple and reliable technique for a comprehensive assessment of a newborn used by midwives. The Apgar scale is determined by evaluating the newborn baby on five simple criteria on a scale from zero to two. Five criteria including muscle tone, heart rate (the norm is 130 to 140 beats per minute), reflex irritability, skin colour and respiration are assessed. The test is generally done at one and five minutes after birth. Apgar scores, in absence of asphyxia, depend on a term of delivery and functional maturity (Shchurov et al., 2008).

Study groups included Kurgan based women aged 20 to 30 years. Assessments were produced within several years (from 1989 to 2010 with an interval of one year), with 100 patients with IUGR and 100 normal infants born in June. Newborns with a weight of less than 2000 g were not included in the major group. Body dimensions were measured in females at the age of 18 year (when longitudinal growth is complete) for analyzing correlations between economic environment and anthropometric parameters. A maternal job and household income were estimated. A group of 100 infants with IUGR was additionally assessed every month within six months and at 12 months after birth. Anamnestic measurements of body size at birth were collected from 65 females of major group.

IUGR was found in the history of 21 kids out of 86 aged 6.5 to 7 years who attended five kindergartens in the city of Kurgan. A preschool psychological evaluation included six criteria — auditory and visual memory, concentration, analytical thinking, arbitrary psychic processes, fine motor skills (Grebenschikova, 2009).

Statistical analysis was performed using Microsoft EXCEL 2010. Student’s t-test was employed to assess significant differences in the results with normal distribution. The text and a table present average values and error of the mean.

**RESULTS OF THE STUDY**

The mean body weight and length in the group of normal full-term infants were significantly greater than those in patients with IUGR (Table 1). Due to a less IUGR body weight the newborns showed less body weight and height index. Control body weight and height index was 66±0.2, and IUGR index was 55±0.2 (p≤0.001). Interestingly, major group showed considerable delay in weight gain (by 22%), less delay in length gain and head circumference, and rather high values of functional maturity.

Whereas, normal babies showed proportionate body weight and length gain (Figure 1). IUGR infants developed inadequate weight gain after they reached the height of 50 cm.

Control infants showed proportionate body length gain and increase in head circumference (Figure 2). IUGR infants showed slow head growth. Mean head circumference of IUGR newborns was 4.1% (p≤0.001) less than that in normal infants. Maximal head circumference was measured with the body length of 59 cm in the control group, and 54 cm in the major group (Figure 2). Whereas delayed dynamics in IUGR babies can be explained by disturbed nutrition, a slow head growth indicates to a more complicated genesis. Apgar-1 and Apgar-2 tests showed retardation in functional maturity of major group by 1.6% (p≤0.001) and 0.8% (p≤0.001), correspondingly.

Analysis of further dynamics in body length gain and head circumference of both groups showed insignificant differences at the end of the first year.

Mean longitudinal body length of normal preschool girls (6.5-7 years) measured 120±1.1 cm, boys 119±0.7 cm, with a body weight of 23±0.5 and 22±4 kg, correspondingly. IUGR children had height of 115±2.0 and 120±1.5 cm, and body weight 19±0.8 (p≤0.01) and 22±1.1 kg, correspondingly. Restriction in psychic development of involved children was either absent (analytical thinking, fine motor skills, arbitrary psychic processes) or insignificant (concentration, and visual memory) including auditory memory (Figure 3). Auditory memory scored 6.61±0.17 in normal children and 6.05±0.28 in IUGR children.

<table>
<thead>
<tr>
<th>Group of Newborn (number of observations)</th>
<th>Body weight (g)</th>
<th>Body length (cm)</th>
<th>Circumference of the head (cm)</th>
<th>Apgar-1</th>
<th>Apgar-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (n=848)</td>
<td>3521±37</td>
<td>52.8±0.21</td>
<td>35.4±0.05</td>
<td>7.55±0.03</td>
<td>8.64±0.02</td>
</tr>
<tr>
<td>IUGR Infants (n=886)</td>
<td>2745±5.7</td>
<td>49.8±0.05</td>
<td>34.0±0.04</td>
<td>7.42±0.02</td>
<td>8.57±0.02</td>
</tr>
<tr>
<td>Difference</td>
<td>-22%</td>
<td>-5.7%</td>
<td>-4.1%</td>
<td>-1.6%</td>
<td>-0.8%</td>
</tr>
</tbody>
</table>

|                  | P≤0.001        | P≤0.001         | P≤0.001                       | P≤0.001 | P≤0.01  |

Table 1. Anthropometric values of normal and IUGR infants.
7.5±0.2 in children whose body weight at birth measured 3590±0.013 g. Low weight (P, r) of IUGR females at birth did not affect preschool assessment. Several assessment parameters, visual memory in particular, were involved in IUGR males (M= 0.007*P-12.2; r =0.85).

Therefore, intraterine growth retardation detected in infants cannot be explained by disturbed trophic processes only since it was associated with delayed body and head growth, and to lesser extent, dynamics in functional maturity. Growth retardation is compensated with further development in full-term children with asymmetrical IUGR, and to preschool time, in particular.

Correlation between body weight gain and family income of normal and IUGR infants was analyzed. IUGR family
income was shown to be considerably less than that of the families in the control group (Figure 4).

The whole group of parturient women of different age was evaluated at the age of 18. The female height was measured as much as 166±1.3 cm in the year of 1993. It was shown to decrease with subsequent years measuring 162±0.4 cm (p≤0.05) in the year of 2004. The same dynamics was observed in both the parturient pelvis dimensions and newborns’ body length. Head circumference was found to decrease in both normal and IUGR infants (Figure 5).

However, functional maturity values of infants born after 1997 were observed to be approximate to the normal level of 2001 with stabilization of economic situation despite the decrease in the head circumference. The Apgar scores are likely to be repetitive in fertility of infants born in Nineties (Figure 6). The Apgar scores of IUGR babies were slightly different from those of control group and had similar dynamic tendencies.

IUGR rate was shown to decrease after the year of 1997 (Figure 7).

Therefore, with considerable worsening of quality of life decrease in the newborn body size develops gradually within several years. The delayed transitional processes are determined by the fact that women give birth 7 to 10 years after their own longitudinal body growth is complete. And probably, it can justify short-term natural disasters, poor crops, warfare having a smaller impact on anthropometric parameters of newborns than less significant but continuous changes in quality of life (Novikov, 1981).
In the first years of adverse environmental effects, poor weight gain in infants can be caused by inadequate mother's diet and result in growth retardation. In the subsequent years decreased infant body size is likely to be a preprogrammed biologically reasonable adaptation reaction aimed at low energetic and plastic fetus demands. This reaction prevents infants from disturbed functional development and decreased values of functional maturity. The women who gave birth to IUGR babies were shown to have less body size as compared to maternal values in the control group (160.9±0.27 and 163.4±0.44 cm, p≤0.001, correspondingly). The tendency to decreased definitive female body size was characteristic to control group only, whereas body dimensions in the major group remained low within the last 20 years (Figure 8).

Moreover, the less body weight, the IUGR newborns had...
the less was the body weight of their mothers at birth (Figure 9).

We made no review of infants with body weight less than 500 to 2000 g due to severe disorders that were often non-survivable. Additional anthropometric assessment of 30 children with severe congenital spine malformation showed delay in longitudinal body size and weight by 9% (p≤0.001) and by 18% (p≤0.001), correspondingly, as compared to the control group. This group of children with severe pathology of axial skeleton failed to compensate delay in the longitudinal body size being typical for the group of IUGR infants. The delay in the height was more than 12% when growth was complete (Figure 10).

One of the factors indicating to improved dieting quality in the current century is returning to systemic maternal BP values of 118±1.0 mm Hg. BP was shown to decrease from
116±1.1 mm Hg (1990) to 106±2.1 mm Hg (p≤0.001) at the end of the last century. Persistent optimal BP plays an important role for uteroplacental circulation (Shchurov and Mogeladze, 2010) that is vital for the fetus.

A direct correlation was found between IUGR infant body weight (P, r) and systolic BP (D, mm Hg) in maternity hypotension: P=100*D -9265.4; r =0.579. IUGR infant body weight and length were shown to be less than normal values in maternal hypertension (Figure 11).

The correlation between maternal BP and infant’s longitudinal body size can be explained by good placental microcirculation with maternal BP values close to 120 and 80 mm Hg.

IUGR is a specific condition. Newborns with severe
congenital spine malformation did not show such a considerable decrease in body weight and weight and height index at birth that was observed in IUGR infants. Compensation mechanism for disproportionate development is involved in the natural body growth. Body weight gain is mostly impaired in IUGR infants as alimentary hypotrophy. As shown earlier (Bochegova et al., 2002), with slow body weight gain grade I postnatal growth retardation exhibits normal development of vital life support organs, myocardium in particular, that allows for retaining dynamics in BP to make up for body growth

Conclusions

1. Newborns with intrauterine growth retardation are slow to gain body weight and develop cranial bones. Psychic abilities of IUGR children at 6 years of age have shown to approach to those in normal peers.

2. Economic conditions, genetic predisposition and maternal blood pressure were found to affect an incidence and severity of IUGR.

3. Body height and weight were shown to be significantly decreased in full term infants with spine malformations as compared to the control group. Postnatal body growth was delayed in axial pathology with definitive body height being decreased by 10-15%.

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REFERENCES


Figure 11. Correlation between maternal systolic BP and IUGR infant height.


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