

ORIGINAL ARTICLE

Neonatal Anthropometry: Measurement of the Abdominal Circumference in Newborns

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Summary

Introduction. Neonatal anthropometric measurements, including body weight, length, head circumference and abdominal circumference are routine procedures in obstetric and neonatal departments. Standard values for neonatal population are established for body weight, length, head and thoracic circumference, however there are no reference values for neonatal abdominal circumference, furthermore, this measurement currently is not a routine procedure in every obstetric and neonatal unit. In order to evaluate the increase of abdominal circumference in newborns with a disease of organs of abdominal cavity including necrotizing enterocolitis (NEC), the abdominal girth of newborns soon after birth without pathology in the abdominal cavity should be ascertained. Thereby, the average value of the abdominal circumference of newborns in Latvia could be obtained.

Aim of the Study. The aim of our study is to measure the abdominal circumference in premature and term-born neonates soon after birth and to define the correlation between abdominal circuit and birth weight.

Materials and Methods. The measurement of waist girth was carried out in 460 neonates within 30 minutes after birth. Newborns were divided into 4 groups according to birth weight: extremely low birth weight (ELBW) – under 1000 g, very low birth weight (VLBW) – 1001 g – 1500 g, low birth weight (LBW) – 1501 g – 2500 g and term neonates with 2501 g – 4590 g birth weight. The abdominal circumference was measured in 2 obstetric units in accordance with the previously established measurement methods.

Results. There was no statistical difference between abdominal circumference in boys and girls in ELBW, VLBW and LBW groups ($p > 0.05$). Mean abdominal circumference in ELBW group was 18,70 cm (SD=0,84) in boys and 18,67 cm (SD=1,40) in girls, VLBW group was 22,20 cm (SD=1,42) and 21,94 cm (SD=1,29) in boys and girls, respectively. Mean abdominal circumference in LBW group was 24.47 cm (SD=2.36) in boys, and 24.92 cm (SD=2.23) in girls.

Independent Samples Test: Mean abdominal circumference was statistically different in boys and girls in 2500g -4590g birth weight group with median value 30.56 cm in boys, and 33.23 cm in girls ($p < 0,05$). Mean value in girls was 3.33 cm higher than in boys.

Dependent Variable linear regression: Specific formula for estimation of normal abdominal circumference was developed as a result of this study: $y = 0.0044x + 16.38$ (y – abdominal circumference, cm; x – body weight, grams; 0.0044 – regression coefficient; 16.38 – regression constant).

Conclusions. The difference of mean abdominal circumference was not statistically significant in boys and girls in ELBW, VLBW and LBW groups, however, the difference was significant in the term-born neonates group.

As a result of this study reference values and specific formula were established, which allows determination of normal abdominal circumference in neonates depending on birth weight.

Key-words: Abdominal circumference; anthropometric measurements; newborn

INTRODUCTION

Anthropometric measurements of a newborn, including body weight, length, head circumference and abdominal circumference are routine procedures in obstetric and neonatal departments. There are standard values determined for body weight, length, head and thoracic circumference (4). Standard values for abdominal circumference are not established and evaluation of the abdominal girth is not a routine procedure in obstetric and neonatal units. In order to ascertain the size of abdominal viscera in healthy newborn and objectively determine and specify the circumference of waist in case of NEC or some other disease in the abdominal cavity, the measurement of waist circumference is necessary. Standardized values for neonatal abdominal circumference have not been determined. Thus, to

objectively determine the increase of the waist girth in newborns with NEC, the abdominal circumference of newborns soon after birth without pathology in the abdominal cavity should be ascertained. Accordingly, the average value of the waist circumference of newborns in Latvia could be obtained.

AIM OF THE STUDY

The aim of our study is to measure the abdominal circumference in premature and term-born neonates 30 minutes after birth and to define the correlation between abdominal circuit and birth weight.

MATERIALS AND METHODS

Abdominal girth was established routinely with other anthropometric measurements – weight, head

circumference, chest circumference and length. The measurement of abdominal girth was carried out in 460 neonates (235 boys and 225 girls) within 30 minutes after birth. Newborns were divided into 4 groups according to birth weight: extremely low birth weight (ELBW) – under 999 g, very low birth weight (VLBW) – 1000 g – 1499 g, low birth weight (LBW) – 1500 g – 2499 g and term neonates with 2500 g – 4590 g birth weight.

As there is no unified methodology for determination of abdominal circumference in newborns, methodological protocol of defining the waist girth was developed by modifying „National Health and Nutrition Examination Survey (NHANES). Anthropometry Procedures Manual” – the detection protocol of abdominal circumference in paediatric age group and protocol for defining newborns’ waist girth developed in Wisconsin – Milwaukee University (9,13). According to our methodological protocol, 30 minutes after birth during the physical examination abdominal circumference at the umbilical level was measured; simultaneously body weight, length, head and thoracic circumference were measured (2,6,7,8). Disposable D&P Abrams 61.9 cm paper tape measure was used. The measurements were performed after cleaning the newborn, but before breastfeeding or any enteral feeding. Measures were obtained when the newborn was lying on his back, tape measure was placed under the back, perpendicular to the spine at the umbilical level, touching skin, but not pressing the tissue (2). Infant weights are measured without clothes on an infant weighing scale (*Seca Baby Scale 376*) and the scale was calibrated daily for accuracy. Physical examination of newborn and anthropometric measurements were performed in the delivery room or in the room for newborn care, which meet the requirements for delivery or newborn intensive care departments: fluorescent lights, available equipment for oxygen substitution, maintaining normothermy of the patient, free airways avoiding aspiration, parenteral input of medication and fluids, monitoring the vital parameters (airways, heart-rate, circulation). The abdominal circumference was measured by two independent investigators with one of them being constant (No. 1). Measurements of both investigators were compared and statistical reliability was detected. Data were obtained and processed with *Microsoft Excel 2010* and *SPSS v. 19.0* programs using *t-test*.

RESULTS

The results of independent sample t-test showed that difference of abdominal circumference in ELBW, VLBW and LBW groups in boys and girls was not statistically significant ($p>0.05$). In ELBW group boys’ mean abdominal circumference was 18.70 cm (SD=0.84), girls’ - 18.67 cm (SD=1.40). In VLBW group boys’ mean abdominal circumference was 22.2. cm (SD=1.42) and girls’ - 21.94 cm (SD=1.29), but in LBW group mean abdominal circumference in boys and girls was 24.47 cm (SD=2.36) and 24.92 cm (SD=2.23) respectively. We found statistically significant difference between abdominal circumference in boys and girls in term

neonates with 2500 g – 4590 g birth weight, where mean abdominal girth in boys was 30.56 cm (SD=1.62), in girls – 33.23 cm (SD=1.62) ($p<0.05$)(Tab.1).

Results of two dependent sample t-test showed statistically significant difference in LBW group between obtained measurements of investigator No.1 and No.2 ($p<0.005$); though in other groups the difference of mean abdominal circumference was not statistically significant ($p>0.05$).

In all groups close correlation between abdominal measurements of both investigators was observed ($r=0.99$). Mean abdominal circumference in measurements of investigator No. 1 was 27.96 cm, in measurements of investigator No. 2 – 27.97 cm ($r=0.99$; $p>0.05$)(tab. 2).

Independent sample linear regression equation showed that abdominal circumference of a newborn has a close positive correlation with birth weight ($R^2=0.91$)(fig.1). Specific formula for estimation of normal abdominal circumference was developed as a result of this study: $y=0.0044x+16.38$ (y – abdominal circumference, cm; x – body weight, grams; 0.0044 – regression coefficient; 16.38 - regression constant).

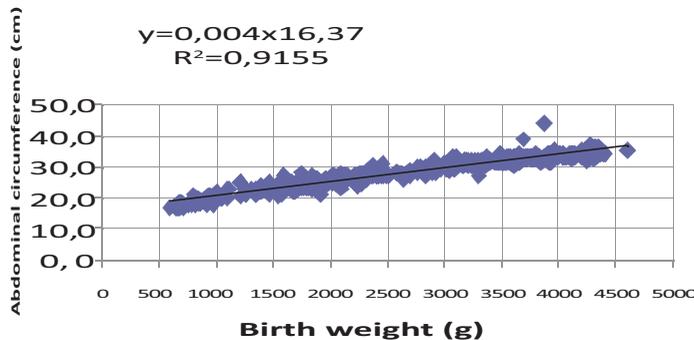
Tab. 1. Abdominal circumference of newborn boys and girls

Birth weight	Gender	n	Mean abdominal circumference (cm)	SD	95% CI	P value
<1000g	boys	6	18.70	0.84	-1.17 -1.30	0.17 (>0,05)
	girls	27	18.67	1.40		
1001-1500g	boys	23	22.20	1.42	-0.65 - 1.17	0.58 (>0,05)
	girls	16	21.94	1.29		
1501-2500g	boys	99	24.47	2.36	-1.09 - 0.21	0.54 (>0,05)
	girls	88	24.92	2.23		
2501-4590g	boys	130	30.56	1.62	-3.06 - 2.23	0.04 (<0,05)
	girls	110	33.23	1.62		

2.tab. Measurement difference between two investigators

Birth weight	n	Mean abdominal circumference (cm) Nr.1	Mean abdominal circumference (cm) Nr.2	Mean diff	SD	St. error diff	P value
<1000g	33	18.70	18.67	0.03	0.17	0.03	0.32 (>0,05)
1001-1500g	39	22.09	22.04	0.05	0.19	0.03	0.10 (>0,05)
1501-2500g	148	25.36	25.40	0.03	0.16	0.01	0.02 (<0,05)
2501-4590g	240	31.78	31.80	0.02	0.18	0.01	0.11 (>0,05)
Together	460	27.96	27.97	0.01	0.17	0.01	0.11 (>0,05)

Fig. 1. Abdominal circumference and birth weight in neonates



DISCUSSION

Anthropometric parameters in newborns such as body weight, length, head and thoracic circumference have a wide range of use during neonatal period; they can be applied by a general practitioner for assessment of newborn’s physical development, as well as by neonatologist in neonatal unit. These measurements are easy to interpret, as there are clear standards, growth curves and percentile scores available.

The abdominal circumference is influenced by several factors: resistance of the anterior abdominal wall, time before or after feeding or defecation, phase of breathing, layer of fat. The above mentioned could be a reason for the lack of standard of the abdominal circuit in newborns. Measurements of the waist girth are widely

studied; they are associated with a lot of measurement error studies (7,18). In many countries including United States, United Kingdom, Germany, India, China, New Zealand, assessment of anthropometric parameters of newborns is being implemented (10, 3, 1, 5, 14, 15). These studies show changes in the abdominal circumference in connection with other physical parameters: body weight in preterm and term-born newborns, body length, gestation age, skin fold measurement. There are data in several studies suggesting that anthropometric parameters of newborn, including waist girth, considered in context with anthropometric parameters of mother and fetus, allow antenatal prediction of size of the newborn (11,12). The vast majority of studies regarding anthropometric parameters of newborn are focused on intrauterine growth retardation, discrepancy between body weight and other physical measurements of newborn and gestational age. To evaluate the physical development of fetus, prenatal ultrasonography is performed (6,11,20,19).

The significance of measurement of abdominal circumference in newborns is not shown in studies regarding anthropometric parameters. The increase of waist girth together with other clinical signs of NEC has an important diagnostic role. With each clinical stage of NEC, the abdominal circumference increases (6). This can be proven by dynamic measurement of abdominal girth, which can be achieved by routine measurement of waist circumference together with other anthropometric measurements in delivery department. Thereby the initial data can be used in future dynamic measurements of abdominal girth, if the NEC or other disease of organs of abdominal cavity develop. There is no common tactic in Latvia or in other countries for the measurement of abdominal circumference in neonatal units. Routine waist girth measurements in all neonates and sick newborns admitted to neonatal units, could be a meaningful indicator of prognosis and early diagnostic of diseases of abdominal cavity.

The mean values of abdominal circumference obtained in our study can be used in clinical praxis in neonatal units, allowing more precise determination of the increase of waist girth in case of NEC or other diseases in abdominal cavity.

CONCLUSIONS

The difference of mean abdominal circumference was not statistically significant in boys and girls in term-born neonates group.

There was no statistically significant difference in the mean abdominal circumference in boys and girls in ELBW, VLBW and LBW groups.

There is a positive correlation between abdominal circumference and body weight.

The formula for estimation of normal abdominal circumference developed as a result of our study is useful for determination of predictive abdominal circumference.

Conflict of interest: None

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