Acta Paediatrica Academiae Scientiarum Hungaricae, Vol. 19 (4), pp. 357—365 (1978)

Transverse diameter of chest and heart after birth asphyxia in the newborn infant

By

J. WEISENBACH[1], K. SCHULTZ[1] and Margit SCHMELZER[2]

[1] Department of Paediatrics and [2]Central Research Laboratory, University Medical School, Pécs, Hungary

Received April 25th, 1978

The transverse diameter of the chest and heart was measured in 745 newborn infants after birth asphyxia. Both diameters showed a good correlation with birth weight. The great individual variations of the measurements were due to different degrees of birth asphyxia observed in the infants and to their different responses to compensate asphyxia. A wet lung and an increased transverse diameter of the chest (above the 90th percentile) indicate a good, and a decreased transverse diameter of the chest (bellow the 10th percentile) indicate a bad prognosis for survival. The cardiomegaly usually disappears after the first 12 hours of life, but in some cases it persists for more than 5 days, depending on the severity of birth asphyxia.

Adaptation to extrauterine life of the cardiorespiratory system of the newborn infant is prolonged after birth asphyxia; the absorption of amniotic fluid in the lungs is delayed, dystelectasis and emphysema develop, the physiological shunts in the heart remain open, the size of the heart increases [2, 9, 11, 13, 14, 15, 16]. These changes are clearly seen on the chest X-rays and the transverse diameter of the chest and the heart can be measured. When studying the X-ray picture of the wet lung it is important to assess the degree of emphysema (increased chest diameter) and dystelectasis (decreased chest diameter). In the present paper we have compared the transverse diameter of the chest (TDC) and the heart (TDH) in normal infants and in infants who had experienced different degrees of asphyxia at birth. A comparison was made between these measurements and the severity of birth asphyxia.

Materials and Methods

The records of 745 newborn infants admitted for birth asphyxia were evaluated, and a retrospective analysis was made. Infants of diabetic mothers, small-for-dates newborns, infants with congenital heart disease, hypoglycaemia or hypocalcaemia were excluded from the study. The criteria for the diagnosis of birth asphyxia or postasphyctic syndrome were

1) factor(s) predisposing to asphyxia in the history of pregnancy or delivery;

2) a 1 minute Agar score less than 7;

Supported by grant No. 3—23—0502—04—1/M of the Hungarian Ministry of Health.

3) pH less than 7.30, with a Base excess less than −5mE/l and a pCO_2 above 40 mm Hg;

4) clinical signs suggesting that the infant had experienced birth asphyxia (tachypnea, cyanosis, neurological signs, etc.).

The infants studied were divided into mild, moderate and severe groups, depending on the X-ray picture of the chest and heart. The classification was based on principles accepted in the literature [11, 14, 16]. TDC and TDH were measured in each case. The technique of roentgenograph and measurements has been described earlier.

Roentgenograms were made within the first 12 hours of life, then at 24, 48, 72 hours and on the 5th postnatal day.

Statistical evaluation was done by correlation and regression analysis, the latter by parabolic approach ($d = c\sqrt{m}$).

Cases in which the TDC was above the 90th or below the 10th percentile were analysed individually in the first 12 hours, after 24 hours and on the 5th day of life. The same was done if the TDH was above the 90th percentile within 12 hours and on the 5th day of life.

Results

Data for the pregnancies and deliveries are given in Table I. In the roentgenograms, wet lung disease (27.7%), cardiomegaly (23.1%) or the two typical changes together (49.1%) were the most striking findings. According to the classification of Nielsen [11] and Wesenberg [15, 16], 43.9% of the cases were considered mild, 43.9% moderately severe and 12.8% severe.

There was a close correlation ($p < 0.001$) between birth weight and the two diameters in all age groups (Figure 1a and 1b, Table II).

Table I

Maternal pathological conditions during pregnancy Factors predisposing to perinatal asphyxia

Number of cases	Pathological conditions
8	Congenital heart disease
3	Epilepsy
4	Hypertension
2	Asthmatic bronchitis
6	Shirodkar cerclage
1	Appendectomy
1	Gastric surgery
1	Gynaecological surgery
1	Tuberculosis
1	Purulent bronchitis
1	Oophoritis
1	Trichomonas infection
1	Criminal abortion

Number of cases	Predisposing factors
58	Umbilical cord twisted around neck
24	Protracted delivery
3	Precipitated delivery
16	Placenta praevia
119	Premature ruptura of membranes
29	Meconium stained amniotic fluid
34	Signs of intrauterine asphyxia
1	Placenta zonaria
51	Placental infarction
3	Uterine neck contraction
14	Breech presentation
11	Transverse presentation
1	Vertex presentation
3	Face presentation
2	Occipital presentation
1	Footling presentation
2	Dystocia
6	Fraction of arm
8	Prolapse of cord
3	Short umbilical cord
4	Persistent membranes
4	Traction of leg
2	Contracted pelvis
1	Myoma of uterus
1	Rupture of membranes during amnioscopy

The individual TDC data in postasphyctic babies were different from the normal values in all age groups. Within the first 12 hours of life we

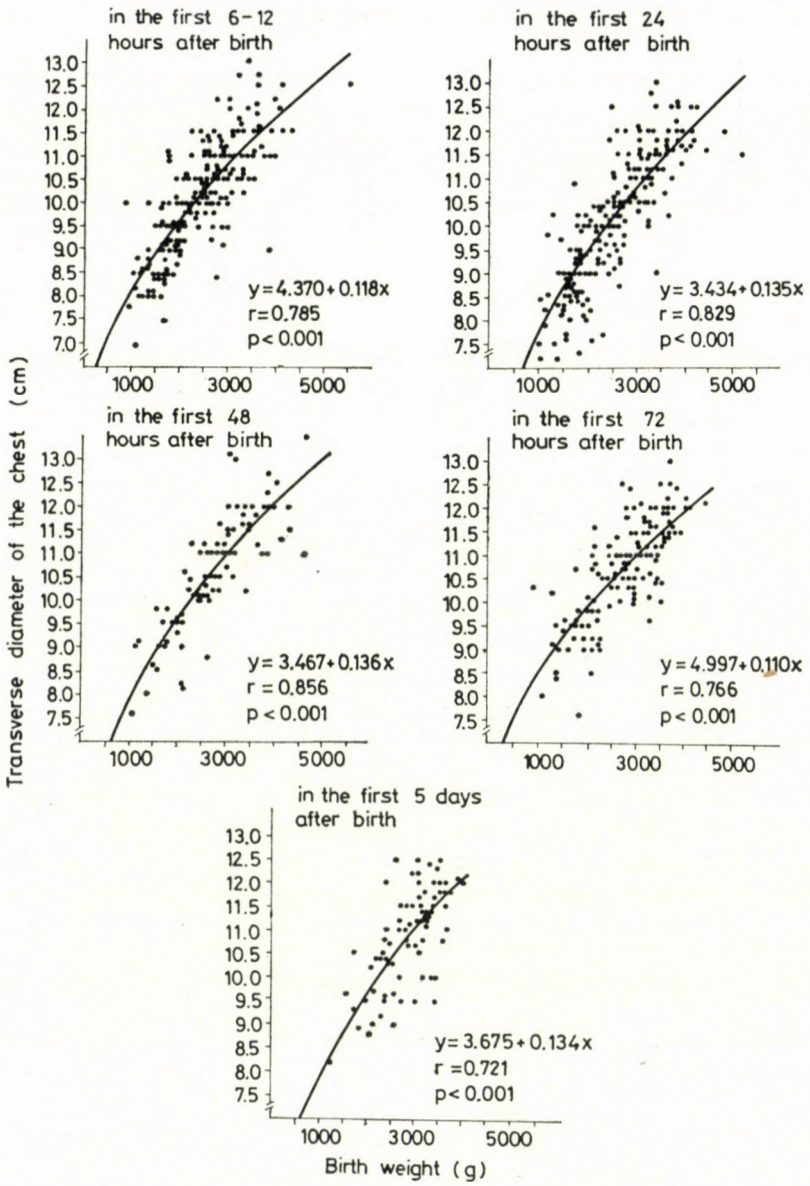

FIG. 1/A

had data only from babies with a birth weight between 1250—2250 g. Most of the TDC measurements were within the 10th and 90th percentile in this group of babies, and only a small fraction was above the 90th percentile. Later, at 24, 48 and 72 hours and at 5 days of life more data were below the 10th percentile (Figure 2b).

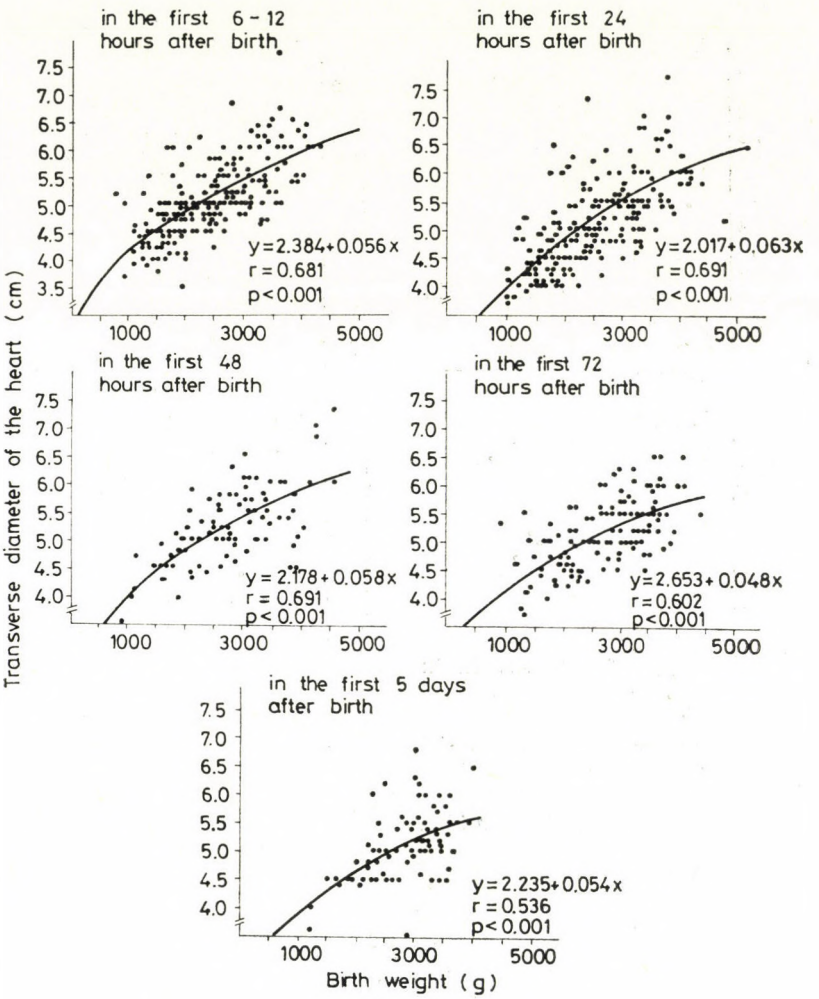

FIG. 1/B

All cases with a TDC above the 90th or below the 10th percentile were analysed individually. In both groups asphyxiating factors had occurred during pregnancy or delivery twice as often as in the other babies (Table III).

In cases with a TDC above the 90th percentile, the dominating radiological sign was emphyseme and with a TDC below the 10th percentile, dystelectasis of the lung.

In the first 12 hours of life, two babies died in the first and 11 in the second group. Asphyxiating factors were similarly frequent in babies with a TDH above the 90th percentile, if the measurements were made at 12 or 24 hours or 5 days. Mortality rate in these cases decreased with

TABLE II

			Time of investigation after birth				
			6—12 hours	24 hours	48 hours	72 hours	5 days
Postasphyctic cases	Birthweight	Mean	225	217	86	134	81
		N	2425	2505	2765	2747	2860
		SD	795	830	855	747	614
	TDC	Mean	10.107	10.111	10.542	10.707	10.802
		SD	1.211	1.364	1.358	1.073	1.130
	TDH	Mean	5.081	5.100	5.011	5.165	5.105
		SD	0.053	0.755	0.722	0.601	0.612
Control cases	Birthweight	N	130	217	164	177	136
		Mean	1651	2214	2274	2230	2531
		SD	456.0	707.0	789.0	773.0	579.0
	TDC	Mean	8.786	9.716	9.750	9.832	10.400
		SD	1.035	1.082	1.220	1.204	0.856
	TDH	Mean	4.11	4.51	4.12	4.37	4.59
		SD	0.454	0.524	0.548	0.506	0.367

TABLE III

In brackets, total number of postasphyctic cases

Transverse diameter of chest	Number of cases*	Number of factors of predisposing to birth asphyxia	Died
12 hours after birth			
TDC > the 90th percentile	18(745)	34(832)	2
TDC 10th—50-th percentile	36(745)	53(832)	11
24 hours after birth			
TDC < 90th percentile	28(745)	45(832)	2
TDC < 10th percentile	32(745)	58(832)	4
5 days after birth			
TDC > 90th percentile	13(745)	22(832)	—
Transverse diameter of heart			
12 hours after birth			
TDH > 90th percentile	61(745)	125(832)	13
24 hours after birth			
TDH > 90th percentile	60(745)	142(832)	6
5 days after birth			
TDH > 90th percentile	21(745)	38(832)	—

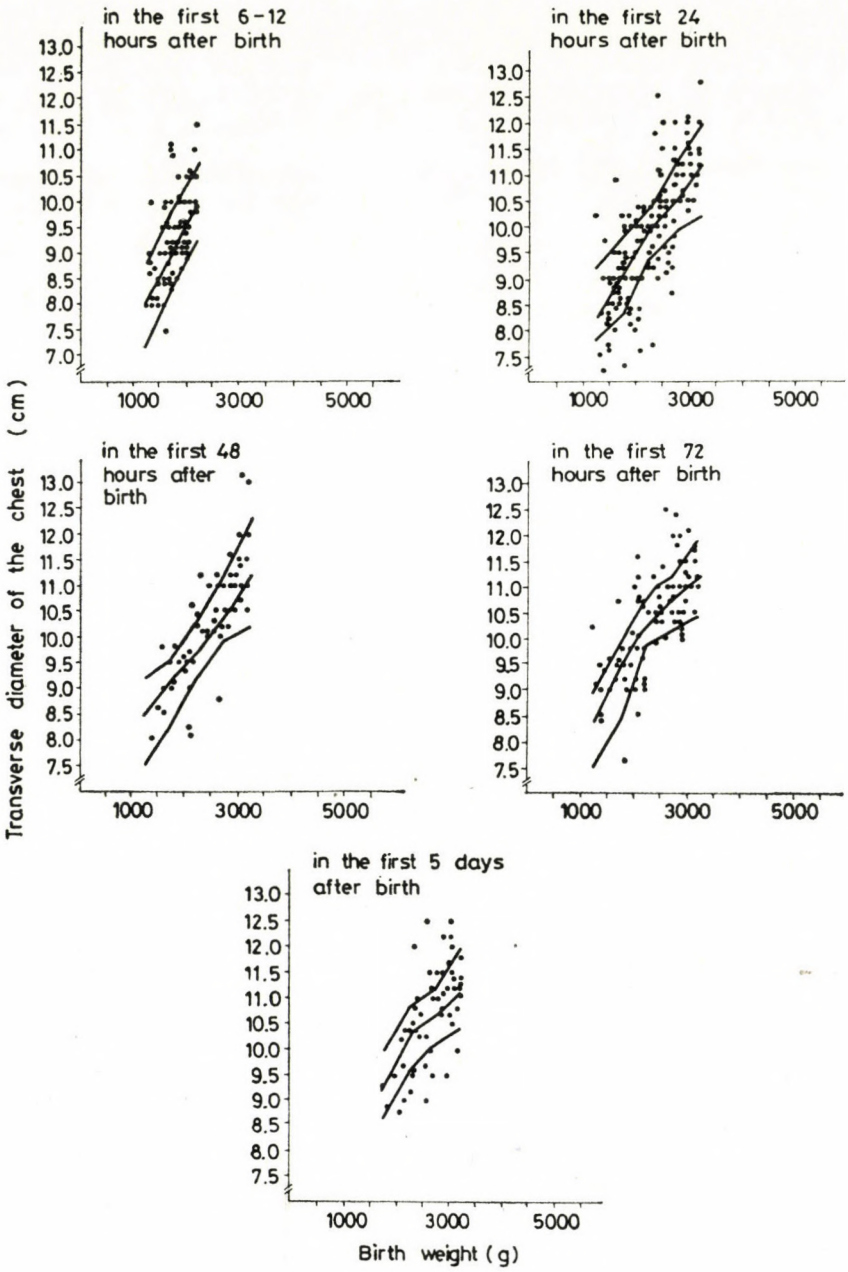
in the first 6–12 hours after birth
in the first 24 hours after birth
in the first 48 hours after birth
in the first 72 hours after birth
in the first 5 days after birth
Transverse diameter of the chest (cm)
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
1000
3000
5000
Birth weight (g)

FIG. 2/A

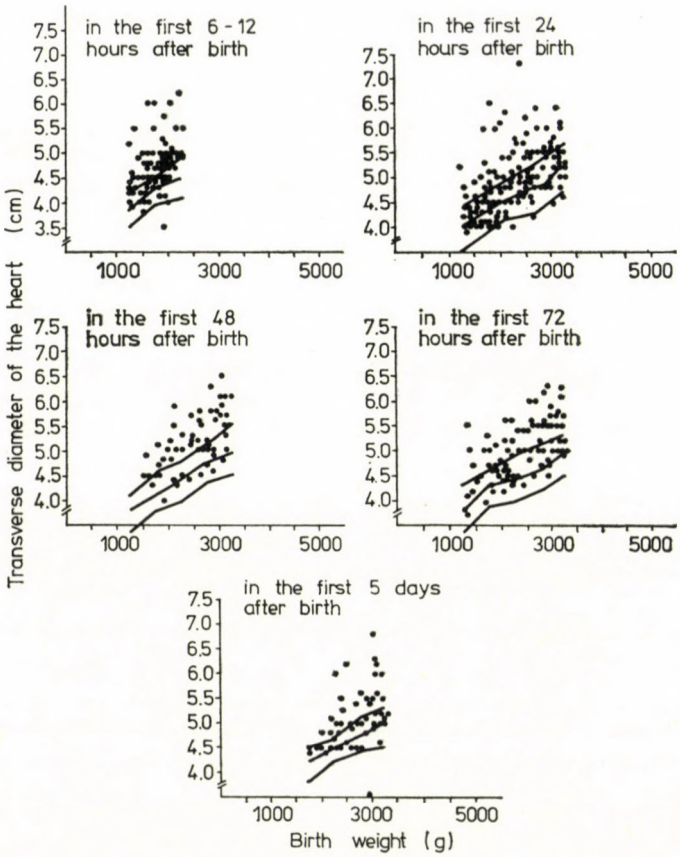

FIG. 2/B

increasing postnatal age (Table III).

Mean TDC, TDH and birth weight were higher in postasphyctic babies than in the normal control group. The increase in mean TDC and birth weight was proportional, but the increase in mean TDH was higher than the increase in birth weight.

DISCUSSION

There are several pathological processes which may change the size of the newborn chest and heart and lead to a disturbance in cardiorespiratory adaptation to extrauterine life [1, 5, 9, 16].

Measuring the volume of the lung or the heart by different methods [8, 10, 12] is not useful in everyday practice, while the TDC and TDH measured on the newborn's chest roentgenogram are useful indicators of the postasphyctic state.

The TDC was measured at different times postnatally. Opinions differ concerning the period that is necessary for cardiovascular adaptation after birth asphyxia. Karlberg's data

show that the process may take more than two days [7], according to Martin and Friedel [9] it takes between two days and a week, and according to Nielson [11] between two and six days. Wesenberg observed complete cardiorespiratory adaptation after 72 hours even in severely asphyxiated babies [16].

In our cases, 12 hours after birth asphyxia the chest roentgenogram showed a patchy pattern with atelectasis and emphysema in both lung fields. This patchy appearance decreased gradually by the 5th day of life, but after severe asphyxia the changes persisted for more than 5 days. Generally, in the first 12 hours of life emphysema, thereafter dystelectasis was the dominating finding on the newborn's chest roentgenogram.

Emphysema was more common among babies with a birth weight over 2000 g. There was a great variability in the measurements due partly to the heterogeneity of the newborn population observed and the different degrees of birth asphyxia. The extent of dystelectasis and emphysema was closely related to the severity of asphyxia and to the individual compensation capacity of the baby. Mean birth weight of the infants studied was higher than in the control group. The newborn infants tolerate birth asphyxia better than preterm infants, as the latter develop hyaline membrane disease after intrauterine or intrapartum asphyxia.

The survival rate was high among babies whose TDC was above the 90th percentile in the first 12 hours of life. On the basis of the above findings, an increased TDC means a good prognosis for survival, while a decreased TDC with a patchy radiographic appearance of the lungs means a poor prognosis in the asphyxiated newborn infant.

Burnard and James [2] reported on a gradual decrease of the TDH in the first 5 days. In our babies who had experienced birth asphyxia, cardiomegaly was a frequent finding in the first 12 hours of life, then its frequency decreased in the next 12 hours. Subsequently the number of infants with cardiomegaly remained unchanged until the 5th day.

The small number of our cases does not allow to draw definite conclusions, but it appears justified to infer that cardiomegaly in low birth weight babies is a worse prognostic sign than in severely asphyxiated term newborn infants.

References

1. Adams, F. H., Lind, H.: Physiologic studies on the cardiovascular status of normal newborn infants, with special reference to the ductus arteriosus. Pediatrics **19,** 431 (1957).
2. Burnard, E. D., James, L. S.: Radiographic heart size in apparently healthy newborn infants: Clinical and biochemical correlations. Pediatrics **27,** 726 (1961).
3. Dawes, G. S., Mott, J. C.: The vascular tone of the foetal lung. J. Physiol. (Lond.) **164,** 469 (1962).
4. Emmanouilides, G. C., Moss, A. J., Duffie, E. R., Adams, F. H.: Pulmonary arterial pressure changes in human newborn infants from birth to 3 days of age. J. Pediat. **3,** 65 (1964).
5. Gefferth, K.: Röntgendiagnostik der Säuglingspneumonien. Akadémiai Kiadó, Budapest 1967, P. 78.

6. James, L. S., Weisbrot, I. M., Prince, C. F., Holaday, D. A., Apgar, V.: The acid–base status of human infants in relation to birth asphyxia an the onset of respiration. Pediatrics **52,** 379 (1958).
7. Karlberg, P.: The adaptive changes in the immediate postnatal period, with particular reference to respiration. Pediatrics **56,** 585 (1960).
8. Klepzig, H., Frisch, P.: Röntgenologische Herzvolumenbestimmung. Georg Thieme, Stuttgart 1965.
9. Martin, J. F., Friedel, H. L.: The roentgen findings in atelectasis of the newborn. Amer. J. Roentgenol. **67,** 905 (1952).
10. Mushoff, K., Reindell, H., König, K., Kenl, J., Roskamm, H.: Das Herzvolumen und die körperliche Leistungfähigkeit bei 10- bis 19jährigen gesunden Kindern. Arch. Kreisl.-Forsch. **35,** 12 (1961).
11. Nielson, H. C., Riemenschneider, T. A., Jaffe, R. B.: Persistent transitional circulation: roentgenographic findings in thirteen infants. Radiology **120,** 649 (1976).
12. Ratford, M.: Measurement of airway resistance and thoracic gas volume in infancy. Arch. Dis. Childh. **49,** 611 (1974).
13. Sisson, T. R. C., Wahlen, L. E.: The blood volume of infants III. Alterations in the first hours after birth. J. Pediat. **56,** 43 (1960).
14. Swischuk, L. F.: Radiology of the newborn. Pediat. Clin. N. Amer. **13,** 1017 (1966).
15. Wesenberg, R. L., Stanley, N. G., Esward, B. M.: Radiological findings in wet-lung disease. Radiology **98,** 69 (1971).
16. Wesenberg, R. L.: The newborn chest. Harper and Row, Hagerstown, Md. 1973.

Dr. I. Weisenbach
József A. u. 7.
H-7623 Pécs, Hungary