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Original Article

Assessment of the quality of general movements in newborn infants: a tool to predict developmental disorders at an early age

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Abstract

Background Nowadays, quality assessment of general movements (GMs) in infants can be used as a tool to predict developmental outcome. Until now, there is no published study in this field in Indonesia.

Objectives The aim of this study was to evaluate the quality of GMs of newborn infants.

Methods A prospective study was done at neonatal ward, Dr. Soetomo Hospital in Surabaya, between December 2006 and January 2007. A single supine position video recording of newborns at GMs preterm and writhing age was made using Precthl's method. Infants were chosen consecutively among singletons above 28 week gestational age. The quality of GMs was assessed by means of Gestalt perception by one of the authors, who had been trained and certified in GMs. GMs were classified into: normal-optimal, normal-suboptimal, mildly-abnormal, and definitely-abnormal. Correlation tests were used to assess the relationship between perinatal conditions and the quality of GMs.

Results 106 videos were recorded, and 100 were assessed completely. Abnormal GMs were found in both 35 preterm age (normal-optimal 2.9%; normal-suboptimal 28.6%; mildly-abnormal 45.7%; definitely-abnormal 22.9%) and 65 writhing age (3.1%; 41.5%; 41.5%; 13.8%, respectively) (P=0.285). There was a weak negative correlation between birth weight and the quality of GMs (r=-0.20, P=0.044).

Conclusions The quality of GMs in Indonesian newborn infants in our study was predominantly abnormal, which puts these infants at high risk for later developmental disorders. The lower the infants'birth weight, the more likely for abnormal GMs. **[Paediatr Indones 2008;48:292-8]**.

Keywords: *general movements, Prechtl's method, low birth weight, developmental disorders*

Improvements in obstetrical and neonatal intensive care have a positive impact on perinatal mortality. On the other hand, the number of infants who are at high risk for developmental problems are gradually increasing.[1,2] Detection of children with a developmental disorder at an early age is notoriously difficult. This is reflected by the heterogenecity in predictive validity of the various techniques.[3] Recently, Precthl developed a new form of motoric evaluation of young infants based on the assessment of the quality of general movements (GMs). This method has a high specific predictive value for later developmental outcomes, which has never been achieved previously by traditional neurological examinations, or even by sophisticated equipment, such as brain imaging, electroencephalogram (EEG),

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and visual or somatosensory-evoked potentials.[3,4] During the past few years it became clear that the quality of GMs of young infants is a powerful predictor of the developmental outcome, especially for cerebral palsy (CP).[5,6] Various obstetrical, pre- and post-natal conditions can give rise to abnormal GMs quality.[4] Studies of infants at risk for developmental disorders reported that the presence of definitely-abnormal GMs at fidgety age (2-4 months post-term), predict CP with an accuracy of 85-98%.[7,8] Recent studies showed that infants who do not develop CP might show other developmental disorders, such as minor neurological dysfunction (MND), attention deficit hyperactivity disorder (ADHD), cognitive problems, and aggressive behavior.[7]

European experience shows that GMs assessment can be implemented easily into clinical practice, as it only requires a video recording of spontaneous motor behavior of young infants for several minutes.[9] GMs assessment is also very effective and reliable, with a high inter-observer agreement and high test-retest agreement.[7,10] Although this method is considered to be useful, it is not widely used, perhaps because so far only a few researchers outside Precthl's original circle have been trained ,and almost all published studies come from this original group. Therefore it is important to validate Precthl's method in other populations. The present study was designed to study the distribution pattern of the quality of GMs by applying the Prechtl's method in a population of Indonesian newborn infants, to find out the possible correlation between several perinatal conditions and the quality of GMs. Ours is the first experience in Surabaya and Indonesia to the best of our knowledge.

Methods

Samples

A prospective study was performed at NICU and neonatal ward, Dr. Soetomo Hospital in Surabaya, between December 2006 and January 2007. Infants included were chosen consecutively among singletons, above 28 weeks of postmenstrual age (PMA), free of the mechanical devices that could affect the expression of spontaneous movements, and their parents signed on a written informed consent. Exclusion criteria were severely sick infants who needed ventilatory support and the presence of major congenital malformations. The obstetrical, pre-and post natal clinical data were recorded carefully.

Method of recording

A single video recording of the spontaneous movements was made for each infant, following Prechtl's recording procedures.[11] The recording time varied according to the infants' age; 30 minutes – 1 hour for preterms, and 15-30 minutes for term infants. This time period was considered enough by other studies.[12] A Sony DCR-HC30E® portable digital video camera attached to a Sony VCT-D480RM® tripod was used. The video camera was placed mid-sagitally or laterally from above the infant's body, the screen fixed for the shortest possible distance.

Depending on its age and condition, the infants were placed in the supine position in the incubator, the cot or on a mattress on the floor. They wore either diapers or clothes which did not hinder their movements, or with the visualization of their arms

Table 1. Age-specific characteristic of normal GMs.[3,9]

GMs Type	Period of presence in weeks' PMA
Preterm GMs	From 28 wk to 36/38 wk
Writhing GMs	From 36/38 wk to 46/52 wk
Fidgety GMs	From 46/52 wk to 54/58 wk

(Writhing and *fidgety* are also words used to describe pathological movements. Here the words denote age-specific details of normal GMs. At any age, the basic characteristics of normal GMs are participation of all body parts and movement complexity and variation).

Table 2. Classification of the quality of GMs.[9]

Classification	Complexity	Variation	Fluency
Normal-optimal GMs	+++	+++	+
Normal-suboptimal GMs	++	++	-
Mildly-abnormal GMs	+	+	-
Definitely-abnormal GMs	-	-	-

Complexity and variation: +++, abundantly present; ++, sufficiently present; +, present but insufficiently; -, virtually absent or absent

Fluency (the least important aspect of GMs assessment): + present; -, absent

and legs. No manipulation was allowed during the recording. The recordings were performed between feedings, preferably during active wakefulness, or during sleep (mainly in preterms), but always when spontaneous movements were present. If prolonged fussing or crying were present, the recording was postponed. All infants were video recorded within the first postnatal week. They were grouped into three distinguished GMs age periods.[3,9] Preterm GMs: From 28 wk to 36/38 weeks PMA, Writhing GMs from 36/38 weeks to 46/52 weeks PMA, Fidgety GMs from 46/52 weeks to 54/58 weeks PMA.

Assessment of GMs quality by Gestalt perception

The qualitative evaluation of the GMs was done according to Prechtl's method for the assessment of spontaneous movements.[11] Each recording was observed and analyzed by one of the authors (AS), who was previously trained and certified in basic GMs' method from The Institute of Developmental Neurology, Universiteit Medisch Centrum Groningen, Netherlands. He was not aware of the history of the infants.

Table 3. The obstetrical, pre- and post-natal condition of the infants

Characteristic	Age period at the time of recorded		
	Preterm (n=35)	Writhing (n=65)	P value
Obstetrical variables			
High-risk pregnancy, n (%)	28 (80)	52 (80)	0.856
Primi gravida, n (%)	17(49)	26 (40)	0.327
Pre-natal condition			
Vertex presentation, n (%)	27(77)	59 (91)	0.165
Cesarean section delivery, n(%)	14(40)	26 (43)	0.602
PRoM, n (%)	8(23)	5 (8)	0.570
Post-natal condition			
Age of infants (wk PMA, mean(SD)):			
- at birth	32.7 (2)	36.9 (1.53)	<0.0001
- at recording	33.3 (25)	38.0 (1.59)	<0.0001
Sex, n-male (%)	16 (45.7)	40 (62)	0.144
Birth weight, g - mean (SD)	2107 (580.1)	3019 (643.1)	<0.0001
Birth head circ. cm - mean (SD)	31.9 (4.89)	33.1 (2.20)	0.840
Low birth weight, n (%)	24 (69)	14 (22)	<0.0001
Prematurity (Ballads score), n (%)	35 (100)	9 (14)	<0.0001
Asphyxia, n (%)	9 (26)	12 (19)	0.445
Hyperbilirubinemia, n (%)	11 (31)	9 (14)	0.640
Hypoglycemia, n (%)	4 (11)	5 (8)	0.716
RDS, n (%)	6 (17)	1 (2)	0.350
Turbid amnion fluid, n (%)	6 (17)	9 (14)	0.365

PRoM: Premature rupture of the membrane; RDS: Respiratory distress syndrome

Table 4. The quality of GMs at preterm and writhing age period

Period of Assessment	The Quality of GMs			
	Normal-Optimal	Normal-Suboptimal	Mildly-Abnormal	Definitely-Abnormal
Preterm age, n (%)	1 (2.9)	10 (28.6)	16 (45.7)	8 (22.9)
Writhing age, n (%)	2 (3.1)	27 (41.5)	27 (41.5)	9 (13.8)

The GMs quality was assessed by means of Gestalt perception. This global Gestalt perception is the result of evaluation of the complexity and variation of GMs. The final judgment was done, according to standardized classification by Hadders-Algra M, 2004 (**Table 2**).[9]

Statistical analysis

The statistical analysis used SPSS 14.0. Independent t-test or chi-square was used to analyze differences between the groups. The Pearson test assessed the correlation between the nominal variables of perinatal conditions and the quality of GMs. If the data were not normally distributed we used the Spearman-Rank correlation test. A two-tailed P-value of < 0.05 was considered significant.

Results

Among 180 singleton infants born with gestational age above 28 weeks PMA during the study period, 106 were included and recorded. A total of 100 video recordings could be analyzed completely, and 6 (5.7%) excluded because technical recording reasons. There were no significant differences between preterm group and writhing age group in the obstetrical, pre- and post-natal conditions listed, except age and birth weight (**Table 3**).

The quality of GMs

Both at preterm age or writhing age period the GMs were predominantly abnormal quality, as shown in **Table 4**.

There was no significant difference in the quality of GMs using dichotomy analysis (normal (optimal suboptimal) versus abnormal (mildly definitely)) between preterm GMs and writhing GMs (P=0.285). (**Figure 1**).

Perinatal condition and the quality of GMs

Caesarean section seems to correlate with the quality of GMs in the preterms only. The only variable which correlates with the quality of GMs consistently is birth weight. The summary is presented in **Table 5**. A weak negative correlation was found between birth weight and the quality of GMs in all infants (r=-0.20, P=0.044) (**Figure 2**).

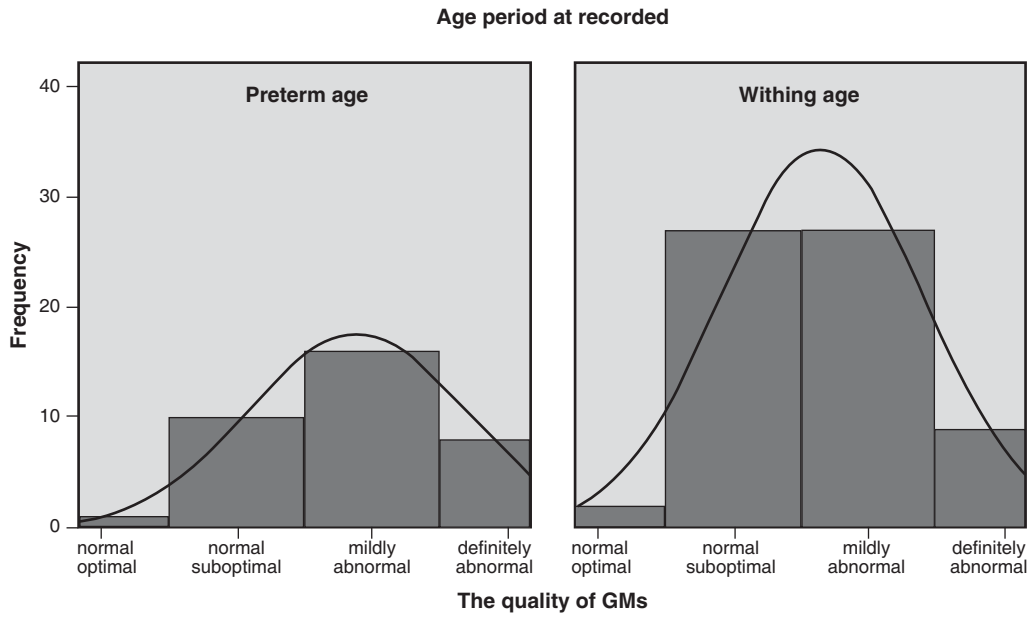

Figure 1. Histogram with normal curve of the quality of GMs distribution at preterm and writhing age period (P=0.285).

Discussion

Prechtl and the pioneers in the field of early human development studied motor activity in newborn infants. They realized that self-generated motility in young infants plays an important role in survival and adaptation. Precthl also discovered that the quality of spontaneous movement, especially the quality of general movements, reflect the condition of the nervous system integrity of fetuses and young infants.[4,13] Nowadays, Prechtl's method of assessing the quality of GMs has developed as a new technique for early identification of children at high risk for developmental disorders.[5]

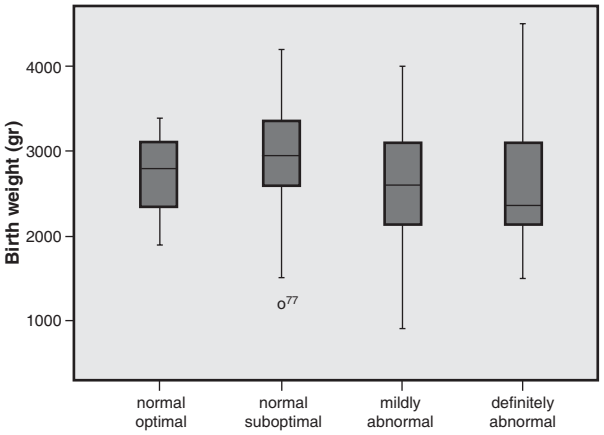

Figure 2. Box-plot of the correlation between birth weight and the quality of GMs in total infants (preterm + writhing age period) (r = -0.20, P = 0.044)

Table 5. The correlation analysis between perinatal conditions and the quality of GMs.

Variable	Preterm GMs		Writhing GMs	
	R	P	r	P
High-risk pregnancy	0.16	0.173	0.83	0.510
Primi gravida	-0.80	0.323	-0.12	0.343
Vertex presentation	0.74	0.337	0.16	0.210
Cesarean section delivery	0.30	0.042	0.19	0.386
Age of infants at birth	-0.10	0.284	-0.37	0.786
Birth weight	-0.40	0.041	-0.34	0.027
Birth head circumference	-0.19	0.133	-0.36	0.589
Prematurity (Ballads score)	0.12	0.474	0.38	0.869
Asphyxia	0.17	0.166	0.05	0.683
Hyperbilirubinemia	0.42	0.405	0.06	0.621
Hypoglycemia	0.18	0.155	0.05	0.761
RDS	0.12	0.241	0.12	0.331
Turbid amnion fluid	0.67	0.353	0.04	0.768
PRoM	0.17	0.170	0.14	0.253

We conducted the present study as a beginning of a still progressing longitudinal study. GMs assessment can be implemented relatively easy, non-intrusive, cheap and do not require sophisticated equipments – a technique which we need as a developing country. Details on the practical aspects of Precthl's method based on our experience are reported in a separate paper. Before analyzing the result of our study, some methodological aspects should be explained since the present study is our first experience.

In this study, we observed the quality of GMs during the first week of life. The two groups we studied were only infants at GMs preterm and writhing age period since our subjects were recruited from hospitalized newborns infants at NICU and neonatal ward. Both groups were relatively small in number and consisted of a mix of low-risk and high-risk preterm and fullterm newborns. The common procedure to use such a mix of subjects is to study the distribution pattern as an early assessment technique implementation. Thus the result of the present study cannot be extrapolated directly to other populations.

The baseline characteristics of our subjects, evaluated from their obstetrical, pre-and post-natal conditions, showed significant differences only on variables related to gestational age and birth weight. These indicated that there was no bias in the distribution between the preterm age period group and the writhing age period group at the time they were recorded.

Since the method for assessing GMs depends on a judgment based on qualitative observation, inter-observer and test-retest reliability are crucial.[11] Qualitative evaluation can be assessed in a standardized and reliable way, but which required considerable specific training.[3,9] Since in our institution only one person had been trained and certified in basic GMs' method, we could not perform an inter-observer agreement. Therefore, we used standardized classification of GMs into four categories: normal-optimal, normal-suboptimal, mildly-abnormal and definitely-abnormal. In other studies, the inter-observer agreement was very good ($\kappa = 0,80 - 1,0$).[7,13-15]

The present study showed that both groups had a high proportion of abnormal GMs. Most infants had abnormal GMs during their preterm period. While the

proportion of normal-suboptimal GMs was higher at writhing period. Similar findings reported, and that movement quality is not a fixed phenomenon.[16-18] Actually, the present and previous data showed the majority of typically developing infants exhibit GMs which are normal-suboptimal.[15] Normal-optimal movements are observed only in 10-20% of 3-months old term infants.[19] A study showed the quality of GMs was stable over age in about 60% of the infants and in the GMs quality changed only once. The improvements indicate that the young nervous system is a sensitive organ which, in response to perinatal adversities, can react with transient dysfunctions. The deteriorations suggest that neural dysfunction that has an impact on later neurological function occasionally need time before they become fully expressed. This finding probably is related in particular to the developmental, creative and unpredictable characteristics of the nervous system itself.[15]

Various perinatal adversities can give rise to mildly and definitely abnormal GMs, such as premature rupture of the membrane (PRoM),[20] intrauterine growth retardation (IUGR),[16-18,21,22] hyperbilirubinemia, perinatal asphyxia,[6] and prematurity.[5,23-26] Our study could not find correlation between those variables and GMs quality, but surprisingly, the only variable which correlates consistently with GMs quality was birth weight, both at preterm or writhing age. These differences might not arise only from a mixed and heterogenity of our subjects, but also because we did not perform the GMs assessment at fidgety age period as the other authors. Nevertheless, our result indicates that birth weight related with gestational age can result in abnormality of the quality of GMs. We are confident that our findings represent effects of a reduced fetal supply of nutrients in low birth weight infants on the post-natal development of GMs. A study demonstrated that alteration of muscle function due to chronic fetal malnutrition in preterms and small for gestational age infants might contribute GMs abnormal quality,which was present in 15 out of 19 infants.[18]

Compared to a low-risk group, consisting of appropriate-for-gestational age preterm infants, the proportion of infants with normal findings on brain scans who had an abnormal quality of GMs was high. The quality of GMs normalized before or during the third month post term in most infants. This study also indicate that intrauterine growth retardation may cause prolonged, but in most cases transient brain dysfunction. Only gestational age was found to correlate to brain ultrasound abnormalities (Spearman Rank coefficient $r=0.555$, $P<0.002$).[18]

The predictive validity of GMs quality varies with the age at evaluation and with the type of outcome. The best prediction can be obtained by longitudinal series of GMs assessment.[7,9] The quality of GMs at writhing and fidgety period is related significantly to developmental outcome at toddler and school age.[15] GMs quality at fidgety age period is the best predictor, and would be more accurate when GMs quality at writhing age was known as well. GMs quality during preterm age did have an prognostic significance.[7] Other studies found the same results.[3,4,8,15] In other words, the better quality of GMs in early infancy, the lower the risk for developmental disorders during later childhood. Therefore, the result of our present study can not be used as predictors since we only did a single assessment at preterm and writhing period.

We may conclude that the predominantly abnormal GMs of preterm and writhing age periods in our observation puts these infants at a high risk for developmental disorders later on. The lower the birth weight the more likely for infants to show abnormal GMs. This would need further longitudinal studies.

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