

NEUROLOGICAL EXAMINATION IN THE HEALTHY TERM NEWBORN

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ABSTRACT - We carried out a cross-sectional study with a sample of 106 normal full-term newborns examined within 24 to 72 hours of birth. The following findings were evaluated: head and chest measurements, muscle strength, tone, tendon reflexes, superficial reflexes, primitive reflexes, and cranial nerves. All 106 newborns were considered neurologically normal. We found no differences in the neurological examination findings for newborns with different gestational ages. Primitive reflexes and appendicular tone in newborns examined at earlier postnatal ages tended to be less intense. We were able to determine the prevalence of certain neurological examination findings for the normal newborn and to discuss some differences between our results and those of other studies. Prevalence estimations for the different findings in our study may be valid for different populations as long as the same methodology is adopted.

KEY WORDS: newborn, neurologic examination, physical examination.

Exame neurológico do recém-nascido de termo normal

RESUMO - Com o objetivo de revisar o exame neurológico do recém-nascido na atualidade, foi realizado um estudo transversal com uma amostra aleatória de 106 recém-nascidos de termo normais com 24 a 72 horas de vida, período em que o recém-nascido permanece na maternidade. Os seguintes itens foram incluídos no exame neurológico: medidas do crânio e tórax, trefismo, força, tono, reflexos miotáticos fásicos, reflexos superficiais, reflexos primitivos, sensibilidade e nervos cranianos. A frequência dos itens examinados foi estimada através do intervalo de confiança de 95%. Todos os 106 recém-nascidos foram considerados neurologicamente normais. Não encontramos diferenças no exame entre as crianças nascidas de parto vaginal e cesariana, bem como nas diferentes idades gestacionais. Os reflexos primitivos e o tono apendicular foram menos intensos nos recém-nascidos examinados com menor tempo de vida. Os nossos resultados indicam a necessidade de revisar dados do exame neurológico estabelecidos por pesquisas realizadas no passado e o exame do recém-nascido em uso atualmente. As estimativas encontradas no presente estudo podem ser válidas para diferentes populações, desde que a mesma metodologia seja usada.

PALAVRAS-CHAVE: recém-nascido, exame neurológico, exame físico.

Different methods have been used to evaluate the nervous system of newborns (NB): neurological examination (NE), neurophysiologic examination, imaging studies, laboratory investigation, and observation of spontaneous and/or provoked behavior¹. The integrity and maturation of the nervous system can be evaluated by a structured neonatal neurological examination that provides information for diagnosis, follow-up and prognosis²⁻⁵. Recent studies have compared NE with sophisticated methods, such as nuclear magnetic resonance (NMR) and ultrasound (US), and have shown that the NE may be a better choice for the prognosis and follow-up of children^{6,7}.

However, it is now widely accepted that the use of this method in association with imaging studies makes the diagnostic and prognostic processes more sensitive and yields higher positive and negative predictive values⁶⁻⁸.

An experienced examiner is the best judge of what laboratory investigations should be performed, since the sophisticated neurodiagnostic technology now available for complementary examinations does not preclude the use of NE⁹. However, the growing sophistication and ease of use of imaging methods – US, NMR, computed tomography – have led the NE to be seen as less valuable. Also, the growing use of

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neonatal behavioral scales has led us to pay less attention to the classic NE items, which have been increasingly minimized¹⁰⁻¹². The simplification of the NE has been attempted partially because it is not an easy examination to perform, takes a long time, and has been used only by specialists in neurology.

Only a few recent studies report the use of the complete NE; most of these studies are limited to the investigation of isolated reflexes or of a small group of findings¹³⁻¹⁶. The new method of neurological examination of the NB, which evaluates the general quality of movements¹⁷, is useful but should be used in conjunction with the complete NE⁴. The inclusion of a large number of NE tests in this study is an attempt to restore the importance of the complete NE of the NB, as performed for children of any age. The purpose of this study was to determine the current prevalence of different items of the complete NE for the normal NB.

METHOD

From April to August 1995, 1,066 term infants were born at Hospital de Clínicas de Porto Alegre, Brazil. From this population, we randomly selected 106 NB for a cross-sectional study (patients were selected among all the NB present in the maternity ward on sample collection days by means of draw). The following inclusion criteria were considered: age between 24 and 72 hours, gestational age \geq 37 weeks¹⁸, weight \geq 2,500 g, 5-minute Apgar score \geq 8, and no evidence of prenatal or perinatal pathological events.

The study was approved by the Ethics Committee of the hospital, and informed consent was obtained from the parents of all patients.

The examination (Table 1) was carried out by one of the authors (F.S.P.), according to the techniques suggested

by Lefèvre¹⁹, Paine²⁰, Pretchl¹, Jaynes et al.¹³, Pedroso & Rotta¹⁴, and Parmelle²¹. Responses were considered present, no matter what the degree of intensity, as long as they were clearly observed in at least one test. The tests were repeated up to four times whenever the response was absent. We used only behavioral states 3 and 4¹. The variables were initially evaluated on videotape with the agreement of the main author, head of the research project (N.T.R.), and the procedure was periodically reviewed. From the examination protocol we organized a database in the EPI INFO program, which was used to carry out all analyses. We calculated mean and standard deviation for the quantitative variables, and estimated the prevalence of the qualitative variables with a 95% confidence interval calculated by the Fleiss Quadratics test.

RESULTS

Of the 106 NB, 56 (52.8%) were male and 77 (72.6%) were white; mode of delivery was vaginal for 84 (79.2%) and cesarean for 22 (20.8%). In terms of gestational age, three NB were younger than 38 weeks, 46 had between 38 and 39 weeks of age, 55 had between 40 and 41 weeks of age, and two were 42 weeks old. We observed that 91 (85.9%) were adequate for gestational age, 12 (11.3%) were large for gestational age, and three (2.8%) were small for gestational age²². Anthropometric data are shown in Table 2.

All mothers of the selected NB agreed to participate in the study, and the 106 NB included in the study were considered neurologically normal – therefore, it was not necessary to exclude any patient. Fifty-two (49%) NB were examined on the first day of life, 33 (31%) on the second, and 21 on the third day of life (20%). We did not find any differences in

Table 1. Protocol for Neonatal Neurological Examination.

1. Inspection	· Facies · Spontaneous Movements · Attitude · Vocalization
2. Anthropometrics	· Weight · Length · Skull (inspection, palpation, head circumference, bi-auricular and anteroposterior distances, anterior fontanel) · Chest circumference
3. Muscle bulk/ Muscle strength/Tone	· Inspection · Palpation · Passive motion (passive palance) · "Echarpe" · Edge of the bed · Withdrawal/Propulsion of lower limb
4. Primitive reflexes	· Palmar/Plantar grasp · Sucking · Rooting · Palmomental/Babkin · Moro · Plantar cutaneous extensor · Placing · Crossed extension · Asymmetric tonic neck · Plantar support · Walking · Landau
5. Tendon and superficial reflexes	· Glabella · Oro-orbicularis · Jaw jerk · Brachioradialis · Biceps · Triceps · Ankle jerk · Knee jerk · Adductor of the thigh · Cutaneous-abdominal · Cremasteric · Ankle clonus
6. Sensory	· Tactile · Painful
7. Cranial nerves/ Cortical function	· Photomotor · Doll's eye · Optical blink · Acoustic blink · Grimace and cry · Movement of the palate, neck and tongue · Visual orientation to inanimate stimulus · Consolability

Table 2. Anthropometric data (n=106).

Data	Range	Mean ± SD
Weight (g)	2500–4290	3299±396.42
Length (cm)	44–54	49.49±1.80
HC (cm)	32–38	34.59±1.12
AF (cm ²)	0.56–45	5.07±3.44
BD (cm)	16–22	19.42±0.87
AD (cm)	17–24	20.99±1.08
CIn (cm)	0.86–1	0.93±0.03
CC (cm)	29–36	32.75±1.47

SD, standard deviation; HC, head circumference; AF, anterior fontanel, BD, bi-auricular distances; AD, anteroposterior distances; CIn, cephalic index (BD/AD); CC, chest circumference.

the NE findings for the following parameters: vaginal or cesarean delivery, different gestational ages, behavioral states 3 and 4, and size for gestational age. However, we observed that NB examined at an earlier postnatal age tended to have less intense primitive reflexes and appendicular tone.

The predominant attitude for all NB in supine position was arms and legs semiflexed and varying degrees of head rotation. The results for muscle tone evaluation and the prevalence of primitive reflexes and cranial nerves found are presented in Tables 3 and 4. Facial expression evaluated according to grimace and cry was normal in all NB, as well as motility of the palate, neck and tongue. We were able to visualize the eyes of 95 NB: all responded positively to Doll's eyes, and 66 (69.5%) presented eye movement towards a round, bright red object.

Results for tendon and superficial reflexes are shown in Table 5. All NB presented symmetry in the parameters muscle strength, tendon reflex, and muscle bulk. Ankle clonus was not observed in any of the NB. Following noxious stimuli²⁰, all NB responded with crying, but were easily consoled. Withdrawal responses were symmetrically elicited when tactile stimuli were applied to the limbs.

DISCUSSION

We collected the sample for this prevalence study of the neonatal NE items during the mothers' normal hospital stay using randomization and normalcy criteria, since this is the most appropriate procedure for estimating normal neurological aspects of NB in the immediate postnatal period, in contrast with convenience sampling. Our sampling process differed from other classic neonatal NE prevalence studies that included a large number of findings in the ex-

Table 3. Tone evaluation (n=106).

Tone	n [CI = 95%]	%
Appendicular hypertonia (physiological)	99 [86.4–97.1]	93.4
Appendicular hypotonia	7* [2.9–13.6]	6.6
Axial hypotonia	106 [95.6–100]	100

CI, Confidence interval; *all newborns with ≤ 48 hours of life.

Table 4. Primitive reflexes and cranial nerves (n=106).

Reflexes	n [CI = 95%]	%
Palmar grasp ¹	106 [95.6–100]	100
Plantar grasp ¹	106 [95.6–100]	100
Sucking ¹	106 [95.6–100]	100
Rooting ¹	99 [86.4–97.1]	93.4
Palmo-mental ²¹	99 [86.4–97.1]	93.4
Babkin ¹⁴	106 [95.6–100]	100
Moro ¹	106 [95.6–100]	100
Plantar cutaneous extensor ¹³	106 [95.6–100]	100
Placing ¹	98 [85.2–96.4]	92.5
Crossed extension ²⁰	89 [75.3–90.1]	84
Asymmetric tonic neck ¹	71 [57.1–87.8]	67
Plantar support ²⁰	89 [72.1–90.1]	84
Walking ¹	68 [54.2–73.1]	64.2
Landau ²⁰	0	
Photomotor ¹	98/98 [95.3–100]	100
Doll's eyes ¹	95/95 [95.2–100]	100
Optical blink ¹	106 [95.6–100]	100
Acoustic blink ¹	106 [95.6–100]	100

CI, confidence interval.

mination^{19,23}. One of the main differences was the age at which NB were examined – some at one week of age – and the consequent inclusion of NB who presented pathologies, which characterized a convenience sample²³. These same studies^{19,23} reported a higher prevalence of positive responses for some primitive reflexes – such as rooting, crossed extension, plantar support and walking – than did our study, in which 80% of the NB were at the most 48 hours old and may have presented weaker neurological responses because of the shock of birth²⁴.

Table 5. Tendon and superficial reflexes (n=106).

Reflexes	n [CI = 95%]	%
Glabella ¹	106 [95.6–100]	100
Oro-orbicularis ¹	18 [10.6–25.8]	17
Jaw jerk ¹	106 [95.6–100]	100
Brachioradialis ¹⁹	85 [71.1–87.1]	80.2
Biceps ²⁰	106 [95.6–100]	100
Triceps ²⁰	91 [77.4–91.6]	85.8
Ankle jerk ²⁰	87 [73.2–88.6]	82.1
Knee jerk ²⁰	106 [95.6–100]	100
Thigh adductor ¹⁹	106 [95.6–100]	100
Cutaneous abdominal ¹	88 [74.2–89.3]	83
Cremasteric ¹	21/56* [25.2–51.5]	37.5

CI, Confidence interval; *male newborns only.

Dubowitz et al.⁴ adopted inclusion criteria very similar to ours and studied a sample of normal NB. The prevalence they reported is in agreement with the results for common findings in our study. They did not, however, associate the differences found in tone and primitive reflexes with postnatal age at the time of NE, but rather with NB gestational age, which was not observed in our study.

Dargassies²³ did not observe the cutaneous abdominal reflex in NB, and interpreted the response obtained as Galant's reflex. We observed that the Galant's reflex can be independently triggered by stimuli in the lateral abdominal surface, but even in this area this reflex is often associated with contraction of the abdominal anterior wall muscles. Our results are closer to those of De Angeles²⁵, who found this reflex in 82 of the 88 NB examined. Prechtl¹ believes that the cutaneous abdominal reflex is always present in the NB, although weaker in the first two days after birth. The concept that visual fixation is associated with the disappearance of the Doll's eyes reflex, usually after the second week of age^{1,23}, is not supported by our results. Although short-lasting, visual orientation and fixation responses were observed in 66 (69.5%) of the 95 NB whose eyes could be observed. This was also reported by Dubowitz et al.⁴. All these NB had a positive response for doll's eyes reflex, which indicated that visual fixation may coexist with this reflex.

The discrepancies observed in the prevalence of NE findings for all ages certainly result from the lack of theoretical conceptual uniformity and the

methodology adopted. This can be seen even in more recent studies when items such as the prevalence of the plantar cutaneous response of the term NB are evaluated^{13,26}. In our study, this response was extensor for all infants, and in the study of Jaynes et al.¹³ this same response was observed in 90% of the NB, and was flexor in 3% of them. It is known that the plantar cutaneous extensor response will become flexor after a few months as maturation takes place, and that the flexor response does not occur in the normal NB. What may in fact occur is a plantar grasp caused by stimulus in the lateral edge of the foot in some NB.

In 1997, Magnemer & Mazer selected nine studies²⁷ that used the standardized neonatal NE to determine its reliability and validity by evaluating internal consistency of scores, tests, retests and agreement between different examiners. They concluded that it was necessary to define the patterns and variability of healthy NB behavior more clearly, since these items were responsible for lower reliability and validity of the evaluations. Dubowitz et al.⁴ followed the same approach but removed some behavioral items from their neurological evaluation scale. The findings they removed presented high variability for normal NB because they did not differentiate normal from abnormal and were difficult to use in intensive care units. These studies show that it is necessary to keep all the classic findings of the neonatal NE.

The methodology we used allowed us to determine the prevalence of several NE findings for the normal NB, and thus discuss some differences between our results and the findings of other studies. Prevalence estimations for the different NE findings in our study may be valid for populations from different geographic regions, races and socioeconomic status as long as the same methodology is adopted.

REFERENCES

1. Prechtl HFR. The neurological examination of the full-term newborn infant. In *Clinics in Developmental Medicine*. 2.Ed. London: William Heinemann, 1977:1-68.
2. Volpe JJ. Value of the neonatal neurological examination. *Pediatrics* 1979;64:547-548.
3. Volpe JJ. Neonatal neurological evaluation by the neurosurgeon. *Neurosurg Clin N Am* 1998;9:1-16.
4. Dubowitz L, Mercuri E, Dubowitz V. An optimality score for the neurological examination of the term newborn. *J Pediatr* 1998;133:406-416.
5. Limperopoulos C, Majnemer A, Shevell MI, Rosenblatt B, Rohlicek C, Tchervenkov C. Neurological status of newborn with congenital heart defects before open heart surgery. *Pediatrics* 1999;103:402-448.
6. Mello RR, Dutra MV, Silva KS, Lopes JM. The predictive value of neonatal neurological assessment and neonatal cranial ultrasonography with respect to the development of very low birth weight premature infants. *Rev Saude Publica* 1998;32:420-429.

7. Amess PN, Wylezinska M, Lorek A, et al. Early brain proton magnetic resonance spectroscopy and neonatal neurology related to neurodevelopmental outcome at 1 year in term infant after presumed hypoxic-ischaemic brain injury. *Dev Med Child Neurol* 1999;41:436-445.
8. Mercuri E, Guzzetta A, Haataja L, et al. Neonatal neurological examination in infants with hypoxic ischaemic encephalopathy: correlation with MRI findings. *Neuropediatrics* 1999;30:83-89.
9. Fenichel GM. Neurological examination of the newborn. *Brain Dev* 1993;15:403-410.
10. Brazelton TB. Neonatal behavioral assessment scale. In *Clinics in Developmental Medicine*. London: William Heinemann, 1973:1-35.
11. Morgan A, Koch V, Lee V, Aldag J. Neonatal neurobehavioral examination: a new instrument for quantitative analysis of neonatal neurological status. *Phys Ther* 1988;68:1352-1358.
12. Camann W, Brazelton TB. Use and abuse of neonatal neurobehavioral testing. *Anesthesiology* 2000;92:3-5.
13. Jaynes ME, Gingold MK, Hupp A. The plantar response in normal newborn infants. *Clin Pediatr* 1997;36:649-651.
14. Pedroso FS, Rotta NT. From the foot-mouth reflex to the hand-mouth reflex: a continuum of responses to appendicular compression. *Arq Neuropsiquiatr* 1997;55:186-192.
15. Futagi Y, Suzuki Y, Goto M. Clinical significance of plantar grasp response in infants. *Pediatr Neurol* 1999;20:111-115.
16. Neelon FA, Harvey EN. The Babinski sign. *N Engl J Med* 1999;340:196.
17. Einspieler C, Prechtl HFR, Ferrari F, Cioni G, Bos AF. The qualitative assessment of general movements in preterm, term and young infants - Review of the methodology. *Early Hum Dev* 1997;50:47-60.
18. Capurro H, Konichezky S, Fonseca D, Caldeyro-Barcia R. A simplified method for diagnosis of gestational age in the newborn infant. *J Pediatr* 1978;93:120-122.
19. Lefèvre AFB. [Contribution to the standardization of the neurological examination of the normal newborn]. Thesis, Universidade de São Paulo; São Paulo, 1950.
20. Paine RS. Neurological examination of infants and children. *Pediatr Clin N Am* 1960;17:471-510.
21. Parmelee AH. The palmental reflex in premature infants. *Dev Med Child Neurol* 1963;5: 381-387.
22. Battaglia FC, Lubchenco LO. A practical classification of newborn infants by weight and gestational age. *J Pediatr* 1967;71:159-163.
23. Dargassies S. El recién nacido de término. In *Desarrollo neurológico del recién nacido de término y prematuro*. Buenos Aires: Panamericana, 1977:19-186.
24. Riesgo RS, Rotta AT, Rotta NT. Shock of birth. *Arq Neuropsiquiatr* 1996;54:361-368.
25. DeAngeles F. Reflexes of the newborn. *Am J Dis Child* 1923;26:211-215.
26. Curless RC, Neelon FA. A baby with a Babinski reflex. *N Engl J Med* 1999;340:1929-1930.
27. Majnemer A, Mazer B. Neurological evaluation of newborn infant: definition and psychometric properties. *Dev Med Child Neurol* 1998;40:708-715.