Prognostic Significance of the Electrically Elicited Blink Reflex in Neonates

Tomoko Tanaka, MD; Yutaka Tomita; Satoko Nishimura

Abstract

The electrically elicited blink reflex was examined in ten normal neonates, 11 postasphyxial neonates, and 3 congenital hydrocephalus cases. The blink reflex was elicited in all cases. In normal neonates, the latencies and amplitudes were 10.9 ± 0.7 msec and 159 ± 62 μV at R_1, 34.3 ± 1.4 msec and 123 ± 30 μV at R_2, and 40.7 ± 2.3 msec and 84 ± 25 μV at R_2' respectively. Ischemic-hypoxic brain damage during the neonatal period mainly influenced the late components of the blink reflex. The blink reflex of the postasphyxial neonates showed significantly prolonged latencies of R_2 and R_2'. The amplitudes were increased in cases with a fair prognosis and decreased in cases with a poor prognosis. A case of congenital hydrocephalus with mental retardation also showed the prolonged latencies of R_2 and R_2' in neonatal period. The blink reflex in neonates appears to be useful in predicting the outcome in cases of neonatal asphyxia and congenital hydrocephalus. (*J Child Neurol* 1987;2:287–292).

The blink reflex following electrical stimulation consists of an early ipsilateral component and bilateral late components.[1,2] These features of the blink reflex represent the results of multiple synaptic transmissions and axonal conduction,[3] both of which are influenced by brain maturation[4] and central nervous system disorders. Therefore, the blink reflex has been widely used in the diagnosis of brain stem disorders[5–7] and higher central nervous system disorders[4] in both adults and children.[8–12]

Because the central nervous system is too immature to show adequate responses to many external stimuli, there have been considerable difficulties in the physiological evaluation of brain function in neonates. Several reports on the blink reflex in healthy neonates have recently been published, but the data are inconsistent as to the appearance of each wave and the distinction between normal and abnormal. Therefore, we have attempted to establish values for the normal blink reflex in neonates, and then examined the blink reflex of infants with neonatal asphyxia and congenital hydrocephalus and correlated the findings with outcome.

Subjects

The blink reflex was evaluated in 24 term newborn infants of 37 to 44 weeks postconceptual age. Ten of these infants were born in our hospital, were apparently healthy without neonatal asphyxia, hyperbilirubinemia, or neurological abnormalities during the neonatal period (group I), and were normal on follow-up study. Eleven cases were born with neonatal asphyxia (Apgar score < 7) and were transferred to the neonatal intensive care unit of our hospital. Two cases required immediate endotracheal intubation after birth. The other nine neonates were evaluated on admission according to Sarnat's clinical classification,[13] and all eleven cases were examined by computed tomographic (CT) scans during the neonatal period. These asphyxiated neonates were divided into two groups according to their outcome at the time of reevaluation at 12 to 24 months of age. Five cases had a fair outcome with normal developmental milestones and no neurological abnormalities (group II) (see table 1), while six cases had poor

Received Nov 30, 1985. Received revised March 17, 1986, and Aug 29, 1986. Accepted for publication Sept 29, 1986.

From the Division of Child Neurology, Institute of Neurological Sciences, Tottori University School of Medicine, Yonago, Japan.

Address correspondence to Tomoko Tanaka, MD, Division of Child Neurology, Institute of Neurological Sciences, Tottori University School of Medicine, Nishi-machi 86, Yonago 683, Japan.

TABLE 1
Neonates With Asphyxia

Group	Case	GA at birth (wk)	Birth Weight (g)	Apgar Score (1 min)	Sarnat	PCA at examination (wk)	CT Findings (PCA)	Outcome
	1	31	1,180	6	—	41	WLD (41)	Normal
	2	41	2,900	6	II	43	WLD (42)	Normal
II	3	40	3,700	6	II	42	WLD (43)	Normal
	4	40	2,786	1	I	43	WLD (44)	Normal
	5	36	1,786	0	—	43	WLD (39)	Normal
	6	42	3,060	3	II	44	WLD (44)	CP, MR
	7	42	3,050	2	II	44	WLD (43)	CP, MR, MC
III	8	37	2,455	1	II	39	WLD BD (39)	CP, IS
	9	42	2,430	6	II	44	WLD (44)	CP, IS, severe MR
	10	39	3,090	5	II	41	WLD (41)	CP, severe MR
	11	39	2,628	1	I	41	WLD (41)	CP, MR

GA = gestational age; PCA = postconceptional age; CT = computed tomography; WLD = white matter low density; BD = bleeding; CP = cerebral palsy; MR = mental retardation; IS = infantile spasms.

outcome with severe psychomotor delay and cerebral palsy (all six cases) and infantile spasms (two cases) (group III). Three cases of congenital hydrocephalus were also examined (group IV) (see table 2). Case 1 was diagnosed prenatally as hydrocephalus and cystic hygroma by means of fetal ultrasonography. After birth, he had nonprogressive hydrocephalus, but had mild psychomotor delay and convulsions at 1 year of age. Case 2 had slowly progressive hydrocephalus due to aqueductal stenosis demonstrated by metrizamide CT scans. She had a shunt operation at 1 month of age and showed normal development at 2 years of age. Case 3 suffered from recurrent vomiting and was diagnosed with hydrocephalus at 1 week of age. The hydrocephalus was nonprogressive and her development appeared normal at 2 years of age. There were no significant differences between groups I, II, III, and IV in postconceptional ages at the time of examination.

Methods

The subjects were examined supine in the alert state in a quiet, shielded room. No sedation was used. Twenty to 30 minutes were needed to complete the blink reflex studies. Electrical stimulation was selectively delivered under good conditions, when the infants were silent, quiet, and alert, and their eyes were in the neutral position; when the infant appeared drowsy, the examination was temporarily halted.

The supraorbital nerve was percutaneously stimulated with disk electrodes, the cathode being placed over the supraorbital foramen on one side and the anode on the forehead.[2] Stimulation was 0.1 msec in duration and repeated at intervals greater than 15 sec. The stimulus intensity was maintained above 25mA until the latencies of all the components became stable (see Figure 1). Recordings were obtained simultaneously from both orbicularis oculi muscles.

The sweep time of the oscilloscope was set at 50 or 100 msec. The latencies of the early ipsilateral component (R_1), late ipsilateral component (R_2), and late contralateral component (R_2') were measured at the initial deflection from the baseline (see Figure 2). Because there were no statistically significant differences in the latencies of R_1, R_2, and R_2' between the

TABLE 2
Congenital Hydrocephalus Cases (Group IV)

Case	GA at birth (wk)	Birth Weight (g)	Apgar Score (1 min)	HC (cm)	V-P Shunt	PCA at Examination (wk)	Prognosis
1	38	3,880	8	41.4	−	40	Epilepsy, MR
2	40	3,500	9	36	+	41	Normal
3	40	3,300	9	33	−	41	Normal

GA = gestational age; PCA = postconceptional age; HC = head circumference; MR = mental retardation.

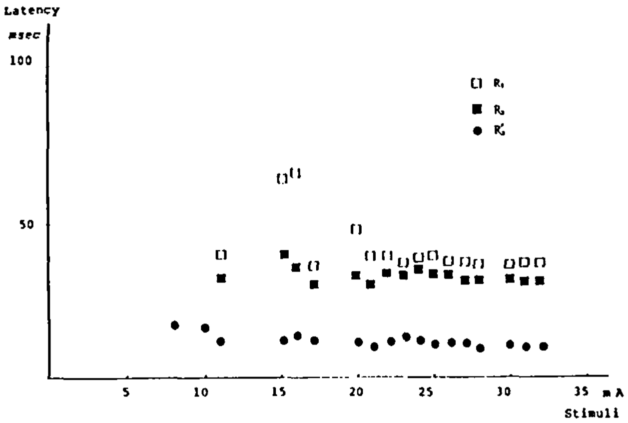

FIGURE 1
Relationship between stimulation strength and latencies of blink reflex in normal full-term neonate.

right and left sides, mean values were obtained by combining the results of testing both sides.

Results

Group I (Normal Term Neonates)

Each component of the blink reflex was elicited in all cases, and the mean latencies and amplitudes (shown in Table 3), were 10.9 ± 0.7 msec and 159 ± 62 μV (mean ± SD) for R_1, 34.3 ± 1.4 msec and 123 ± 30 μV for R_2,and 40.7 ± 2.3 msec and 84 ± 25 μV for R_2', respectively.

Postasphyxial Neonates

Each component of the blink reflex was elicited in all cases, but in some cases of group III, the blink reflex was difficult to obtain by the usual method. In these cases, more intense stimulation (above 30mA) was needed to obtain a stable blink reflex. The results are summarized in Tables 3, 4, and 5.

Group II (Cases With Fair Prognosis) (Table 4). There were no significant differences in the latencies or amplitudes of R_2 and R_2' between groups I and II, but the latencies of R_2' in group II were significantly prolonged compared to those in group I ($p < 0.05$) and the amplitudes of R_2' of group II were significantly higher than those of group I ($p < 0.05$).

In this group, the Apgar score ranged from 0 to 6.

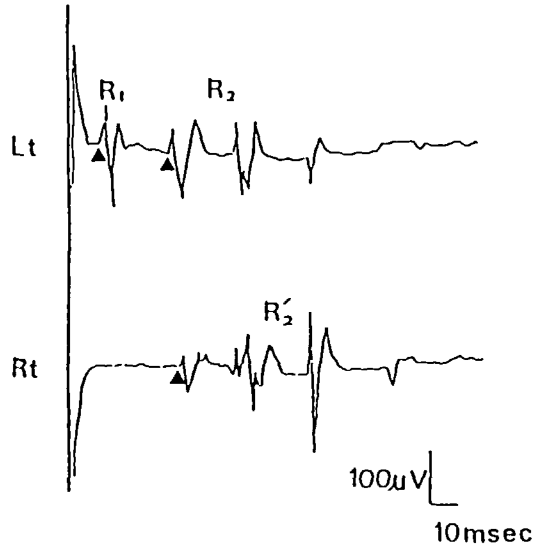

FIGURE 2
Typical oscilloscope recording of blink reflex in normal neonate. Stimulation is on left side.

TABLE 3
Blink Reflex in Normal and Postasphyxial Neonates (Groups I, II, and III)

Group	R_1: Latency Amplitude	R_2: Latency Amplitude	R_2': Latency Amplitude
I (n=20)	10.9 ± 0.7 msec 159 ± 62 μV	34.3 ± 1.4 msec 123 ± 30 μV	40.7 ± 2.3 msec* 84 ± 25 μV
II (n=10)	11.1 ± 0.7 msec 222 ± 107 μV	35.7 ± 1.9 msec 172 ± 96 μV	43.3 ± 2.3 msec* 145 ± 77 μV*
III (n=12)	11.1 ± 0.6 msec 121 ± 64 μV	38.5 ± 2.1 msec† 91 ± 35 μV†	46.0 ± 4.4 msec‡ 62 ± 15 μV

Note: All values are mean ± standard deviation; Group I = control; Group II = cases with fair outcome; Group III = cases with poor outcome.
* $p = 0.05$
† $p = 0.01$
‡ $p = 0.001$

TABLE 4
Blink Reflex in Postasphyxial Neonates (Group II)

Case	R_1: Latency Amplitude	R_2: Latency Amplitude	R'_2: Latency Amplitude
1	10.6 msec 217 μV	36.2 msec 168 μV	41.8 msec 197 μV
2	10.3 msec 365 μV	34.5 msec 291 μV	43.3 msec 222 μV
3	12.2 msec 92 μV	38.1 msec 100 μV	44.5 msec 45 μV
4	11.0 msec 142 μV	33.3 msec 112 μV	44.9 msec 78 μV
5	11.4 msec 295 μV	36.4 msec 192 μV	42.4 msec 185 μV

TABLE 5
Blink Reflex in Postasphyxial Neonates (Group III)

Case	R_1: Latency Amplitude	R_2: Latency Amplitude	R'_2: Latency Amplitude
6	10.2 msec 203 μV	40.8 msec 80 μV	48.0 msec 54 μV
7	11.6 msec 89 μV	39.7 msec 79 μV	42.4 msec 67 μV
8	11.3 msec 96 μV	38.2 msec 81 μV	68.1 msec 64 μV
9	11.0 msec 50 μV	36.0 msec 51 μV	49.0 msec 41 μV
10	11.4 msec 154 μV	39.0 msec 132 μV	45.8 msec 74 μV
11	10.7 msec 115 μV	36.3 msec 126 μV	40.5 msec 73 μV

In two cases with very low Apgar scores, the blink reflex showed normal latencies and amplitudes of R_1 and R_2, and prolonged latency and high amplitude of R'_2. Representative blink reflex recording of case 5 is presented in Figure 3. This infant was born with neonatal asphyxia (Apgar score was 0 at 1 min), but was developmentally normal at 1 year of age and the latencies of R_1 and R_2 were almost within the normal range.

Group III (Cases With Poor Prognosis) (Table 5). There were no significant differences in the latencies of R_1 between groups I and III. But the latencies of both R_2 and R'_2 in group III were significantly prolonged

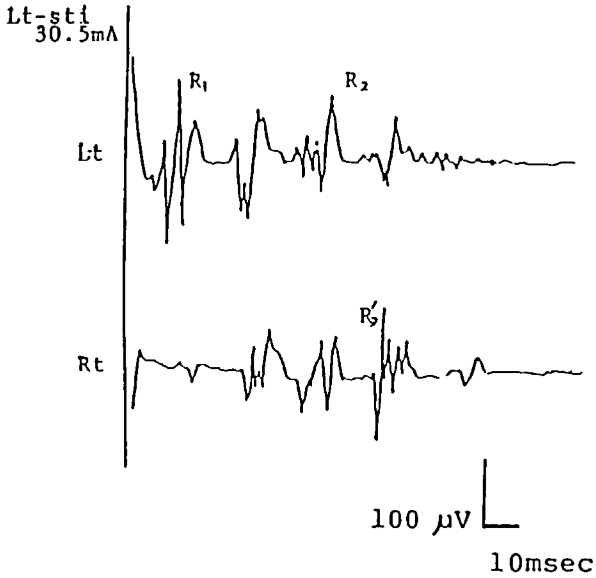

FIGURE 3
Postasphyxial neonate with fair prognosis; born at 36 wk and weighed 1784 g. Apgar score was 0 at 1 min and 2 at 5 min.

compared with those in group I (R_2, $p < 0.01$; R'_2, $p < 0.001$). The amplitudes of R_1 were within the normal range, but those of R'_2 tended to be decreased in group III. However, the amplitudes of R_2 in group III were significantly decreased compared with those in group I (R_2, $p < 0.01$). In this group, Apgar score was less than 3 in cases 6, 7, 8, and 11, and 5 to 6 in cases 9 and 10.

Representative blink reflex recording of a case from group III is presented in Figure 4. This infant

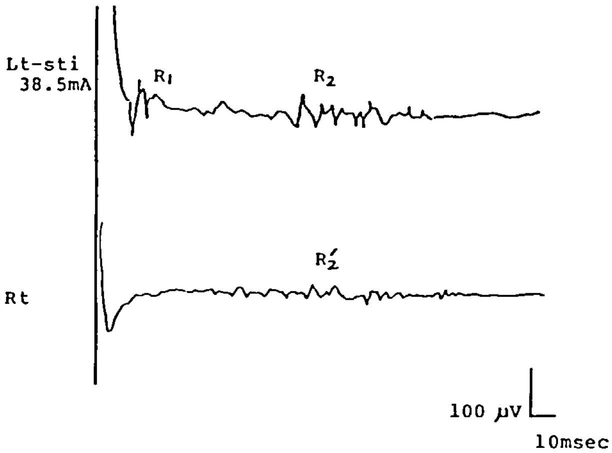

FIGURE 4
Postasphyxial neonate with poor prognosis; born at 42 wk and weighed 3050 g. Apgar score was 2 at 1 min.

TABLE 6
Congenital Hydrocephalus Cases (Group IV)

Case	R_1: Latency Amplitude	R_2: Latency Amplitude	R_2': Latency Amplitude
1	12.3 msec 136 μV	40.6 msec 146 μV	66.0 msec 87 μV
2	12.0 msec 178 μV	36.5 msec 144 μV	42.4 msec 82 μV
3	10.6 msec 325 μV	38.1 msec 90 μV	42.4 msec 91 μV

had severe hypoxic-ischemic encephalopathy at birth, and later, at 8 months of age, had spastic quadriplegia, severe mental retardation, and infantile spasms. The latencies of R_2 and R_2' were prolonged, and their amplitudes were decreased.

Group IV (Congenital Hydrocephalus)

The blink reflex findings in three cases of congenital hydrocephalus are summarized in Table 6. The latency of R_1 was normal in all three cases, and the latency of R_2 was prolonged in cases 1 and 3, but was within the normal range in case 2. The latency of R_2' was markedly prolonged in case 1. The amplitudes of R_2 and R_2' were within the normal range in cases 1 and 2, but the amplitude of R_1 was high in case 3.

Discussion

It has typically been very difficult to predict the outcome in neonates with brain insults, because infants provide few clues to cerebral function that can be objectively evaluated with clinical and laboratory examinations. Our study of the blink reflex during the neonatal period suggests that this technique may be useful in predicting the outcome of such infants.

Because the response latency is influenced by the degree of myelination of the central nervous system,[4] in evaluating the blink reflex, the degree of maturation of the brain of neonates must be taken into account. Therefore, we chose to examine the blink reflex within the postconceptional age range of 37 to 44 weeks. When the neonates were quiet and their eyes were in the neutral position, all the components of the blink reflex were uniformly elicited. However, in cases of neonatal asphyxia with subsequent poor outcome, more intense stimulation (such as from 30 to 40mA) was sometimes required to elicit stable components. We consider this increase in the stimulation threshold to be an abnormal finding.

The relationship between the features of the blink reflex during the neonatal period and the subsequent outcome, from 12 to 24 months after birth, was investigated in our study. During the neonatal period, the group with a fair outcome following neonatal asphyxia showed prolonged latencies and increased amplitudes of R_2', while in the group with poor outcome the latency of R_2' was especially prolonged, and the latency prolonged and amplitude decreased of R_2. However, there were no changes in the latency of R_1 in these cases. Thus, neonatal hypoxic-ischemic insults seemed mainly to influence the late components of the blink reflex. Among our three cases of congenital hydrocephalus, prolonged latencies of R_2 and R_2' were seen only in the infant (case 1) who had evidence of psychomotor retardation and infantile spasms at 15 months of age.

The reflex pathway of R_1 is thought to consist of an exteroceptive and oligosynaptic pontine reflex arc involving the main trigeminal sensory nucleus and the facial nuclei.[4,14,15] Therefore, damage to this area of the pons may result in the absence of R_1. The reflex pathway of late components of the blink reflex has been considered polysynaptic and conducted through the medulla oblongata with projection from the ipsilateral trigeminal nucleus to the ipsilateral and contralateral facial nuclei. There are several reports indicating that latencies of R_2 and R_2' were increased or that R_2 and R_2' were absent in patients with damage involving more rostral central nervous system structures, for example, unilateral hemispheric lesions,[15,16] cerebral tumor,[6] and coma.[17,18] Consequently, the prolonged latency or decreased amplitude of R_2 and R_2' in the infants with a poor outcome suggests a dysfunction in the more rostral central nervous system.

In the postasphyxial group with a fair outcome, the amplitude of R_2 was unexpectedly increased with normal latency, while R_2' had both increased amplitude and prolonged latency. This suggests hypersynchrony of the reflex components, which may have some connection with the reported transient facilitation of visual evoked potentials.[19]

According to Sarnat's clinical classification scheme, the postasphyxial neonates in this study belonged to grade I or II, while the 1-minute Apgar scores varied over a wide range. CT scans performed during the neonatal period showed only nonspecific changes such as low-density white matter and brain edema, except for one group III case with intracerebral hemorrhage. Thus, the blink reflex may be more useful for predicting future outcome of asphyxiated neonates than either clinical staging or CT scan evaluation, with prolonged latencies of R_2 and R_2' during the neonatal period being closely related to a poor prognosis.

Acknowledgment

The authors would like to thank Professor K. Takeshita and Assistant Professor S. Takashima for their valuable advice and discussion.

References

1. Kugelberg E: Facial reflex. *Brain* 1952;75:385–396.
2. Kimura J: *Electrodiagnosis in Disease of Nerve and Muscle: Principles and Practice*. Philadelphia, FA Davis, 1983, pp 323–351.
3. Tokunaga AM, Kato HT, Hirata T, et al: An experimental study of facial reflex by evoked electromyography. *Med J Osaka Univ* 1958;9:397–411.
4. Kimura J: The blink reflex as a test for brainstem and higher central nervous system function, in Desmedt JE (ed): *New Developments in Electromyography and Clinical Neurophysiology*. Basel, Karger, 1973, Vol 3, pp 682–691.
5. Kimura J: Alteration of the orbicularis oculi reflex by pontine lesion. *Arch Neurol* 1970;22:156–161.
6. Kimura J, Lyon LW: Alteration of orbicularis oculi reflex by posterior fossa tumors. *J Neurosurg* 1973;38:10–16.
7. Ongerboer de Visser BW, Kuypers HGJM: Late blink reflex changes in lateral medullary lesions. An electrophysiological and neuroanatomical study of Wallenberg's syndrome. *Brain* 1978;101:285–294.
8. Hopf HC, Hufschmidt HJ, Stroder J: Development of the trigemino-facial reflex in infants and children. *Ann Paediatr* 1965;204:52–64.
9. Kimura J, Bodensteiner J, Yamada T: Electrically elicited blink reflex in normal neonates. *Arch Neurol* 1977;34:246–249.
10. Vecchierini MF: Evolution de reflexe de clignement pendant les trois premieres anness de la vie cheleneant. *Rev EEG Neurophysiol* 1983;13:137–144.
11. Clay SA, Ramseyer C: The orbicularis oculi reflex in infancy and children. Establishment of the normal value. *Neurology* 1976;26:521–524.
12. Blank A, Ferber I, Shapira Y, et al: Electrically elicited blink reflex in children. *Arch Phys Med Rehabil* 1983;64:558–559.
13. Sarnat HB, Sarnat MS: Neonatal encephalopathy following fetal distress. A clinical and electroencephalographic study. *Arch Neurol* 1976;33:696–701.
14. Kimura J, Lyon LW: Orbicularis oculi reflex in the Wallenberg syndrome: Alteration of the late reflex by lesion of the spinal tract and nucleus of the trigeminal nerve. *J Neurol Neurosurg Psychiatr* 1972;35:228–233.
15. Kimura J: Effect of hemispheral lesions on the contralateral blink reflex. A clinical study. *Neurology* 1974;24:168–174.
16. Beradrelli A, Accornero N, Cruccu G, et al: The orbicularis oculi response after hemispheral damage. *J Neurol Neurosurg Psychiatr* 1983;46:837–843.
17. Settats AF, Parker SA, MeriuspCaras A: The blink reflex in coma and after recovery from coma. *Acta Neurochir* 1976;34: 79–97.
18. Lyon L, Kimura J, McCormick WF: Orbicularis oculi reflex in coma. Clinical electrophysiological and pathological correlation. *J Neurol Neurosurg Psychiatr* 1972;35:582–588.
19. Hebek A, Karlberg P, Kjolmer I, et al: Clinical application of evoked electroencephalographic response in newborn infants. *Dev Med Child Neurol* 1977;19:33–44.