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A Protocol for Structured Observation of Motor Performance in Preterm and Term Infants

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ABSTRACT

A new protocol for structured observation of motor performance has been designed for assessment of the progress and quality of motor development in preterm and term infants. A detailed scale of motor development based on the present knowledge of motor development in healthy term infants has been constructed. The motor performance is observed in each part of the infant's body in the supine and prone positions and in the whole body with the infant sitting, standing and during locomotion, and is evaluated in relation to defined levels of motor performance. If the quality of motor performance is optimal for a certain level, no deviation is noted. Any deviation from the motor performance described in the protocol for the level in question is graded as suspected or clear and classified by type. All observations are recorded on videotape for documentation. In a study of inter- and intraobserver agreement, such recordings from 17 infants were reassessed on two occasions more than one year apart. The interobserver agreement ranged between 73 and 87 % and the intraobserver consistency between 77 and 88 %. The protocol is currently being used in a follow-up study.

INTRODUCTION

The survival of critically ill newborn infants, both fullterm and, especially, preterm infants has increased markedly over the past 20 years. Most of these infants survive without major neurological disabilities (27, 43). There have been frequent reports, however, on longterm problems concerning motor co-ordination, perception, cognitive ability and behaviour in such infants (4, 8, 15, 21, 32, 35, 36). Severe neuromotor disabilities in these infants are readily revealed during infancy, while disabilities of a moderate and mild degree may remain undiscovered until later ages (5, 14, 44). Motor co-ordination problems that are not classified as cerebral palsy are not usually observed until preschool age, when more advanced motor skills are required. Some minor motor dysfunctions which are noticed at an early age may appear and

disappear during the first year of life and are reported as transitory (2, 16, 38). A significant number of infants who exhibit these transient signs later have problems in motor performance, perception, cognitive ability and behaviour at preschool and school age (16).

Follow-up studies of infants born at risk are often performed as repeated neurological examinations (1, 37, 40, 41) and/or assessments with standardized developmental scales (7, 19, 26, 34). The neurological methods include assessment of postures, passive and active tone, reflexes and reactions. Standardized developmental scales are used in evaluating the developmental level in different areas of behaviour and are designed on a pass/fail basis. Neither neurological methods nor standardized developmental scales assess in detail how movements are performed during activity, i.e. the qualitative aspect of motor performance. During recent years, however, some methods for assessing the quality of neuromotor development have been presented (11, 18, 25, 42, 46).

We present here a new protocol for structured observation of motor performance, whereby both the developmental progress and the quality of the performance can be assessed. This protocol has the advantage of allowing distinction between levels of motor development in different parts of the body and in different body positions. In addition, the quality of the motor performance is assessed in terms of degree and type of deviation from that described in the protocol for a certain level. The protocol is now being used in a follow-up study of a population of infants of ages 0-10 months, both preterm and fullterm, who needed intensive care neonatally, together with a control group of healthy fullterm infants.

AIMS OF THE PROTOCOL

The protocol has been designed with the following aims:

- to assess the progress of motor development in different parts of the body and in different positions compared with defined levels of development.
- to allow comparisons of developmental progress between different groups of infants,

and when used repeatedly,

- to determine which deviations in motor performance occur during motor development,
- to determine whether any deviations are transient or permanent,
- to determine whether any deviations are predictive for the longterm outcome,
- to assess the predictive value of the total number of deviations.

DESCRIPTION OF THE PROTOCOL

The protocol describes the motor performance in different body positions, i.e. supine, prone, sitting and standing and during locomotion from the prone to the standing position. An ascending scale of motor development has been constructed for each part of the body in the supine and prone positions (head, arms and hands, trunk, legs and feet), and for the whole body in the sitting and standing positions, and during locomotion from the prone to the standing position. A corresponding ascending scale of grasp function for each hand is also included. All scales are given in detail in the Appendix. The ascending scales are based on the present knowledge of the development of motor function in healthy fullterm infants (23, 24, 41, 45).

At each examination the level of motor development of each part of the infant's body is determined by comparison of the motor performance with the levels listed in the protocol. Any observed deviation from what is considered an optimal motor performance as described for a particular developmental level is then classified and noted as suspected or clear deviation - suspected if the motor performance does not fully correspond to that described in the protocol for the level in question, and clear if it is definitely not in agreement with the described performance.

If a finding is regarded as a suspected or a clear deviation, the type of deviation is classified (see Appendix). The side or sides of the body on which the deviation can be seen are noted in the protocol. For deviations in rotation, a note is made of the side towards which the rotation is directed. The total number of deviations is summed and noted in the protocol at the end of the assessment. The deviations listed in the protocol are those presented in the literature both in descriptions of abnormal motor development and concerning neurological tests (3, 9, 41).

APPLICATION OF THE PROTOCOL IN THE FOLLOW-UP STUDY

In our current follow-up study observation of the motor performance according to the protocol constitutes one part of the infant's assessments at the corrected ages (i.e. age from estimated due date of delivery) of 0, 2, 4, 6 and 10 months (± one week) and when applicable at 18 months (± two weeks).

OTHER METHODS USED FOR DATA COLLECTION IN THE FOLLOW-UP STUDY

The follow-up of the infants also includes physical and neurological examination, and assessment of postural reactions. A standardized motor-perceptual evaluation (MPU; 31) is also carried out. Since many of the items in the MPU require an interaction between the examiner and the infant, these defined tools and procedures are used in a standardized way in order to stimulate movements.

DESCRIPTION OF THE ASSESSMENT PROCEDURE

The examination is made by two investigators, one physiotherapist and one out of seven neonatologists. One of them examines the infant while the other observes and records the motor performance on videotape. The recordings are made for documentary purposes and to permit an assessment of inter- and intraobserver reliability, and occasionally to allow assessment of forgotten items. One of the two main investigators, the physiotherapist (KP) and one neonatologist (also a specialist in paediatric neurology; BS) is always present.

The examination takes place in a warm and comfortable room. Every effort is made to keep the infant calm and co-operative. The examinations are made in a given order, which is only occasionally changed to meet the needs of the infant. Procedures which are uncomfortable or possibly frightening are always left to the end. Each examination is scheduled to take place at times convenient for the mothers and infants and is re-scheduled if the infant is unwell. The state of the infant as described by Brazelton (10) and the degree of co-operation are noted in each sequence of the assessment (see Appendix).

One of the examiners observes and interacts with the infant in order to encourage the infant to move. The infant is observed in the body positions described in the protocol. Before the infant has acquired postural control for sitting and standing, he is placed and supported in these positions. At a corrected age of 10 months the assessments in the supine and prone positions are excluded if the infant is able to move into and out of the sitting position without any deviations. The supine and prone positions have to be maintained for a minimum of two minutes each. In order to get informative recordings on videotape, the infant is placed with his head, feet and each side of the body facing the camera for at least 30 seconds each. The protocol is filled in after the examination in consensus between the two observers.

RELIABILITY

To study the interobserver agreement and the intraobserver consistency the recordings from 17 infants who had primarily been assessed in the follow-up study by both main observers (KP; BS) together, were sampled. The observers were not informed about the identity, age or history of the infant. Each reassessment was made separately by the main observers. The reassessments from the recordings were made independently on two different occasions more than one year apart. The percentage of interobserver agreement regarding the level of motor development, grade of deviation and asymmetry ranged between 73 and 87%, while the intraobserver consistency ranged between 77 and 88%. Details of this study will be presented elsewhere (28).

CLINICAL EXAMINATION AND OVERALL JUDGEMENT

After completion of the protocol for assessment of motor performance, an overall evaluation of the infant's neurological status is made on the basis of the impressions obtained from the whole examination. The result of this evaluation is recorded as normal, possibly abnormal or abnormal. Deviations are indicated as differences between sides, deviations in muscle tone or deviations concerning co-ordination. In addition, the total numbers of suspected and clear deviations are counted.

DISCUSSION

The method for structured observation of motor performance presented in this paper is designed to obtain objective data on the progress and quality of motor development in preterm and fullterm infants. As pointed out by Burns and co-workers (11), qualitative aspects can be very subjective unless well defined test criteria are established. With our protocol the observer determines the motor development in relation to ascending levels of motor performance described in the protocol. Furthermore, deviations are assessed in relation to given descriptions of motor performance instead of relative to poorly defined normal/abnormal values. As the motor development in healthy fullterm infants is known to show great variation and as it may vary even more in preterm infants (17, 20, 22, 33, 39), difficulties may arise in interpreting deviations as normal or abnormal. In our protocol any deviations from the motor performance described for a certain level are therefore noted in terms of type and degree. In addition, their persistence can be assessed at later examinations and their prognostic value can be determined when the outcome is known.

Standardized developmental scales are adapted to describe the motor development in the traditional cranial-caudal way. Accordingly, items concerned with early movements in the legs and feet are seldom included (7, 19). Harris (29, 30) reports that in infants aged four months, assessed by the Motor Assessment of Infants (MAI; 13), antigravital movements of the extremities are early predictors of cerebral palsy. In our protocol equal attention is given to the motor performance in all parts of the body in different body positions so that early deviations can be detected and their predictive value determined.

In contrast to the qualitative assessments of spontaneous movements of preterm and fullterm infants reported by Ferrari and co-workers (18), our assessment requires interaction between the examiner and infant. This is necessary for determination of the level of motor development and for detection and evaluation of deviations in motor performance according to the movements described in the protocol. Some of these movements such as movements of the head or hands are

similar to the volitional movements included in MAI (13). Harris (30) suggests that deviations in these movements are better early predictors of later abnormal development than items measuring primitive reflexes.

In order to evaluate the maturity and state of the neuromotor system, neurological examinations include elicitation of primitive reflexes and reactions (1, 12, 37, 40, 41). In our method primitive reflexes and postural reactions are only noted if they disturb the motor performance on a certain level. They are noted in the protocol as deviations such as fisted hands, retracted shoulders and hyperextension of the neck.

In spite of all the information that can be gathered by neurological assessments and standardized developmental scales, a systematic way of looking at the longitudinal process of motor development is still lacking (6). Our protocol for structured observation of motor performance is an attempt to provide a supplement to neurological assessments, with the main purpose of making a detailed description of the motor performance with respect to both progress and quality.

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APPENDIX

A PROTOCOL FOR STRUCTURED OBSERVATION OF MOTOR PERFORMANCE IN PRETERM AND TERM INFANTS

This protocol is intended for use at the corrected ages (i.e. age from estimated due date of delivery) of 0, 2, 4, 6, 10 and 18 months. At the corrected ages of 0, 2, 4 and 6 months the infants are assessed in all positions mentioned in the protocol. Before the infant has reached postural control, he is placed and supported in the sitting and standing positions. At corrected ages of 10 and 18 months the assessments in the supine and the prone positions are excluded if the infant is able to move into and out of the sitting position, without any deviation. If the infant refuses, or his condition contraindicates an assessment, or if the observer has forgotten a part of the test, this is noted. The state and co-operation of the infant in every observed position is also marked in the protocol. The state is graded from 1 to 6 according to the scale of Brazelton (10), while co-operation is graded subjectively by the examiner as good, partial or no co-operation.

SUPINE POSITION

Motor performance level

Head

1. Head turned to either side.
2. Keeps the head briefly in midline.
3. Keeps head stable in midline and turns head slightly to both sides.
4. Keeps head stable in midline. Turns head completely to both sides.
5. Turns head without associated movements in the rest of the body.
10. None of above.

Arms and hands

1. Keeps arms on surface, rotated outwards. Elbows flexed. Loosely fisted hands.
2. Starts to lift arms. Hands alternately open and loosely fisted.
3. Moves hands to midline. Open or loosely fisted hands.
4. Grasps an object and brings it to the mouth using both hands equally.
5. Extends arms across the midline in order to grasp an object.
10. None of above.

Trunk

1. Trunk unstable. Movements of head or extremities elicit movements of trunk.
2. Keeps trunk stable and straight, independently of movements of head and extremities. The back is kept against the surface.
3. Turns to both sides and back to supine.
4. Turns from supine to prone position over both sides.
10. None of above.

Legs and feet

1. Alternating extension and flexion of hip, knee and ankle. Alternating rotation inwards and outwards combined with abduction or adduction of the hip.
2. Foot and toe movements can be performed independently of movements in the rest of the leg.
3. Brings soles together, with flexion, abduction and outward rotation of hips.
4. Alternating kicks, independent of movements in the rest of the body.
5. Flexes hips in order to make hand-foot contact possible.

6. When turning from supine to prone position, the infant extends his lower and flexes his upper leg.
10. None of above.

PRONE POSITION

Motor performance level

Head

1. Head lies against the surface with face turned to either side.
2. Lifts chin briefly above the surface.
3. Turns head from one side to the other and back again.
4. Lifts head in midline to an angle of 45° between the face and the surface.
5. Lifts head in midline to an angle of 90° between the face and the surface. Turns head to either side.
6. Complete head control. Moves head without associated movements in the rest of the body.
10. None of above.

Arms and hands

1. Keeps arms rotated outwards with flexed elbows and loosely fisted hands held at the shoulder level.
2. Takes weight briefly on both forearms with hands loosely fisted.
3. Takes weight on both forearms with hands mostly open.
4. Arms and hands are held in the air with outward rotation and shoulder retraction.
5. Takes weight on open hands and straight arms.
6. Lifts one arm in order to grasp an object and takes weight on the other.
7. Pivots by pushing one hand against the surface while the other is repositioned in the moving direction.
10. None of above.

Trunk

1. Lateral flexion of trunk to either side depending on the position of the head.
2. Brief extension of the neck.
3. Extension of the whole spine.
4. Takes weight on the pubis and on the extended arms.
5. Turns from prone to supine position over both sides.
10. None of above.

Legs and feet

1. Legs flexed at hip, knee and ankle. Alternating kicking movements.
2. Incomplete hip extension combined with abduction and outward rotation.
3. Moves knee and ankle without influencing hip extension.
4. Complete hip extension with ability to move in knee and ankle.
5. Pivots to either side with one leg extended and the other leg flexed, abducted and outwardly rotated.
10. None of above.

LOCOMOTION

Motor performance level

0. No voluntary locomotion.
1. Moves by alternating arm and leg movements with the abdomen against the surface.
2. Takes weight on hands and knees.
3. Moves from crawling to sitting position over either hip.
4. Crawls on hands and knees with alternating movements.
5. Pulls himself to standing position.
6. Walks on the whole foot to either side holding on to furniture.
7. Stands up from kneeling, taking weight on either foot. Sits down.
8. Stands on whole foot without support.
9. Walks on whole foot without support. No rotation in the trunk.
10. None of above.

SITTING POSITION

Motor performance level

1. No extension in the back. Head cannot be raised. Legs flexed.
2. No extension of the back. Lifts head intermittently. Legs flexed.
3. Extension of the thoracic spine. Head control in the sagittal plane. Arms loosely flexed with hands open. Legs flexed and abducted.
4. Complete head control. Almost complete extension of the back. Hands open and held forwards for support.
5. Sits stably without support. Protective reactions with open hands.
6. Moves from sitting to prone position over flexed and outward rotated leg.
7. Sits stably without support. Moves head, trunk and arms without associated movements.
10. None of above.

STANDING POSITION

Motor performance level

1. Takes no weight on legs and feet.
2. Takes weight briefly on toes or sole.
3. Flexes the legs without taking weight.
4. Takes weight on soles.
5. "Jumps" with support.
6. Stands with support.
7. Stands without support.
10. None of above.

FINE MOTOR FUNCTION

Motor performance level

Right hand

1. Has palmar grasp reflex
2. Palmar grasp reflex has disappeared.
3. Grasps with ulnar side of palm.
4. Grasps with radial side of palm.
5. Transfers objects from hand to hand.
6. Finger grasp.
7. Pincer grasp.
10. None of above.

Left hand

1. Has palmar grasp reflex.
2. Palmar grasp reflex has disappeared.
3. Grasps with ulnar side of palm.
4. Grasps with radial side of palm.
5. Transfers objects from hand to hand.
6. Finger grasp.
7. Pincer grasp.
10. None of above.

DEGREE OF DEVIATION

11. No deviation.
12. Suspected deviation.
13. Clear deviation.

TYPE OF DEVIATION

14. No difference between the sides.
15. Difference between the sides.
16. Right side deviates.
17. Left side deviates.
18. Right side deviates more than left.
19. Left side deviates more than right.
20. Movements are sparse.
21. Hyperextension.
22. Lateral flexion.
23. Rotation.
24. Extension of the arms.
25. Inward rotation-adduction-pronation of the arms
26. Fisted hand.
27. Retracted shoulders.
28. Extension-outward rotation-abduction of the legs.
29. Extension-inward rotation-adduction of the legs.
30. Plantar flexion of the foot.
31. Varus position of the foot.
32. Valgus position of the foot.
33. Flexion of the hip.
34. Pulls himself forwards with the arms.
35. Bottom shuffler.
36. Stands on tip-toes.
37. Walks on tip-toes.
38. None of the precoded deviations. Describe.
39. Instability.
40. Pronated hand.
41. Adduction of the thumb.
42. Dysmetria.
43. Extension of the leg.
44. Tremor.
45. Uneasy during change of position.
46. Deviant muscle tone during activity.
47. Hypertonia.
48. Hypotonia.
49. Mixed tone.