Predictive validity of the Movement Assessment of Infants (MAI) for six-month-old Very Low Birth-Weight Infants.

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INTRODUCTION

Low birth weight has been defined by WHO as weight at birth of less than 2,500 grams and Very Low birth weight (VLBW) as <1500gms. Low birth weight babies face serious long-term health problems, such as mental retardation, cerebral palsy, impairment of lung function, visual and hearing impairment. Very low birth weight (<1500grams) is an increased risk for delayed attainment of walking in very low birth weight children.1 Minor neurological deviations like attention deficit hyperactivity disorder,2 clumsiness, and intention tremors are also common in them. Numerous infant assessment tools have been developed to evaluate the neuromotor status of the risk infants.3-9 Movement assessment of Infants (MAI) is a landmark test, as it was the first tool to assess quality of movement in children with disordered movement.6 It is a criterion referenced scale that evaluates motor dysfunction in high risk infants from birth to 12 months of age. Currently profiles of MAI for 4-month, 6-month and 8 month-old infants based on normative data exists.10-12 MAI at 4 month is a useful clinical tool in identifying neurological dysfunction in risk infants at 12 months and 24 months.13 Same author in 1987 studied the sensitivity and specificity of MAI and Bayley’s scale, and reported that MAI was more than twice as sensitive as the Bayley Motor Scale in detecting early signs of cerebral palsy.14 In preterm infants adjusting for prematurity resulted in better combination of screening rates of the MAI.15 Studies of MAI at 4months and 8 months in low birth weight infants reported a sensitivity of 83.3% and 96% respectively with

ABSTRACT

Objective: This prospective observational study was designed to examine the relationship between the Movement Assessment of Infants risk scores at six-months with neurodevelopmental outcome at one year. Method: Babies (n= 60) with birth weight ≤1500gms and admitted to neonatal intensive care unit formed the cohort of the study. Infants with congenital anomalies, genetic disorders, neuromuscular disorders, metabolic disorders and neurological disorders like hydrocephalus, meningitis, encephalitis during neonatal period influencing neuromotor outcome were excluded. The infants, whose mothers consented to participate, were evaluated using the Movement Assessment of Infants scale at 6-months of corrected age by the principal investigator. The follow up assessment was done at one year of corrected age by a trained clinical psychologist using the motor and mental scale of Bayley scale of infant development-II. Results: The infants total risk scores of Movement Assessment of Infants at six months significantly correlated (p value<.000) with both motor and mental scale of Bayley at one year. There was significant negative correlation between all the categorical scores (muscle tone, primitive reflexes, automatic reactions and volitional movements) of six-month, Movement Assessment of Infants with the both mental and motor scale of Bayley at one year (p<.000) Conclusion: The Movement Assessment of Infants at 6-month appears to be a valid tool to identify both mental and motor abnormalities in Very low birth weight infants although it is primarily an evaluation tool of neuromotor status. Key words: Movement Assessment of Infants, Very low birth weight infants, motor and mental development.

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neurodevelopmental outcome at 18 months.\textsuperscript{11} Reports on MAI at 4 months in extremely low birth weight infants demonstrated high specificity (91\%) and acceptable sensitivity (64\%).\textsuperscript{16} The best predictive values of MAI were obtained at 8 months in very low birth weight infants.\textsuperscript{17}

However in the reviews of the MAI a lack of predictive validity of 6-month MAI in infants at risk for developmental abnormalities was cited as limitation of clinical utility of the tool. Since infants at risk for developmental abnormalities are seen at ages other than 4 and 8 months and commonly receive sequential follow up evaluations,\textsuperscript{12} a need for examining the predictive validity of MAI on populations of 6-month old infants at risk for developmental abnormalities is needed. Although normative data of MAI exists for 6-month old infants, no reported studies on the predictive power of 6-month MAI in very low birth weight infants at one year of corrected age, hence the need for the study. This was the first step in making the tool clinically more useful.

MATERIALS AND METHODS

Infants born with birth weight ≤1500gms during January 2008 to June 2009, admitted to NICU of a multi-specialty hospital and medical research center formed the cohort of the study. After discharge from the NICU, 74 infants were consecutively recruited for the study that was approved by the institutional ethics committee and an informed consent was obtained from the primary caregiver.

The six-month MAI examination was performed between the corrected ages of 15 days to 15 months. It was performed by two experienced and trained physiotherapist based on the instructions in the training DVD and the manual. Reliability was established for MAI between pair of examiners before testing and was reevaluated once during the course of study. The scoring for the 65 test items of MAI was done on the 6-month MAI profile score sheet and the total risk points (TRS) were calculated. A cut-off score of ≥6 was considered as 'risk' for neuromotor abnormality. This cut-off ‘risk’ score is the TRS one standard deviation above the mean for healthy full term 6-month old infants. The Bayley motor and mental scales were administered by a trained clinical psychologist who was masked to infant’s history and prior MAI scores at one year follow up visit. The psychomotor development index (PDI) and mental developmental index (MDI) were calculated as per instructions in the BSID-II manual and a score of ≤84 was considered as delayed neuromotor development which is one standard deviation below the published mean.

Instrument:

The MAI is a neuromotor assessment tool comprising 65 items in four areas: muscle tone, primitive reflexes, automatic reactions, and volitional movement. It requires 45 to 60 minutes for administration of the test. Each MAI item is scored independently using a numerical scale with specific behavioral criteria. Based on normative data collected for 6 month-old infants, MAI "6-month profile" was developed indicating which scores for each item were considered to be deviant, to identify an infant to be at risk. Any item for which a 6-month-old infant's score identifies him as being at risk was circled and became a "risk score." After the entire examination had been administered and scored, the categorical risk scores were obtained for each area. The four categorical risk scores were then summed to yield a "total risk score." The lower the risk score, the more optimal the infant's prognosis for development.\textsuperscript{10,11}

Bayley Scale of infant development-II:

BSID-II is a revised version of BSID-I, evaluates children between birth and 42 months. It consists of a Mental Scale, a Motor Scale, and a Behavior Rating Scale. According to the manual, the Motor Scale assesses degree of control of the body, coordination of the large muscles, finer manipulatory skills of the hands and fingers, dynamic movement, dynamic praxis, postural limitation and stereognosis. The Mental scale assesses environmental responsiveness, sensorial and perceptual abilities. Raw scores on the Motor and Mental Scale are converted to developmental age-equivalent scores as well as standard scores called the PDI and MDI scores respectively. The mean
standard score is 100 and the standard deviation (SD) is 15. The BSID II Motor and mental Scale classifies performance based on whole-number SD from the mean, into categories of accelerated performance (115 and above), within normal limits (85-115), mildly delayed (70-84), and significantly delayed performance (≤69). The BSID II Motor and mental Scale classifies performance based on whole-number SD from the mean, into categories of accelerated performance (115 and above), within normal limits (85-115), mildly delayed (70-84), and significantly delayed performance (≤69).18

**Figure-1: Schematic flowchart for participants in the study**

**Table-I Demographic data for infants in sample (N=60)**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight(gms)</td>
<td>1365.5</td>
<td>137.96</td>
</tr>
<tr>
<td>Length (cms)</td>
<td>39.8</td>
<td>3.16</td>
</tr>
<tr>
<td>Head Circumference (cms)</td>
<td>30.5</td>
<td>2.19</td>
</tr>
<tr>
<td>Pondral Index</td>
<td>.022</td>
<td>.004</td>
</tr>
<tr>
<td>Gestational Age(wks)</td>
<td>32.98</td>
<td>2.53</td>
</tr>
</tbody>
</table>

**Table-2: Pearson product moment correlation of 6-month MAI with 12 month Bayley scale of infant development-II**

<table>
<thead>
<tr>
<th>6 month MAI</th>
<th>12 month MDI*</th>
<th>P value</th>
<th>12 month PDI**</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Risk Score</td>
<td>-.683</td>
<td>.000</td>
<td>-.639</td>
<td>.000</td>
</tr>
<tr>
<td>Muscle Tone</td>
<td>-.596</td>
<td>.000</td>
<td>-.510</td>
<td>.000</td>
</tr>
<tr>
<td>Primitive Reflex</td>
<td>-.544</td>
<td>.000</td>
<td>-.477</td>
<td>.000</td>
</tr>
<tr>
<td>Automatic Reaction</td>
<td>-.614</td>
<td>.000</td>
<td>-.641</td>
<td>.000</td>
</tr>
<tr>
<td>Volitional Movement</td>
<td>-.684</td>
<td>.000</td>
<td>-.644</td>
<td>.000</td>
</tr>
</tbody>
</table>

**PDI-Psychomotor development index,*MDI-Mental development index**

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RESULTS

Pearson’s Product moment correlation was used to examine the relationship between six-month MAI and one year MDI and PDI scores of BSID II. The predictive power of each of the four MAI categorical risk scores (muscle tone, primitive reflexes, automatic reactions, and volitional movements) as well as the total risk score was examined. Table-1 presents the demographic data of the infants. The data analysis of 60 VLBW infants, who completed one year evaluation, indicated that 17 infants (28.33%) had abnormal motor development. Mild motor delay was present in 5 infants (8.33%) and significant motor delay that is cerebral palsy was present in 12 infants (20%). About 7 (11.66%) infants had abnormal mental development, out of which 4 (6.66%) infants had mild delay and 3 infants (5%) had significant delay. Both motor and mental abnormality were present in 7 infants (11.66%), of which 4 infants (6.66%) had mild abnormality and 3 (5%) had significant abnormality.

Table-2 presents the relationship between the MAI risk scores at 6-month with Bayley’s mental and motor scale at 12 months. There was highly significant correlation between 12 month Bayley’s motor and mental scale with the total risk score as well as categorical scores of MAI at p value<.000. Categorical risk score for automatic reactions and volitional movements showed strongest correlation with motor outcome whereas primitive reflexes were relatively weak. No individual category showed better correlation with motor outcome than the total risk score.

DISCUSSION

This is the first reported study evaluating the predictive validity of 6 months MAI in at-risk infants. The results of the study are encouraging with significant correlation between the 6-month MAI evaluation and Bayley’s scale of Infant development-II at one year indicating the clinical usefulness of the MAI as an early neuromotor measure of developmental risk. MAI is specifically a test of infant motor function and appropriately correlated with the Bayley’s motor scale at one year. The correlation of total risk score of MAI with the Psychomotor developmental index score of BSID-II were similar to correlations demonstrated by four and eight month MAI in low birth weight infants with 18 months developmental outcome. Similar correlations were reported for four-month MAI with neurodevelopmental outcome at 12 and 24 months. The trends indicated by the earlier studies at four and eight months and the present study at 6-months are similar, indicating that the same basic relationship of predictive validity exists. The strongest correlation with motor outcome at one year were found for volitional movement section of categorical risk score (r=-.644), slightly exceeding those for total risk score. Items in the volitional movement section of the MAI include gross motor activities like prone weight bearing, sitting, crawling, standing and walking. The Bayley’s motor scale at one year also has gross motor items like pull to stand from floor, throwing ball, standing alone for 2sec and walking. This could be the reason for volitional movement section to predict well to later performance on Bayley’s motor scale. This signifies the usefulness of tool in identifying quality of movement in high risk infants. Our findings support the reports indicating the motor skill assessments, including the volitional movement section of MAI as the best predictors of developmental outcome. This confirms the importance of combination of abnormal physical findings and failure to pass at least one developmental milestone was a strong predictor of later cerebral palsy than presence of neurological pathology alone. As reported in the study on performance of 6-month old term infants the ability to bring head and hands to midline and maintain this posture was consistent indicating the importance of midline orientation in the developing infant’s motor repertoire. Inability to demonstrate antigravity midline postures would appear to be very atypical. The automatic reactions and muscle tone strongly correlated with the outcome substantiating the findings of Ross et al who reported that individual items in muscle tone and balance responses at nine months were the most predictive of gross and fine motor functions. Primitive reflexes were found to be the least predictor of later handicap. It is interesting that the MAI, an assessment

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of infants neuromotor function, significantly correlated with mental scale of Bayley’s at one year. This could partly be due to the test activities of the mental scale, which include many fine motor items like scribbling, removing pellets from small container, putting beads in small box etc which compromise the performance of children with neuromotor dysfunction, even if they have normal intelligence. It is reported that earliest sign of delayed or impaired motor function is indicative of later cognitive deficit. These early signs of abnormality could be detected by MAI as early as six months of age in VLBW infants. The limitation of present study was a shorter duration of follow up, so future studies should test the validity of MAI with varying high risk sample and longer duration of follow up.

CONCLUSION

The MAI at 6-months appears to be a valid tool to identify both mental and motor abnormalities in VLBW infants although it is primarily an evaluation tool of neuromotor status as indicated by strong correlations between motor and mental scale of Bayley and all the components of MAI.

References


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CONFLICTS OF INTEREST

None identified or declared.