

General Movement Assessment in Prediction of Neurodevelopmental Disability and Cerebral Palsy

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With the incidence of preterm births in India being 7-9%, and further rising, the associated neurodevelopmental complications have an enormous burden on the limited resources available in our country. Early diagnosis and management of these complications can mitigate the risk of adverse neurodevelopmental outcomes and improve caregiver well-being.

The article in this issue of the journal [1], a prospective cohort study with a 2-year follow-up, reiterates the universal utility and feasibility of the Prechtl General Movement Assessment (GMA) [2] for the prediction of neurodevelopmental disorders and disabilities including cerebral palsy (CP) in resource-limited settings, especially if applied at 3 to 5 months post-term age.

The GMA is a noninvasive, highly sensitive, and reliable method to evaluate the young nervous system and has been internationally recommended as the best clinical tool to predict cerebral palsy in infants who are younger than 5 months post-term age [3]. General movements (GMs) are spontaneous entirebody movements present from early fetal life till about 5 months after term age. They are variable sequences of movements of the arm, leg, neck and trunk with changing intensity, force and speed. Essential to GM assessment is the Gestalt visual perception of movement complexity and variation [2]. GMs present distinct age specific patterns during the pre-term and term periods. Prior to term age, the GMs are named Preterm GMs and from term age till two months post-term they are termed as Writhing movements. Writhing movements are typically ellipsoid movements, which creates the impression that the infant is writhing. At 6-9 weeks post-term age, these writhing movements gradually disappear and Fidgety movements (FMs) emerge, which are present until the end of the fifth month or even a bit longer. FMs are very tiny movements with variable acceleration of neck, trunk, and limbs in all directions. They are continual in the awake non-crying infant, except during focused attention [2].

If the nervous system is functionally impaired, GMs lose their variable and complex quality. Therefore, the presence of normal and variable general movements indicate normal development whereas abnormal and monotonous general movements may herald neurologic impairment. During preterm and term age, three types of abnormal GMs have been described [2]:

- *Poor repertoire GMs (PR)*: Here, the sequence of the successive movement components is monotonous and arm, leg, trunk, and head movements do not occur in the normal rich and complex sequence
- *Cramped synchronized GMs (CS)*: wherein the movements appear rigid with almost simultaneous contraction and thereafter almost simultaneous relaxation of limb and trunk muscles.
- *Chaotic GMs (Ch)*: Large amplitude abrupt movements of all limbs that occur in a chaotic order without any fluency or smoothness.

CS GMs have a particularly high predictive value (70% sensitivity and 97% specificity) for spastic CP [2]. CS movements that start already in the moderate to late preterm age are associated with later worse motor impairment. Infants with Ch GMs typically develop CS GMs around term and hence also have a high risk for spastic CP. PR GMs are less predictive and rather unspecific [2], as shown in the present article too [1]. However, if preterm born infants show consistently PR GMs up to 8 weeks after term, they have an increased risk for learning difficulties at school-age [4].

Fidgety movements (FMs) are judged abnormal if they are either absent (F-) i.e., FMs are never observed from ages 6 to 20 weeks post-term; or abnormal (AF), i.e., they may resemble normal FMs, but have moderately or greatly exaggerated amplitude, speed and jerkiness [2,5].

Normal FMs suggest normal neurological development while the absence of FMs at 3-5 months post-term age is the most sensitive and specific indicator of later neurological impairments [2,3,5].

Apart from the categorical GMA, further refinements in scoring of GMs have been recently developed, which include the GM optimality score (GMOS) [6] and the Motor Optimality Score-Revised (MOS-R) [5]. The MOS-R is a detailed structured assessment that is based both on standard GMA and on the assessment of postural and movement patterns co-occurring with FMs. A low motor optimality score is associated with a limited functional mobility and activity and predicts the severity of CP [5]. Recently, it has been shown that the MOS-R was highly predictive for the 12-year neurological and behavioral outcomes in children born extremely preterm [7]. Apart from utility of GMA in prediction of CP, recent evidence reveals increased occurrences of abnormal GMs in infants later diagnosed with autism spectrum disorder, various genetic disorders, as well as in infants born to mothers with viral infections during pregnancy such as HIV, Zika [5] or SARS-CoV-2. The long-term relevance of GMA for cognition and speech-language performance during puberty age or even young adulthood is also increasingly being recognized [8].

GMA requires an adequate video recording which is scored on the basis of the observer's visual Gestalt perception of normal vs. abnormal movement patterns, undisturbed by other environmental impressions. Video recording has the added advantage of playback and storing the recordings for documentation and future reference. An optimal GMA consists of at least one recording during the preterm period, one during term age and another one performed between 9-16 weeks post term [2]. As the appearance, quality and interpretation of general movements depend on the gestational age of the infant, it is imperative that the gestational age be accurately calculated, based on a confirmed last menstrual period date or a first trimester ultrasound, which is a challenge in populations without access to good quality antenatal care.

A few other precautions are necessary while recording: the infant should lie in supine position on a plain, non-distracting surface, preferably dressed in a vest and diaper, leaving arms and legs bare. Filming during prolonged episodes of fussing, crying or hiccups must be avoided. Younger preterm infants can be recorded when bouts of activity occur, also during sleep. The duration of the recording depends on the age of the infant and doesn't need to be more than 2-5 minutes. Standardized GM recordings may be a challenge especially in home-based settings. To overcome this, a boom of technological approaches ranging from mobile-app-based recording tools to automated pose estimation through sensor based or marker less approaches have surfaced recently [9]. Apps allow parents to directly upload a video of their infant's GMs to be assessed by experts, without the need for attending an on-site appointment. However, such a

procedure may not be feasible in the absence of cameras and smartphones. To counter this deficiency, community health workers or ASHAs can be trained to film the movements [10], which can be scored distantly by certified assessors with specific high-quality training.

Despite all these technicalities, GMA is much easier to be carried out than most neurodevelopmental assessments. Hence, GMA is suitable for day-to-day clinical applications, particularly in low-resource settings, where obtaining an MRI may not be practically feasible. Being entirely non-intrusive, GMA is generally accepted by caregivers with divergent social and cultural backgrounds [2,5,9]. It is imperative that the pediatrician become familiar not only with the technique of recording GMs, but also with their interpretation, so as to counsel the parents of high-risk infants and refer for timely intervention.

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