Gestational Age Assessment In The Newborn – A Review

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Citation

P Opara. *Gestational Age Assessment In The Newborn – A Review*. The Internet Journal of Pediatrics and Neonatology. 2009 Volume 12 Number 2.

Abstract

BACKGROUND:Assessment of gestational age of babies has been in existence for many years. There are several methods available which are used routinely. Some of these can assess gestational age prenatally while others are used postnatally.The importance of assessing gestational age cannot be overemphasized. It helps to anticipate problems that a newborn may develop and thereby ensures prompt management. It also helps to categorize low birth weight babies into preterm, small for gestational age or both and these all require different approaches to management. In our environment where pregnancy dates are sometimes uncertain, assessment of gestational age may help meet the needs of the newborn.METHOD: This is a review of various methods of assessing gestational age. Literature search was made through locally available literature, Google search engine, Pubmed and Medline search. Key words employed were gestational age assessment methods, newborn.RESULT: The paper highlights various methods of assessing gestational age, their advantages and disadvantages and their usefulness and drawbacks in practice.CONCLUSION: Some simple methods of assessing gestational age are useful even in very poor settings. These can help identify high risk infants and hence prompt referral to more specialized settings for needed care.

INTRODUCTION

Gestation is the period between the conception and birth of a baby during which the fetus grows, and develops in the uterus.[1]

Gestational age is the time measurement from the first day of mother's last regular menstrual period [LMP] to the current date or date of delivery.[2 3] This time interval is commonly expressed in completed weeks rather than as a mixed number or in days.[2] A pregnancy of normal gestation is approximately forty weeks with a normal range of thirty-seven through forty one weeks. Before thirty seven completed weeks, infants are considered preterm, while at forty two completed weeks or more they are considered post term.[2 4 5]

The knowledge of gestational age is important for Obstetricians and Neonatologists and it is routinely estimated both prenatally and postnatally.[6] The development of some neonatal problems during and immediately after birth is known to be dependent, to a large extent, on gestational age rather than birth weight.[7 8] Assessing gestational age is helpful in meeting the needs of the newborn when the dates of a pregnancy are uncertain. For example, a low birth weight baby may require a different approach to management depending on whether it is small for gestational age, preterm, or both.[5] This is particularly important in some developing countries, like Nigeria, where malaria and malnutrition frequently cause fetal growth restriction and/ or premature delivery.[9] Thus, the average birth weight is lower than in European newborns, leading to confusion in the distinction between short gestation and small-for-date infants.[10-12] The determination of gestational age is therefore important in planning appropriate treatment for the fetus or infant and may modify details of their care.[13-14] Hence its accurate assessment is an essential component of perinatal practice.

There are several methods of assessing gestational age, and these can be done both prenatally and postnatally. This review gives an overview of various methods of gestational age assessment, highlights its importance and the fact that one of several methods can be readily used to aid newborn care irrespective of the environment of practice..

DISCUSSION

Gestational age can be estimated in the prenatal and postnatal periods. Prenatally, the date of the Last Menstrual Period (LMP) and abdominal ultrasound scan are commonly used. Examination of the anterior vascular capsule of the lens, as well as other methods of physical and neurological assessment are commonly used postnatally.

Prenatal Estimation of Gestational Age:-

CLINICAL DATA

LAST MENSTRUAL PERIOD

Antenatally, gestational age is usually calculated from the first day of the last menstrual period [LMP][2 3 6] based on the mother's report. According to Naegele's Rule,[3 15] the standard definition for term gestation is 266 days from conception. This is also defined as 280 days or 40 weeks from the first day of the mother's last menstrual period. This definition assumes that the mother ovulates on day 14 of a 28 day menstrual cycle. The formula used to calculate the date is [LMP + 7 days] - 3 months = Expected date of delivery.[3, 15] This definition is based on observations first reported by Franz Naegele in 1812. He believed that pregnancy lasted 10 lunar months from the first day of the LMP and was not based on empirical data.[15]

The calculation of the gestational age based on the LMP depends on an accurate recollection of the date by the mother.[14 15 16] This vital information is however not always available or reliable, especially in developing countries where women enroll late for antenatal care and therefore recollection is less likely to be accurate.[14 16] Factors such as recent use of contraceptives and their possible effect on ovulation, the possibility of interpreting post-conception 'spotting' as a light period, the mother becoming pregnant in the first menstrual cycle immediately following a recent delivery and unrecognized pregnancy losses, contribute to the inaccuracy of the LMP dates.[14 15 16] It is estimated that nearly 25% of infants who would be classified as preterm births on the basis of the last menstrual period are, in fact, not preterm.[15,17]

Several studies have tried to validate LMP- based gestational age with that derived using early ultrasonic measurements.[15,18] Gardosi et al[18] in their study found that menstrual dates systematically over-estimated gestational age at term when compared with ultrasound dates. They recommended that the proportion of pregnancies considered post term can be considerably reduced by a dating policy which ignores menstrual date and establishes expected date of delivery [EDD] on the basis of ultrasound dates alone. Such a policy, however, can only be feasible in settings where women enroll early for antenatal care, which is not the case for most women in our environment. Ignoring menstrual dates can also lead to less dependence on clinical judgment and over-dependence on ultrasound scan.

OTHER PRENATAL CLINICAL DATA

Other clinical data useful in assessing gestational age include first felt foetal movements [quickening] at 16 - 20 weeks depending on the parity, appearance of foetal heart tones which can be detected with doppler at 9 - 12 weeks, and with foetoscope at about 20 weeks and symphysio-fundal height measurements.[3]

Physical estimation of the baby's size and gestational age is routinely done in the obstetric clinic by measurements of the symphysio-fundal height using palpation, a simple tape measure or caliper. Generally, lcm is equal to one week from the 18th to 20th week of gestation. At 20 weeks, the fundus is at the umbilicus and at term it is at the xiphoid process.[3]

Some authors have studied the effect of clinical bias on fundal height measurements. Engstrom and colleagues[19] tried to determine whether the clinician's fundal height measurements were influenced by their knowledge of gestational age in weeks and their ability to see the numeric markings on the tape measure. In their study, two measurements each were taken by each investigator in twenty four women using marked and unmarked paper tapes and a record was taken of the clinician's fundal height measurements on the prenatal chart. The findings and the subsequent suggestion that clinicians blind themselves to their own fundal height measurements and to the knowledge of gestational age in weeks to avoid bias, may improve assessment of gestational age using this method which is cheap and requires minimal skill.

Anderson et al [20] analyzing individual clinical observations in gestational age assessment, calculated mean intervals from an event to delivery for last menstrual period, first audible fetal heart tones, uterine fundus at the umbilicus and measurements of the fundal height. When variability in each of these estimates was examined and compared, the LMP, if known with certainty, was found to be the most accurate followed by the uterus at the level of the umbilicus, first heard fetal heart tones, fundal height and quickening.

Fundal height measurements, like the other clinical data, are subject to observer errors. Factors such as the position of the umbilicus, amount of fat in the abdominal wall, height of the patient [and thus the abdominal length], the amount of amniotic fluid, and changes effected by the state of fullness of the rectum or bladder affect the reliability of fundal height measurements. Despite these inadequacies, the fundal height method is still useful and widely used in clinical obstetric practice.[19,21]

LABORATORY DATA

There are biochemical parameters that aid in the estimation of gestational age. These parameters are usually estimated from analysis of amniotic fluid contents. They include amniotic fluid creatinine concentration, Lecithin/Sphingomyelin [L/S] ratio, bilirubrin, fat cells, urea, uric acid and total protein.[3 5]

The best available chemical indices of foetal maturity are provided by determination of amniotic fluid creatinine and lecithin which reflect the maturity of the fetal kidneys and lungs respectively.[5] Amniotic fluid creatinine levels < 1.8mg/100mls are seen in 90% of fetuses before 36 weeks while values > 1.8mg/100mls are seen in up to 98% of foetuses after 36 weeks.[22]

Lecithin [L] is produced in the lungs by type 1 alveolar cells and eventually reaches the amniotic fluid via the affluent from the trachea.[5] Until the middle of the third trimester, its concentration nearly equals that of sphingomyelin [S]. Thereafter sphingomyelin [S] remains constant in amniotic fluid while lectithin [L] increases. By 35 weeks, on the average, the L/S ratio is about 2:1, indicating lung maturity.[5]

Several authors have assessed foetal maturity by amniotic fluid analysis.[23–26] A study of 108 samples of amniotic fluid obtained between 28 and 42 weeks gestation from 101 patients revealed that in normal pregnancies, the creatinine concentration, L/S ratio and percent of fat cells correlated well with gestational age of the newborn assessed clinically.[23] It was however found that in abnormal pregnancies i.e. those with obstetric or medical complications or both, the mean creatinine concentration in amniotic fluid was significantly less than expected for gestational age in foetal dysmaturity and greater than expected when the mother had diabetes mellitus.[27] The mean L/S ratio was also increased when the mother had hypertension or smoked or when there was a long interval between rupture of membranes and delivery. It was significantly less in diabetes mellitus. In other words, factors like premature rupture of foetal membranes and maternal hypertension accelerate lung maturity while factors like hydrops foetalis and maternal diabetes mellitus delay lung maturation.[5 23-24]

These findings in complicated pregnancies have also been substantiated by other authors studying the role of foetal and maternal factors in the maturation of foetal lungs in several pathological conditions.[24] These findings undermine the use of these tests in complicated pregnancies. Rome et al[25] suggested that the L/S ratio is a good but not absolute indicator of foetal lung maturity and should be combined with other indices like the creatinine concentration for better index of fetal lung maturity.

Olowe et al[26] suggested that where facilities for ultrasound scan are not available, these simple tests using amniotic fluid indices can be very helpful in the determination of foetal maturity and in the prevention of accidental delivery of immature foetuses. However, amniocentesis is required to obtain amniotic fluid for analysis and carries with it such risks as pregnancy losses, infection and haemorrhage which cannot be over looked. Furthermore, reagents and necessary skills for such studies may not be readily available for routine use in some localities in developing countries.

ABDOMINAL ULTRASOUND SCAN

Since its introduction in the late 1950s, ultrasonography has become a very useful diagnostic tool in obstetrics. It offers a unique opportunity to objectively measure quantitative changes in growth increments of various foetal structures as well as qualitative changes occurring near term which are indicative of foetal maturity.[3 28-29]

Pregnancy dating through ultrasonography is an improvement over clinical and menstrual historical methods of determining gestational age.[30] Early ultrasonic measurements are useful in assessing gestational age when knowledge of the last menstrual period is uncertain which is a common problem in Nigeria and other parts of the world.[9 13 17 31] Even when LMP is certain, many clinicians and investigators have used early ultrasonic measurements as the gold standard to validate other methods of assessing gestational age.[17,31,32]

Measurements used in assessing gestational age include the size and volume of the gestational sac, crown-rump length, biparietal diameter, femur length, abdominal circumference, and head circumference depending on the age of the pregnancy.[3,28,30] The size of the gestational sac best predicts gestational age within 5 - 7 weeks gestation and the crown-rump length within 7 - 12 weeks. There is no certainty as to the best measurements within 13 - 15 weeks. The biparietal diameter on a routine basis has been found to predict gestational age to within 5 days as long as measurements are taken within 15 -19 weeks of gestation.[17,32] In patients with uncertain LMPs therefore, such measurements must be made as early as possible in pregnancy to arrive at accurate dating. In the early second trimester, for example, the growth of the

foetal head is rapid and variations in head size between foetuses are small. Therefore measurements of biparietal diameter are most accurate in assessing gestational age.[3] In the third trimester however, the growth rate falls and the biparietal diameter shows a much greater variation with the duration of pregnancy. There is also a wide variation in normal foetal measurements as a result of non- uniformity of foetal growth thus compromising the accuracy in establishing gestational age.[3, 28]

Early ultrasonic measurements are much used in developed countries where women enroll early for antenatal care.[14] In developing countries however, where many women are uncertain of their LMP, even where ultrasound facilities are available, late attendance to, or even lack of antenatal care undermines the validity of this method of assessment of gestational age. Many authors have recognized ultrasound gestational dating as the most accurate method of assessing gestational age,[17-18,32-34] but others also acknowledge that serial sonography, though accurate, is not practical as a screening tool for growth assessment in a developing country.[21] This is because the equipment is expensive and its operation requires special skill.[21]

It is worthy of note that although harmful effects of ultrasonography have not been demonstrated on mother, fetus or operator,[29] the greatest risks arising from it's use are the possible over, under and mis-diagnosis brought about by inadequately trained staff often working in relative isolation and using poor or obsolete equipment which is a scenario common in the developing world.[29] There is also the possibility of over dependence on ultrasound with less reliance on clinical judgment because of the benefits, moderate cost and relative safety of the procedure.[29]

POSTNATAL ASSESSMENT OF GESTATIONAL AGE:

ANTERIOR LENS CAPSULE VASCULARITY.

Hittner and co-workers[35] described a simple method of gestational age estimation based on the normal embryological process of gradual disappearance of the anterior lens capsule vascularity between the twenty seventh and thirty-fourth weeks of gestation. This is based on the principle that before the twenty seventh week, the cornea is too opaque to allow good visualization of the vascular system and after the thirty fourth week, these vessels have generally atrophied completely.[35]

Anterior lens capsule vascularity was arbitrarily categorized into four grades as follows:-[35]

Grade 4: Anterior lens capsule vascularity covers the entire anterior lens surface [27-28 weeks].

Grade 3: Early vascular atrophy with central clearing [29 – 30 weeks].

Grade 2: More clearing with thinning of peripheral vessels [31-32 weeks]

Grade 1: Few peripheral thin vessels with none reaching the centre [33-34 weeks].

Assessing vascularity of the lens was done within the first 24 hours of birth with dilatation of the pupils under direct opthalmoscopy.

This method of assessment has proved highly accurate in appropriate-for-gestational age infants and is not affected by primary neurological deficits or alert states.[35, 36]

The pupils of premature infants are much more difficult to observe than those of children or adults, partly because the iris is lusterless and therefore difficult to distinguish from the pupil and partly because it is difficult to open the eyes and keep them open.[37]

The requirements of direct opthalmoscopy, lid retractors and pupillary dilators which are often not routinely available in a busy newborn nursery may limit the use of this method of gestational age assessment in our environment. Moreover, this method is only feasible in babies born between 27-34 weeks of gestation.

A few studies report that intrauterine growth retardation has no effect on disappearance of anterior lens capsule vascularity while some case reports state otherwise.[36, 38-39]

In a prospective observational study designed to evaluate the effect of foetal growth restriction on regression of the anterior lens capsule vascularity in low birth weight neonates, Jitender et al[38] found a significantly higher level of agreement between anterior lens capsule vascularity and gestational age in appropriate-for gestational age [AGA] infants than in small-for-gestational age [SGA] infants. About one-third of the SGA infants had persistence of vascularity beyond thirty four weeks.[38]

Other studies,[36,39]however, concluded that intrauterine growth restriction had no significant effect on the relationship between the lens capsules' grade and the clinical

gestational age suggesting that grading was equally valid in this group of neonates.

No data is currently available as to the possible reasons for the delay in regression of anterior lens capsule vascularity in small-for- gestational age babies,[38] a possible explanation is that since the vascular system serves to nourish the growing lens, in nutritionally deprived foetuses, such nourishment may be required for a longer period for the complete growth of the lens allowing for persistence of the vascular structure in such a situation.[38] In the developing world where the prevalence of intrauterine growth retardation is high,[9 14] even amongst preterm infants, the reliability of anterior lens capsule vascularity for gestational age assessment is further limited.

Assessment of Physical and Neurological Maturity:

Interest in ways of assessing gestational age in newborn infants using physical and neurological characteristics has spanned over 30years.[8 37,40] This interest was stimulated by the growing awareness that gestational age was as important as birth weight in determining the hazards faced by the baby during and immediately after birth.[41] There were also reports showing that clinical problems encountered by infants who were small-for-dates differed from those truly premature.[37] It also became clear that other neonatal problems such as patent ductus arteriosus, intraventricular haemorrhage and retinopathy of prematurity are also influenced by gestation rather than birthweight. It therefore became a matter of practical importance to know whether a particular baby of low birth weight was truly premature or mature and small-for-dates or both premature and small-for-dates, a distinction that depended on accurate knowledge of gestational age.[37]

The problems sometimes encountered in gestational age assessment using ultrasonic measurements and LMP dates, as previously highlighted, led to the development of simple cotside techniques for assessment of the maturity of the newborn which are less technologically oriented, painless and inexpensive.[41]

Several methods of assessing gestational age using physical and neurological criteria at the cotside have been proposed. These methods use either a series of physical/external criteria,[8 13 40 42] neurological criteria, [37,43]or a combination of both criteria. [44-46] Generally, external features reflect maturational skin changes while neurological features reflect maturation of the central nervous system.[46]

Clinical methods of assessing gestational age using neurological criteria have been popular since the 1960s. [37,43] This approach is based on the relationship between late prenatal cerebral maturation and certain continuous criteria that develop steadily during the late gestation period. [43 47] These criteria include muscle tone as manifested by changes in posture, popliteal angle, and scarf sign, as well as the development of certain reflexes, such as the moro, and crossed extension reflexes. [43 47]

Amiel – Tison[43]described neurological evaluation of the maturity of the newborn using some of these criteria. Appreciation of muscle tone was a fundamental feature in this examination and included study of 'passive tone' [resting posture or attitude] and 'active tone'. In this method 'passive tone' is appreciated by the physician applying certain movements to the infant who remains passive and at rest, while the amplitude of passive movements of a single joint is measured. In contrast, 'active tone' is studied with the infant in an active situation, the physician, noting for instance, the righting reaction of the trunk when the infant is placed vertically. This method requires a lot of experience in the assessment of muscle tone.[37]

Robinson,[37] in trying to avert this difficulty rejected muscle tone as an indicator of maturity and instead depended on the presence or absence of certain reflexes. He used discontinuous criteria that abruptly change from negative to positive during a specified developmental period. These criteria included 20 different reflexes and responses including the appearance of pupillary reaction to light, the neck righting reflex and head turning to diffuse light. The pupillary reaction showed the clearest relationship to gestational age. Some of the primitive reflexes listed by Robinson[37]have however been extremely difficult for other researchers to elicit, hence this method did not gain so much popularity. [44 47]

Assessment of physical criteria have also been applied to the estimation of gestational age.[8 13 42] The set of physical criteria most often used was initially described by Farr[8] and later elaborated by Finnstrom.[42] These include skin colour, nipple formation, ear firmness and plantar creases. These criteria are considered easier to determine and more reliable than neurological criteria and have been recognized by various authors as valuable markers of foetal maturation.[8 13 47 48] Quite recently, Amiel-Tison also confirmed that physical criteria are still valuable markers of maturity even at the end of pregnancy.[49]

Estimates of gestational age assessment using physical criteria alone have been found to be more accurate than those based on neurological criteria alone, with the combination of the two giving the best estimates of gestational age. [42,44-46] The method of Dubowitz was the first to combine the assessment of physical and neurological criteria and it is the most widely used in clinical practice to assess gestational age in newborn infants.[7] It has been found to be reliable even in African newborn infants.[9] This method combines a subset of 10 physical criteria from Farr[8] and a subset of 11 neurological criteria from Amiel-Tison.[43] The total score for these 21 criteria is used to estimate gestational age. The system was found to be more objective and reliable than the method of trying to base gestational age on the presence or absence of individual criteria as had been the practice of previous authors. [8 37,43] The use of such a large number of variables however diminishes the value of this method as the necessary skills for examination may be difficult to acquire and the examination, time consuming. [46,51] The major drawback however is its complexity for daily practice in view of the large number of variables to be considered.[46] Some authors have tried to simplify the method in order to make it easier and quicker for the clinician and infant, yet preserve its original precision.[13 45,46,42]

Ballard et al[45]simplified the Dubowitz method[44] by leaving out characteristics which are affected by illness of the newborn baby or its in-utero position. They combined the eleven physical criteria described by Farr[8] and subsequently by Dubowitz[44]into six observations. They also combined the most useful neurological criteria used by Amiel-Tison[43] involving passive rather than active muscle tone and including resting posture, angles of flexion, resistance to extension and passive recoil.

The criteria combined were those that had a high intercorrelation. The resulting simplified scoring method consisted of six physical and six neurological criteria. Ballard estimates of gestational age correlated strongly with estimates derived from Dubowitz[44] scoring and from menstrual dates.

This simplified scoring system is performed more easily and in less time than that required in performing the complete Dubowitz examination.[44]

Despite observations that assessment of gestational age based on a combination of both physical and neurological criteria give better estimates of gestational age, there are advantages in limiting the measures used to external characteristics alone.

Problems with implementation and accuracy of neurological methods have been reported.[47] Some of these have already been highlighted. They are more difficult, especially for non pediatricians to perform and inter-observer reliability is poor.[42] Studies have also shown that the chronic stress of malnutrition in pregnant women, which is common in the developing world, or other high risk pregnancies with placental insufficiency, for example, pre-eclampsia can accelerate brain and lung maturation as an adaptation to stress. This can lead to an overestimation of the neurological gestational age.[9 50-53] Higher neurological estimates have also been found in non white infants.[51] Dubowitz[51] proposed that the differences were the result of the lower socioeconomic status of the non-white group, and that chronic malnutrition of the fetus in-utero may well induce accelerated maturation of some of the neurological criteria.

Parkin and co-workers,[13] using four external criteria in a study of predominantly full term infants, reported that neurological scores correlated less well with true gestational age, were more affected by post natal age at time of examination, and exhibited poorer interscorer agreement.

Other authors, comparing the method of Parkin,[13] classical Dubowitz[44]and Dubowitz physical criteria alone, also found that the Parkin[13] method was easier and quicker to perform and appeared more accurate than the classical Dubowitz method,[44] and as accurate as Dubowitz physical criteria in postnatal assessment of gestational age.[7] However, a disadvantage of using only four criteria is that with incorrect scoring of one characteristic, the estimated gestational age is significantly affected.[16] Moreover, three of the four criteria used in this method were found to have relatively poor correlation with gestational age in the African population.[46] Parkin[13] also expressed concern as to the applicability of skin colour in assessing gestational age in African babies. However, Brueton and colleagues,[10] surprisingly found that skin colour and opacity were useful criteria in African newborns especially when examined within a few hours of birth when they were still pink. Feresu at al[14] also reported that assessing skin colour in African newborn babies is problematic especially more than 48 hours after birth.

The Ballard score[45] has been reviewed to confirm that the score is not influenced by racial factors and that the physical components of the score seem to be more useful than those that rely on tone and posture.[47] In a study[16] evaluating postnatal examination of the newborn by nurses in a

developing country, the Ballard method scoring for external criteria alone compared favourably with the Dubowitz method.[44]The nurses involved had no previous experience of clinical assessment of gestational age but with some training, found assessment of gestational age using the physical criteria of the Ballard method much easier and quicker.[16] These findings can easily be applicable in an environment with paucity of skilled manpower.

Several authors have also reported different methods using different physical and neurologic criteria to assess gestational age, each trying to provide what best would suit his locality. For example, Eregie[53]in Benin City, Nigeria, developed a six-feature model which included head circumference, mid-arm circumference, skin texture, ear form, breast size and genitalia. This model was found to have comparable accuracy with the Dubowitz method[44] and has been suggested as an appropriate clinical tool for rapid and reliable maturity determination in healthy and sick newborn infants.

Charts demonstrating each of these various clinical methods of post natal gestational age assessment are readily available in many clinical settings and on the internet and so can easily be applied in any setting which caters for newborn babies.

CONCLUSION

Assessment of gestational age in the newborn is an age old practice and an important aspect of newborn care. There are several methods, many of which have been highlighted. Even in resource poor settings, one of several methods can be used to estimate gestational age and thus aid in the care of the newborn.

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