

Monograph and Instruction Manual for Assessing the Maturation Age of the Newborn Infant Using the New Ballard Score

Jeanne L. Ballard MD

Foreword

Even as technology progresses at a speed blinding to medicine's "raison d'être", the skilled examiner remains the most valuable segment of the medical repertoire.

Overview of Gestational Assessment

Gestational age of a fetus or of a newborn can be assessed currently by three different methods: the mother's menstrual history, prenatal ultrasonography and the postnatal maturational examination.

An accurate menstrual history, when obtainable, remains the best measure of gestational age, but depends upon normal maternal physiology and an accurate and reliable history.

The prenatal ultrasound examination is one indirect method of assessing the gestational age of the fetus. Based upon fetal body part measurements, it relies upon normally timed and proportioned fetal growth rates. When performed early in gestation, fetal ultrasound is a highly accurate method of assessing gestational age. As the conceptus is exposed to a variety of intrauterine influences, fetal growth may be affected in a variety of ways.⁽¹⁾ Fetal ultrasound measurements, affected by differential fetal growth, become increasingly subject to the intrauterine environment as gestation progresses. Late trimester ultrasound measurements are therefore fraught with unavoidable inaccuracies as indicators of fetal gestational age.^(2,3)

The maturational examination, a postnatal, indirect method of assessing gestational age, is based upon indicators of fetal neuromuscular and physical maturation.⁽⁴⁾ As with fetal growth, fetal maturation may be influenced by a variety of intrauterine experiences. Stressful fetal experiences may accelerate pulmonary⁽⁵⁾ and neuromuscular⁽⁶⁾ rates of maturation while slowing or not affecting physical maturation. A completely non-stressed fetus may mature more slowly than the average fetus. The same events that accelerate fetal maturation may adversely affect fetal growth. Conversely, those that accelerate fetal growth may delay its maturation.

Since certain fetal stresses may occur without the patient's or physician's knowledge, the assessment of gestational age by maturational exam is fraught with uncertainties similar to, and probably greater than, those surrounding fetal ultrasound examination.

Keeping those limitations in mind, one can more fully appreciate the usefulness of both methods of fetal age assessment.

Having said this, the neonatal maturational examination remains the most universally accepted postnatal method of assessing gestational age.

To perform the assessment, the most sophisticated of all technological developments is necessary – the clinical observer.

Neuromuscular Maturation

The complexity of fetal brain development cannot be overstated. Even when one considers its unencumbered development, a myriad of untoward events could occur by chance alone. It is understandable then that any deviation from the normal intrauterine environment could influence the delicate balance between growth and differentiation of neural tissue and hence the rate of functional maturation of the developing fetal brain. When performing tests of neuromuscular maturation, we are making an indirect assessment of brain maturity, which in turn gives us an indirect measure of gestational age.

Neonatal Muscle Tone

Muscle tone may be defined as “the slight constant tension of healthy muscles which contribute a slight resistance to passive displacement of a limb.”⁽⁷⁾

The newborn's neuromuscular examination includes an assessment of both active and passive muscle tone. If all newborns were normal and healthy, both active and passive tone could be used routinely to assess neuromuscular maturation. Active muscle tone, (motility, activity, or efforts at righting oneself) is markedly affected by states of illness, recent maternal medications, acute perinatal compromise and level of alertness. Hence active muscle tone is not consistently useful in evaluating baseline neuromuscular maturity. Passive tone essentially is unscathed by those same factors that profoundly affect active tone. Hence passive tone is useful for evaluating maturational development of the neonatal brain, regardless of the infant's state of alertness or level of wellness.

Passive tone may be further subdivided into extensor and flexor tone. The human fetus, lying primarily with limbs extended in the very early phases of development, gradually assumes a progressively flexed attitude. This is true whether development occurs in utero or in the nursery,⁽⁸⁾ and thus reflects maturation of the central nervous system rather than extraneous compressive forces of the uterus. Passive flexor tone gradually overcomes passive extensor tone as maturation progresses.

Progression of neuromuscular tone development proceeds in a caudo-cephalad and centripetal direction; i.e., lower extremity passive flexor tone develops slightly ahead of upper extremity tone, and distal passive flexion precedes proximal passive flexion.⁽⁸⁾

There are three possible methods of assessing passive flexor tone in the neonate. The first is extensor stretch or *passive flexion*, which may better be described as flexibility, and is used to evaluate the degree to which a limb can be flexed passively at the joint by the examiner. This maneuver requires no tone or extensor resistance on the part of the infant. We may be looking at mobility, flexibility or resistance to extensor stretch rather than at passive flexor tone.

The second method of assessing passive flexor tone is *resistance to passive extension*. These maneuvers require a) that the untested portion of the extremity be resting quietly on a supporting surface; b) that the examiner be very sensitive to the infant's slight tendency to resist extension; and c) that the examiner avoid placing pressure on flexors being tested, thereby interfering with their function.






The third method of testing passive flexor tone is measurement of *angles of recoil* to a previously flexed position. This maneuver requires that the examiner a) pre-set the extremity to a flexed position; and b) avoid fatiguing the flexors by maintaining the extremity in the extended position for too long a period of time prior to releasing.

Performing the Assessment of Neuromuscular Maturity

1. Posture

Total body muscle tone is reflected in the infant's preferred posture at rest and resistance to stretch of individual muscle groups. As maturation progresses, the fetus gradually assumes increasing passive flexor tone that proceeds in a centripetal direction, with lower extremities slightly ahead of upper extremities. For example, very early in gestation only the ankles are flexed. Knees will flex as wrists just begin to flex. Hip flexion, then adduction are just ahead of elbow, then shoulder girdle flexion. The preterm infant primarily exhibits unopposed passive extensor tone, while the infant approaching term shows progressively less opposed passive flexor tone.







To elicit the posture item, the infant is placed supine (if found prone) and the examiner waits until the infant settles into a relaxed or preferred posture. If the infant is found supine, gentle manipulation (flex if extended; extend if flexed) of the extremities will allow the infant to seek the baseline position of comfort. Hip flexion without adduction results in the frogleg position as depicted in posture square #3. Hip adduction accompanying flexion is depicted by the acute angle at the hips in posture square #4. The figure that most closely depicts the infant's preferred posture is selected.

NEUROMUSCULAR MATURITY SIGN	SCORE						RECORD SCORE HERE	
	-1	0	1	2	3	4		5
POSTURE								

2. Square Window

Wrist flexibility and/or resistance to extensor stretching are responsible for the resulting angle of flexion at the wrist.

The examiner straightens the infant's fingers and applies gentle pressure on the dorsum of the hand, close to the fingers. From extremely pre-term to post-term, the resulting angle between the palm of the infant's hand and forearm is estimated at $> 90^\circ$, 90° , 60° , 45° , 30° and 0° . The appropriate square on the score sheet is selected.






NEUROMUSCULAR MATURITY SIGN	SCORE						RECORD SCORE HERE	
	-1	0	1	2	3	4		5
SQUARE WINDOW (Wrist)	 $>90^\circ$	 90°	 60°	 45°	 30°	 0°		

3. Arm Recoil

This maneuver focuses on passive flexor tone of the biceps muscle by measuring the angle of recoil following very brief extension of the upper extremity.

With the infant lying supine, the examiner places one hand beneath the infant's elbow for support. Taking the infant's hand, the examiner briefly sets the elbow in flexion, then momentarily extends the arm before releasing the hand. The angle of recoil to which the forearm springs back into flexion is noted, and the appropriate square is selected on the score sheet. The extremely pre-term infant will not exhibit any arm recoil. Square # 4 is selected only if there is contact between the infant's fist and face. This is seen in term and post-term infants.







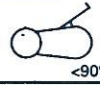
Care must be taken not to hold the arm in the extended position for a prolonged period, as this causes flexor fatigue and results in a falsely low score due to poor flexor recoil.

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
ARM RECOIL		 180°	 140°-180°	 110°-140°	 90°-110°	 <90°		

4. Popliteal Angle

This maneuver assesses maturation of passive flexor tone about the knee joint by testing for resistance to extension of the lower extremity. With the infant lying supine, and with diaper removed, the thigh is placed gently on the infant's abdomen with the knee fully flexed. After the infant has relaxed into this position, the examiner gently grasps the foot at the sides with one hand while supporting the side of the thigh with the other. Care is taken not to exert pressure on the hamstrings, as this may interfere with their function. The leg is extended until a definite resistance to extension is appreciated. In some infants, hamstring contraction may be visualized during this maneuver. At this point the angle formed at the knee by the upper and lower leg is measured.

Note: a) It is important that the examiner wait until the infant stops kicking actively before extending the leg. b) The prenatal frank breech position will interfere with this maneuver for the first 24 to 48 hours of age due to prolonged intrauterine flexor fatigue. The test should be repeated once recovery has occurred; alternately, a score similar to those obtained for other items in the exam may be assigned.

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
POPLITEAL ANGLE	 180°	 160°	 140°	 120°	 100°	 90°	 <90°	







5. *Scarf Sign*

This maneuver tests the passive tone of the flexors about the shoulder girdle.

With the infant lying supine, the examiner adjusts the infant's head to the midline and supports the infant's hand across the upper chest with one hand. The thumb of the examiner's other hand is placed on the infant's elbow.

The examiner nudges the elbow across the chest, feeling for passive flexion or resistance to extension of posterior shoulder girdle flexor muscles.

The point on the chest to which the elbow moves easily prior to significant resistance is noted. Landmarks noted in order of increasing maturity are: full scarf at the level of the neck (-1); contralateral axillary line (0); contralateral nipple line (1); xyphoid process (2); ipsilateral nipple line (3); and ipsilateral axillary line (4).

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
SCARF SIGN								







6. *Heel to Ear*

This maneuver measures passive flexor tone about the pelvic girdle by testing for passive flexion or resistance to extension of posterior hip flexor muscles.

The infant is placed supine and the flexed lower extremity is brought to rest on the mattress alongside the infant's trunk.

The examiner supports the infant's thigh laterally along side the body with the palm of one hand. The other hand is used to grasp the infant's foot at the sides and to pull it toward the ipsilateral ear.

The examiner feels for resistance to extension of the posterior pelvic girdle flexors and notes the location of the heel where significant resistance is appreciated. Landmarks noted in order of increasing maturity include resistance felt when the heel is at or near the: ear (-1); nose (0); chin level (1); nipple line (2); umbilical area (3); and femoral crease (4).

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
HEEL TO EAR								

Performing the Assessment of Physical Maturity

1. *Skin*

Maturation of fetal skin involves the development of its intrinsic structures concurrent with the gradual loss of its protective coating, the vernix caseosa. Hence, it thickens, dries and becomes wrinkled and/or peels, and may develop a rash as fetal maturation progresses. These phenomena may occur at varying paces in individual fetuses depending in part upon the maternal condition and the intrauterine environment.

Before the development of the epidermis with its stratum corneum, the skin is transparent and adheres somewhat to the examiner's finger. Later it smoothes, thickens and produces a lubricant, the vernix, that dissipates toward the end of gestation. At term and post-term, the fetus may expel meconium into the amniotic fluid. This may add an accelerating effect to the drying process, causing peeling, cracking, dehydration, and imparting a parchment, then leathery, appearance to the skin. For scoring purposes, the square which describes the infant's skin the most closely should be selected.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
SKIN	sticky friable transparent	gelatinous red translucent	smooth pink visible veins	superficial peeling &/or rash, few veins	cracking pale areas rare veins	parchment deep cracking no vessels	leathery cracked wrinkled	

2. *Lanugo*

Lanugo is the fine hair covering the body of the fetus.

In extreme immaturity, the skin lacks any lanugo. It begins to appear at approximately the 24th to 25th week and is usually abundant, especially across the shoulders and upper back, by the 28th week of gestation.

Thinning occurs first over the lower back, wearing away as the fetal body curves forward into its mature, flexed position. Bald areas appear and become larger over the lumbo-sacral area. At term, most of the fetal back is devoid of lanugo, i.e., the back is mostly bald.

Variability in amount and location of lanugo at a given gestational age may be attributed in part to familial or national traits and to certain hormonal, metabolic, and nutritional influences. For example, infants of diabetic mothers characteristically have abundant lanugo on their pinnae and upper back until close to or beyond full-term gestation. When scoring for lanugo, the examiner selects the square that most closely describes the relative amounts of lanugo on the upper and lower areas of the infant's back.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
LANUGO	none	sparse	abundant	thinning	bald areas	mostly bald		

3. Plantar Surface

This item pertains to the major foot creases on the sole of the foot. The first appearance of a crease appears on the anterior sole at the ball of the foot. This may be related to foot flexion in utero, but is contributed to by dehydration of the skin. Infants of non-white origin have been reported to have fewer foot creases at birth.⁽⁹⁾ There is no known explanation for this. On the other hand, the reported acceleration of neuromuscular maturity in black infants usually compensates for this, resulting in a cancellation of the delayed foot crease effect. Hence, there is usually no over- or under-estimation of gestational age due to race when the total score is performed.⁽¹⁰⁾

Very premature and extremely immature infants have no detectable foot creases. To further help define the gestational age of these infants, measuring the foot length or heel-toe distance is helpful.^(10,12) This is done by placing the infant's foot on a metric tape measure and noting the distance from the back of the heel to the tip of the great toe. For heel-toe distances less than 40 mm, a minus two score (-2) is assigned; for those between 40 and 50 mm, a minus one score (-1) is assigned.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
PLANTAR SURFACE	✓ heel-toe 40-50 mm:-1 <40 mm:-2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		

4. Breast

The breast bud consists of breast tissue that is stimulated to grow by maternal estrogens and fatty tissue which is dependent upon fetal nutritional status. The examiner notes the size of the areola and the presence or absence of stippling (created by the developing papillae of Montgomery). The examiner then palpates the breast tissue beneath the skin by holding it between thumb and forefinger, estimating its diameter in millimeters, and selects the appropriate square on the score sheet.

Under- and over-nutrition of the fetus may affect breast size variation at a given gestation. Maternal estrogen effect may produce neonatal gynecomastia on the second to fourth day of extrauterine life.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
BREAST	imperceptible	barely perceptible	flat areola no bud	stippled areola 1-2 mm bud	raised areola 3-4 mm bud	full areola 5-10 mm bud		

5. *Eye/Ear*

The pinna of the fetal ear changes its configuration and increases in cartilage content as maturation progresses. Assessment includes palpation for cartilage thickness, then folding the pinna forward toward the face and releasing it. The examiner notes the rapidity with which the folded pinna snaps back away from the face when released, then selects the square that most closely describes the degree of cartilagenous development.

In very premature infants, the pinnae may remain folded when released. In such infants, the examiner notes the state of eyelid development as an additional indicator of fetal maturation.⁽¹³⁾ The examiner places thumb and forefinger on the upper and lower lids, gently moving them apart to separate them. The extremely immature infant will have tightly fused eyelids, i.e., the examiner will not be able to separate either palpebral fissure with gentle traction. The slightly more mature infant will have one or both eyelids fused but one or both will be partly separable by the light traction of the examiner's fingertips. These findings will allow the examiner to select on the score sheet a minus two (-2) for tightly fused, or minus one (-1) for loosely or partially fused eyelids. The examiner should not be surprised to find a wide variation in eyelid fusion status in individual infants at a given gestational age, as the rate of eyelid unfusion may be affected by certain stress-related intrauterine and humoral factors.⁽¹⁴⁾

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
EYE/EAR	lids fused loosely: -1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		

6. *Genitals-Male*

The fetal testicles begin their descent from the peritoneal cavity into the scrotal sack at approximately the 30th week of gestation. The left testicle precedes the right and usually enters the scrotum during the 32nd week. Both testicles are usually palpable in the upper to lower inguinal canals by the end of the 33rd to 34th weeks of gestation. Concurrently, the scrotal skin thickens and develops deeper and more numerous rugae. Testicles found inside the rugated zone are considered descended. In extreme prematurity the scrotum is flat, smooth and appears sexually undifferentiated. At term-to post-term, the scrotum may become pendulous and may actually touch the mattress when the infant lies supine. Note: In true cryptorchidism, the scrotum on the affected side appears uninhabited, hypoplastic and with underdeveloped rugae compared to the normal side, or, for a given gestation, when bilateral. In such a case, the normal side should be scored, or if bilateral, a score similar to that obtained for the other maturational criteria should be assigned.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
GENITALS (Male)	scrotum flat, smooth	scrotum empty faint rugae	testes in upper canal rare rugae	testes descending few rugae	testes down good rugae	testes pendulous deep rugae		

7. Genitals-Female

To examine the infant female, the hips should be only partially abducted, i.e., to approximately 45° from the horizontal with the infant lying supine. Exaggerated abduction may cause the clitoris and labia minora to appear more prominent, whereas adduction may cause the labia majora to cover over them.

In extreme prematurity, the labia are flat and the clitoris is very prominent and may resemble the male phallus. As maturation progresses, the clitoris becomes less prominent and labia minora become more prominent. Nearing term, both clitoris and labia minora recede and are eventually enveloped by the enlarging labia majora.

The labia majora contain fat and their size are affected by intrauterine nutrition. Overnutrition may result in large labia majora earlier in gestation, whereas undernutrition, as in intrauterine growth retardation or postmaturity, may result in small labia majora with relatively prominent clitoris and labia minora late into gestation. These findings should be reported as observed, since a lower score on this item in the chronically stressed or growth retarded fetus may be counter-balanced by a higher score on certain neuromuscular items.

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
GENITALS (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large minora small	majora cover clitoris & minora		

The sum total of all 12 criteria represents the neuromuscular and physical maturation of the fetus. When compared to the grid on the score sheet, the score denotes the infants gestational age by maturational examination.

Summary

The maturational assessment of gestational age is a clinical tool that may be influenced by certain biologic factors. A working knowledge of the assessment tool includes a knowledge of the standardized method for performing the exam, and an awareness of those intrauterine factors that influence the neuromuscular and physical maturational rates of the fetus. This approach increases the accuracy and validity of the tool and facilitates the examiner's understanding and interpretation of the score.

References for Using the New Ballard Score

1. Kretchmer N, Schumacher LB, Silliman K. Biological factors affecting intrauterine growth. *Seminars in Perinatology* 13:169-179, 1989.
2. Siddiqi TA, Miodovnik M, Mimouni F, Clark EA, Khoury JC. Biphasic intrauterine growth in insulin-dependent diabetic pregnancies. *J Am Coll Nutri* 8:225-234, 1989.
3. Secher NJ, Kern Hansen P, Lenstrup C, Pedersen-Bjergaard, Sindberg, Eriksen P. Birthweight for gestational age charts based on early ultrasound estimation of gestational age. *British Journal of Obstetrics and Gynaecology*. 93:124-134, 1986.
4. Ballard JL, Khoury JC, Wedig K, Wang L, Eilers-Walsman BL, Lipp R. The New Ballard Score, expanded to include extremely premature infants. *J Pediatr* 119:417-423, 1991.
5. Gould JB, Gluck L, Kulovich MV. The relationship between accelerated pulmonary maturity and accelerated neurological maturity in certain chronically stressed pregnancies. *Am J Obstet Gynecol* 127:181, 1977.
6. Amiel-Tison C. Possible acceleration of neurologic maturation following high-risk pregnancy. *Am J Obstet Gynecol* 138:303-306, 1980.
7. Field J. Handbook of Physiology, Section 1. *Neurophysiology*, Vol. II. Washington, D.C., American Physiology Society, p 1266, 1960,.
8. Allen MC, Capute AJ. Tone and reflex development before term. *Pediatrics* 85:393-399, 1990.
9. Damoulaki-Sfakianaki E, Robertson A, Cordero L. Skin creases on the sole of the foot as a physical index of maturity: Comparison between caucasian and negro infants. *Pediatr* 50:483-485, 1972.
10. Stevens-Simon C, Cullinan J, Stinson S, McAvarney ER. Effects of race on the validity of clinical estimates of gestational age. *J Pediatr* 115:1000-1002, 1989.
11. Streeter GI. Weight, sitting height, head size, foot length, and menstrual age of the human embryo. *Contrib Embryol* 11:143-170, 1920.
12. Hern WM. Correlation of fetal age and measurements between 10 and 26 weeks of gestation. *Obstet & Gynecol* 1984; 63:26-32.
13. Pearson AA. The development of the eyelids. Part I. External features. *J Anat* 130:33-42, 1980.
14. Carpenter G, Cohen S. Epidermal growth factor. *Ann Rev Biochem* 48:193-216, 1979.

New Ballard Score

NEUROMUSCULAR MATURITY

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
POSTURE								
SQUARE WINDOW (Wrist)	>90°	90°	60°	45°	30°	0°		
ARM RECOIL		180°	140°-180°	110°-140°	90°-110°	<90°		
POPLITEAL ANGLE	180°	160°	140°	120°	100°	90°	<90°	
SCARF SIGN								
HEEL TO EAR								
TOTAL NEUROMUSCULAR MATURITY SCORE								

Total Score _____

MATURITY RATING

score	weeks
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

PHYSICAL MATURITY

PHYSICAL MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
SKIN	sticky friable transparent	gelatinous red translucent	smooth pink visible veins	superficial peeling &/or rash, few veins	cracking pale areas rare veins	parchment deep cracking no vessels	leathery cracked wrinkled	
LANUGO	none	sparse	abundant	thinning	bald areas	mostly bald		
PLANTAR SURFACE	< heel-toe 40-50 mm:-1 <40 mm:-2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		
BREAST	imperceptible	barely perceptible	flat areola no bud	stippled areola 1-2 mm bud	raised areola 3-4 mm bud	full areola 5-10 mm bud		
EYE/EAR	lids fused loosely: -1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		
GENITALS (Male)	scrotum flat, smooth	scrotum empty faint rugae	testes in upper canal rare rugae	testes descending few rugae	testes down good rugae	testes pendulous deep rugae		
GENITALS (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large minora small	majora cover clitoris & minora		
TOTAL PHYSICAL MATURITY SCORE								

GESTATIONAL AGE (weeks)

By exam _____



**Bethesda North
Good Samaritan**



CORPORATE EDUCATIONAL SERVICES
619 OAK STREET
CINCINNATI, OHIO 45206