Med. J. Cairo Univ., Vol. 85, No. 2, March: 493-501, 2017
www.medicaljournalofcairouniversity.net

Motion Analysis of Postural Reactions in Normal Infants

MOHAMED A. RAFAT, M.Sc.*; KAMAL E. SHOUKRY, Ph.D.**; TAREK E. OMAR, Ph.D.*** and GEHAN M. ABD EL-MAKSOUD, Ph.D.**

The Department of Physical Therapy for Pediatrics & its Surgery, Faculty of Physical Therapy, Pharos University, Alexandria, The Department of Physical Therapy for Growth & Developmental Disorders in Children & its Surgery, Faculty of Physical Therapy, Cairo University** and the Department of Pediatrics, Faculty of Medicine, Alexandria University***, Egypt*

Abstract

Purpose: This study was conducted to describe postural reactions from sitting and standing positions through measuring the angles of neck, trunk, upper and lower limbs in normal infants at different ages using video motion analysis.

Subjects and Methods: Two hundred normal infants, who were selected from nurseries and day care centers in Alexandria, shared in this study. Their ages ranged from 6-18 months old. They were divided into four groups according to their ages. Group I: Their ages were ranged from 6 to 8 months old and their postural reactions were measured from sitting position. Group II: Their ages were ranged from more than 8 to 10 months old and their postural reactions were measured from sitting position. Group III: Their ages were ranged from 12 to 15 months old and their postural reactions were measured from standing position. Group IV: Their ages were ranged from more than 15 to 18 months old and their postural reactions were measured from standing position. Head righting angle, trunk righting angle, Rt. and Lt. shoulder displacement, Rt. and Lt. hip displacement for each participant were measured using Kinovea computer program three times by examiner. The gained measurements from Group I were compared with the gained measurement from Group II. The gained measurements from Group III were compared with the gained measurement from Group IV.

Results: Statistically significant differences were found between Group I and Group II regarding head righting angle, trunk righting angle, Rt. and Lt. shoulder angular displacement (p=0.0001, p=0.006, p=0.0001, p=0.001 respectively). Comparison between Group III and Group IV showed a significant difference of Rt. and Lt. shoulder angular displacement, Rt. and Lt. hip angular displacement (p<0.05), while there was no significant difference of head righting angle and trunk righting angle between Group III and Group IV (p=0. 192, p= 0.213 respectively).

Conclusion: It can be concluded that variability of postural reactions decrease with age.

Correspondence to: Dr. Mohamed A. Rafat, The Department of Physical Therapy for Pediatrics & its Surgery, Faculty of Physical Therapy, Pharos University, Alexandria, Egypt

Key Words: *Motion analysis – Postural reactions – Motor development – Infants.*

Introduction

REFLEXIVE movements are often visible in young infants. An infant does not think about making reflexive movements; they occur automatically. Some reflexes occur throughout the life span such as eye blinking, but others are present only during infancy. Infantile reflexes are categorized into three types of movements: Primitive reflexes, postural reactions, and locomotor reflexes [1]. These spontaneous movements have been identified as important in the development of motor control [2]. The primitive reflexes and the postural reactions constitute one of the earliest, simplest, and most frequently used tools among child neurologists, as well as developmental and general pediatricians all over the world to assess the central nervous system integrity of infants and young children [3].

Postural reactions include righting reactions, equilibrium reactions and protective reactions [4]. Righting reactions support positioning of the head vertically in space, alignment of head and trunk, and alignment of trunk and limbs. Equilibrium reactions provide balance when the centre of gravity is disturbed. They are more mature responses to regain balance than righting reactions, and include counter-rotation of the head and trunk away from the direction of displacement, and the use of the extremities. Protective reactions are required to prevent injury if the equilibrium reactions are unable to restore balance. Protective reactions emerge first to the front, then the side and then backwards [5].

Postural reactions are maturational motor skills that develop during the first year of life and form the basis for attainment of functional motor skills. These reactions automatically provide maintaining the body in an upright position through changes of muscle tone, in response to the position of the body and its parts. Postural reactions respond to more global stimuli than primitive reflexes and last for a lifetime, in order to support movement and balance [6].

Various researchers have considered the assessment of postural reactions as an important tool to assess the integrity of CNS in children with neurological disorders [7]. Assessment of postural reactions can be done on a newly developed assessment system which called the postural reaction score sheet [5]. Also, there are a considerable number of developmental scales, developmental screening tests and motor assessment instruments which more or less cope with the evaluation of motor development in either term or preterm infants and young children and include a variable number of primitive reflexes or postural reactions as items [8].

The human motion analysis is the process in which the configuration of body parts is estimated from sensor input. Traditionally, motion capture systems require the attachment of (electromagnetic) markers to the body. These systems have two major drawbacks: They are obtrusive and expensive [9].

Vision-based motion capture systems attempt to provide such a solution, using cameras as sensors. Over the last two decades, this topic has received much interest, and it continues to be an active research domain [10].

One of the uses of human motion analysis is traditional gait analysis aiming to provide medical diagnosis and treatment support. Some other applications of vision-based motion analysis lie in personalized training systems for various sports, medical diagnostics of orthopedic patients, choreography of dance and ballet, etc. [11-13].

There is a lack of studies which assess postural control in children by means of scales and functional tests, as well as exploring postural control during daily functional activities. The majority of studies assessed postural control in static standing posture [14].

The purpose of this study was to describe postural reactions from sitting and standing positions through measuring the angles of neck, trunk, upper and lower limbs in normal infants at different ages using video motion analysis.

Subjects and Methods

A cross sectional study was approved by Ethics Review Committee of the Faculty of Physical Therapy, Cairo University. The study was conducted from August 2015 to September 2016. Parents signed a consent form authorizing the participation of their infants in this study.

Two hundred normal infants from both sexes, their ages were ranged from 6 to 18 months old, seleted from nurseries and day care centers from Alexandria and Damietta. The infants were excluded from the study if they had: A) Chest infection at time of evaluation; B) Fever at time of evaluation; C) Surgical intervention (e.g., orthopedic, neurologic, or heart surgery); or their mothers had no history of major maternal health problems (e.g., diabetes, epilepsy, drug, or alcohol abuse).

The infants were categorized into four groups of equal number according to their ages:

Group I: Their ages were ranged from 6 to 8 months old and their postural reaction was measured from sitting position.

Group II: Their ages were ranged from more than 8 to 10 months old and their postural reaction was measured from sitting position.

Group III: Their ages were ranged from 12 to 15 months old and their postural reaction was measured from standing position.

Group IV: Their ages were ranged from more than 15 to 18 months old and their postural reaction was measured from standing position.

Instrumentation:

- Balance board used for disturbing the infant's position whether sitting or standing.
- Non-reflective markers placed on the infant's anatomical landmarks.
- Tape measurement to measure the distances from the infant and the video camera.

- Video camera used for recording the postural reactions of each infant.
- Computer with installed Kinovea software.

Procedures:

1- Infant preparation:

Each infant's trunk, upper and lower extremities was uncovered by his/her caregiver, and then the markers were placed on the following anatomical landmarks:

- *Head:* Nose and chin.
- *Trunk:* Sternal notch and xyphoid process.
- *Upper extremity:* Acromion and the midpoint between the lateral and medial humeral epicondyles.
- *Lower extremity:* Greater trochanter and the center of patella.

Finally, all markers were removed after recoding postural reactions for each infant.

2- Video camera preparation:

One digital video camera (Sony HDR-CX190) was used to record infant's postural reactions. This camera was mounted on a tripod and positioned 100cm above the floor and 1.5 meter away from the center of infant body to maximize the size of the infant and provide a full view of the infant reactions without using zoom. A clear vertical reference, such as a plumb line, must be recorded after the camera set-up has been completed [15].

3- Video recording process:

In this process, the therapist elicited the postural reactions from sitting and standing positions using the balance board. The infant's reaction to the side to side disturbance was recorded. The therapist performed three consecutive trials to elicit the reactions for each infant to ensure that the best response was recorded. Therapist recorded a vertical reference that already put at the background of the recorded view to enable a true vertical frame of reference.

4- Data collection and analysis:

The therapist transferred the recorded infant's reactions from the video camera to the computer using storage device card. The recorded video was converted to images using free video to JPG converter program; the program settings were changed to convert the infant's three trials video to multiple frames (500 frames for each one second). The joint angular displacement was measured from the video recorded from the frontal plane (head righting, trunk righting, shoulder displacement and hip displacement). The best three images that showed the maximum infant's reaction was chosen. These three images were analyzed using Kinovea program. The reflected dots were connected by straight lines. The intersected joints between adjunctive lines were measured and calculated automatically. Then, the mean of angle in the three selected images was taken for analysis. The angles determined from the frontal plane were:

- *Head righting angle:* It is the angle between line of nose to chin and the vertical line as shown in Fig. (1).
- *Trunk righting angle:* It is the angle between line of sternal notch to xyphoid process and the vertical line as shown in Fig. (2).
- *Shoulder joint angular displacement:* Shoulder joint angular displacement was calculated by subtraction of the angle of initial position (A) from the angle after reaction (B). This angle was between line of acromion to lateral epicondyle of humerus and the horizontal line between right and left acromion as shown in Fig. (3A,B).
- *Hip joint angular displacement:* Hip joint angular displacement was calculated from subtraction of the angle of initial position (A) from the angle after reaction (B). This angle was between line of greater trochanter to center of patella and the horizontal line between right and left greater trochanters as shown in Fig. (4A,B).

Statistical analysis:

By the use of SPSS 23, age, head righting angle, trunk righting angle, Rt. and Lt. shoulder angular displacement, Rt. and Lt. hip angular displacement means were reported as means and (SD). Categorical variable (i.e. Gender) were reported as percent of the sample. Independent *t*-test was used for comparison of means of the measured variables (head righting angle, trunk righting angle, Rt. and Lt. shoulder angular displacement) between Group I and Group II and also between Group III and Group IV. *p*-value of less than 0.05 was considered significant.

Fig. (1): Head righting angle.

Fig. (2): Trunk righting angle.

(A)


(B)

Fig. (3): Shoulder joint angular displacement. (A) The angle at initial position, (B): The angle after reaction.

(A)


(B)

Fig. (4A,B): Hip joint angular displacement. (A) The angle at initial position. (B) The angle after reaction.

Results

A total of 200 normal infants were examined for inclusion in the final data analysis. They were divided into four groups according to their age. Each group included 50 participants. The mean age of Group I and II were 7.2 and 8.99 months respectively. The mean age of Group III and IV were 13.04 and 16.7 months respectively. According to gender, Group I included 64% boys and 3 6% girls, while Group II included 68% boys and 32% girls. Participants in Group III were 62% boys and 38% girls while in Group IV were 58% boys and 42% girls (Table 1).

Independent *t*-test revealed statistically significant difference between Group I and Group II regarding head righting angle, trunk righting angle, Rt. and Lt. shoulder angular displacement (p= 0.0001, p=0.006, p=0.0001, p=0.001 respectively) as shown in (Table 2).

Comparison between Group III and Group IV using independent *t*-test showed a significant difference of Rt. and Lt. shoulder angular displacement, Rt. and Lt. hip angular displacement (p= 0.000 1, p=0.033, p=0.007, p=0.026 respectively). On the other hand, there was no significant difference of head righting angle and trunk righting angle (p=0. 192, p=0.213 respectively) as represented in (Table 3).

Table (1): Demographic characteristics of participants in the four groups.

Items/ groups	Group I (n=50)	Group II (n=50)	Group III (n=50)	Group IV (n=50)
Age (months)a	7.2±0.75a	8.99±0.71	13.04±0.86	16.7±1.29
Gender:				
Girlsb	(18) 3 6%b	(16) 32%	(19) 38%	(21) 42%
Boysb	(32) 64%b	(34) 68%	(31) 62%	(29) 58%

a: Values are mean ± standard deviation.
b: (Frequency) percentage.

Table (2): Statistical analysis of all measured variables between Group I and II.

Parameters	Group I	Group II	*t*-value	*p*-value
• Head righting angle (degrees).	4.00±2.88a	1.36±0.98	6.12	0.0001*
• Trunk righting angle (degrees).	2.28±2.80	1.10±0.86	2.84	0.006*
• Right shoulder displacement angle (degrees).	26.3±9.9	5.7±3.2	13.95	0.0001*
• Left shoulder displacement angle (degrees).	8.92±4.85	2.12±3.21	8.26	0.001*

a : Values are mean ± standard deviation.
t : Independent *t*-test.
* : Significant at p<0.05.

Table (3): Statistical analysis of all measured variables between Group III and IV.

Parameters	Group III	Group IV	*t*-value	*p*-value
• Head righting angle (degrees).	1.54±1.68a	1.18±0.96	1.341	0.192NS
• Trunk righting angle (degrees).	1.72±1.35	1.42±1.01	1.25	0.213NS
• Right shoulder displacement angle (degrees).	23.82±8.84	12.8±4.37	7.866	0.0001*
• Left shoulder displacement angle (degrees).	10.72±4.13	8.84±4.53	2.165	0.033*
• Right hip displacement angle (degrees).	9.76±2.96	8.14±2.96	2.73	0.007*
• Left hip displacement angle (degrees).	6.20±3.21	4.82±2.89	2.26	0.026*

a : Values are mean ± standard deviation.
t : Independent *t*-test.
* : Significant at p<0.05.
NS : Non Significant.

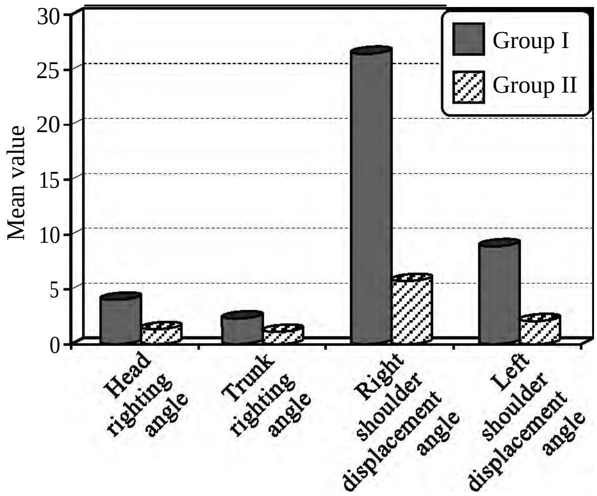

Fig. (5): Mean values of all measured variables (degrees) of infants in Group I and II.

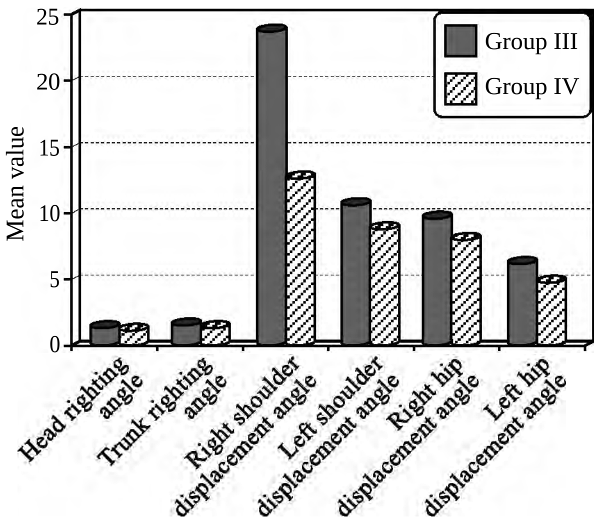

Fig. (6): Mean values of all measured variables (degrees) of infants in Group III and IV.

Discussion

The objective of the current study was to describe postural reactions through measuring the angles of neck, trunk, upper and lower limbs in normal infants at different ages using video motion analysis in sitting and standing positions.

Postural reactions provide automatic support and stability to head, trunk and extremities and facilitate normal weight shift and mobility [16]. They function to keep the head aligned vertically during movement, to provide balance and postural shift mechanisms when the center of gravity is disturbed, and to establish protective responses to prevent a fall during rapid movements [17].

Relatively little research to date has examined prospective postural control in infants. Efficient voluntary action requires postural adjustments that compensate for potential balance disturbances before they occur. These anticipatory postural adjustments have been widely investigated in adults, but relatively little is known about their development, especially during infancy [18].

Selection of the video motion analysis as a method of assessment was supported by Westcott et al., [19] who stated that video goniometry as one of the biomechanical systems to evaluate the postural stability in children. Moreover, Vander Linden et al., [20] who studied the reproducibility and accuracy of angle measurements obtained under static conditions with motion analysis video system.

In the current study statistically significant difference was observed between Group I and Group II regarding head righting angle, trunk righting angle, Rt. and Lt. shoulder angular displacement. This result may be due to increase the maturation of brain with age. Stiles and Jernigan [21] stated that "although the production and migration of neurons are largely prenatal events, surprisingly, proliferation and migration of glial progenitors continues for an extended period after birth". This development of brain tissue will lead to more control on the righting reaction of head and trunk which lead to decrease of the righting angle while the infant's age increases.

Also, the findings of this study may be due to the development of visual system. The human visual system components from the eye to neural circuits, develops largely after birth, especially in the first few years of life. The righting of head depends on the sensory input whether vestibular input or visual input. When the visual system connections increased the postural reactions will change through the first year of infant's life. This point of view is supported by Cech and Martin [22] who discussed that vision becomes more important as the system matures, as evidenced by more successful reaching with vision in the 7-month-old. The ability to use visual information for postural responses increased from 5 to 9 months of age.

The results of the present study concerning head and trunk righting angles may be contributed to the increase in the maturation of vestibular and somatosensory systems over time. Vestibular and somatosensory systems can also trigger balance responses in infants and toddlers in sitting during assessing the development of postural responses during infancy. Head righting develops during the first year in response to gravity's effect on the vestibular system and through the body's contact with the supporting surface. Vestibular sensitivity increases from birth to a peak between 6 and 12 months of age. After this peak, there is a decline to $2\,{}^{1}/_{2}$ years and a more gradual decline to puberty. Infants are more sensitive to vestibular input and that oversensitivity may explain their relative unsteadiness. The slow maturation of vestibular sensitivity is a result of changes in synaptic strength and connectivity in the brainstem and higher centers [23]. Similarly, Cech and Martin [22] reported that maturation of the vestibular system contributes to postural control and general motor development through its contributions to developmental reflexes, such as the Moro and head righting. The vestibular system is mature in the full-term newborn, but modifications and growth in the synapses and dendrites of the vestibular pathways continue until puberty as the child learns to move and adapts to his or her changing body size and shape [24]. They added that vestibular, visual and auditory senses are capable of some level of function at birth but require additional time and environmental experience to complete myelination and maturation of central pathways.

Increased head and trunk righting angles in Group I than in Group II may be explained from the biomechanical point of view. The COG is higher in infants because of their larger heads and shorter extremities, resulting in a greater rate of postural sway. The higher COG means less stability and vice versa. This means the infants at their first months have less control to their position after disturbance of their balance. Also, small length of infant's upper extremities makes it difficult for the infant to reach the balance board for protecting himself. This may explain why they did a substitution by their trunks to reach the balance board by their other hands.

In this study, the disturbance of balance was performed in both sides but, the infant's reaction to disturbance to the left side was taken for analysis. So, the Rt. shoulder displacement was the equilibrium reaction and the Lt. shoulder displacement was the protective reaction.

Higher Rt and Lt. shoulder displacement angles in Group I than in Group II may be related to the large head of infant in relation to his body length which responsible for the easiness of falling down followed by protective and equilibrium reactions from the shoulder girdle to keep the infant's COG within the BOS. With lateral or side to side disturbance of those infant on balance board they shift to one side, they did more shoulder displacement to protect themselves (Lt. shoulder) and to return themselves to the initial balancing position (Rt. shoulder). Also, this finding can be explained by Cech and Martin [22] who discussed that "righting or equilibrium reactions are produced in response to weight shifts within the BOS. When the COM moves out of the BOS, as in a slip or fall, additional automatic postural responses occur. An unexpected perturbation on a force platform is an example of reactive postural control or balance. In this case, the movement of the platform shifts the person's COM resulting in the need for a postural adjustment".

Non-significant difference of head and trunk righting angles between Group III and Group IV may be due to complete development of righting reactions. Those reactions begin at birth and exhibit peak occurrence at 10 to 12 months. This point of view is supported by Solomon and O'Brien [25] who stated that the age of onset of integration of head righting in standing is 12 months and continues throughout life. That is explaining the increase of head and trunk control by aging lead to emerging of the righting reactions.

Equilibrium reactions begin to appear at 6 months of age in the prone position, even as the infant is experiencing supported sitting. The remaining equilibrium reactions appear in an orderly sequence: Prone, supine, sitting, quadruped, and standing. The maturation of the reactions in these postures lags behind the attainment of movement in the next higher developmental posture.

Significant difference of Rt. and Lt. shoulder angular displacement, Rt. and Lt. hip angular displacement of postural reactions from standing position between Group III and Group IV was gained. The angular displacement of shoulder and hip joint at both sides in response to the disturbance were decreased with age. These findings may be due to a high guard position of arms. Because the newly erect infant's center of gravity is relatively high (T12 compared with L5-S 1 in an adult), the BOS is wide. The center of gravity is also forward due to a large liver. For the upper trunk to achieve a vertical position, the lumbar lordosis is increased, and the arms are brought into a high guard position. Also, the infant's sensory system had exposed to various tilting positions throughout the whole previous months. This multiple repetitions increase the infants' ability to maintain their erect stable posture despite the amount of tilting.

The findings of the present study in sitting and standing position may be the results of the development, maturation and more experience that gained with the increase of age. With further development, the circuitry matures, and with experience, the initial variability is reduced. The temporal and spatial features of responses are fine turned to match task-specific demands. According to the neuronal group selection theory, experience continues to shape postural networks by changing the synaptic strength of intergroup and intragroup connections [26].

Conclusion:

It can be concluded that, variability in postural reaction of infants is reduced with increasing the age which indicates maturation and development of many systems responsible for postural reactions.

References

1- HAYWOOD K. and GETCHELL N.: Life span motor development, early motor development, 6 th ed, Champaign, IL, Human Kinetics publishing, 105-6, 2014.

2- PIEK J.: Infant motor development, early movement capabilities, human kinetics publishing, (10): 4-17, 2006.

3- MENKES J., SARNAT H. and MOSER F.: Textbook of child neurology, Neurological examination of the child and infant, Philadelphia: Lippincott-Williams and Wilkins, (6): 1-32, 2000.

4- ALEXANDER R., BOEHME R. and CUPPS B.: Normal development of functional motor skills, The first year of life, Tucson, AZ: Therapy Skill Builders, 202-10, 1993.

5- BATRA M., SHARMA V.P., BATRA V., et al.: Postural reactions: An elementary unit for development of motor control, Disability, CBR and Inclusive Development Journal, (22): 134-7, 2011.

6- ALEXANDER R., BOEHME R. and CUPPS B.: Normal development of functional motor skills: The first year of life, Tucson, Therapy Skill Builders, 25-30, 1993.

7- ZAFEIRIOU D.: Primitive reflexes and postural reactions in the neurodevelopmental examination, Journal of Pediatric Neurology, (31): 1-8, 2004.

8- SCHERZER A.: Diagnostic approach to the infant, Early diagnosis and interventional therapy in cerebral palsy, 3rd ed, New York, Marcel Dekker, 49-94, 2000.

9- AGGARWAL J. and CAI Q.: Human motion analysis: A review, Computer Vision and Image Understanding, (3): 428-40, 1999.

10- POPPE R.: An overview: Vision-based human motion analysis, Computer Vision and Image Understanding, (108): 4-18, 2007.

11- MEYER D., DENZLER J. and NIEMANN H.: Model based extraction of articulated objects in image sequences for gait analysis, Proceedings of the IEEE International Conference on Image Processing, 78-81, 1997.

12- TOHLE M.K., MERKL D. and KASTNER J.: Clinical gait analysis by neural networks: Issues and experiences, Proceedings of the IEEE Symposium on Computer-Based Medical Systems, 138-43, 1997.

13- LAKANY H.M., HAYCS G.M., M. HAZLEWOOD, et al.: Human walking: Tracking and analysis, Proceedings of the IEE Colloquium on Motion Analysis and Tracking, 5-14, 1999.

14- PAVAO S., NEVES DOS SANTOS A., WOOLLACOTT M. and ROCHA N.: Assessment of postural control in children with cerebral palsy: A review, Research in Developmental Disabilities, (34): 1367-75, 2013.

15- PAYTON C.J.: Motion analysis using video, Biomechanical evaluation of movement in sport and exercise, The British Association of Sport and Exercise Science guide, first edition, Routledge, 8-9, 2008.

16- BARNES M.R., CRUTCHFIELD C.A. and HERIZA C.B.: The Neurophysiological Basis of Patient Treatment: Reflexes in Motor Development, Morgantown, Stokesville Publishing Co., 1978.

17- CHANDLER L.: Gross and fine motor development. In Cohen MA, Gross PJ (eds): The Developmental Resource-Behavioral Sequences for Assessment and Program Planning, New York, NY, Grune & Stratton Inc., 119-53, 1979.

18- WITHERINGTON D.C., VON HOFSTEN C., ROSANDER K., ROBINETTE A., WOOLLACOTT M.H. and BERTENTHAL B.I.: The development of anticipatory postural adjustments in infancy, Journal of Infancy, (3): 495-517, 2002.

19- WESTCOTT S.L., LOWES L.P. and RICHARDSON P.K.: Evaluation of postural stability in children: Current theories and assessment tools, Physical Therapy Journal, (77): 629-45, 1997.

20- VANDER LINDEN D.W., CARLSON S.J. and HUBBARD R.L.: Reproducibility and accuracy of angle measurements obtained under static conditions the motion analysis video system, Physical Therapy Journal, (72): 300-5, 1992.

21- STILES J. and JERNIGAN T.L.: The basics of brain development neuropsychology review, (20): 327-48, 2010.

22- CECH D.J. and MARTIN S.T.: Functional movement development across the life span, 3 rd ed, Philadelphia, Saunders Elsevier, 263-84, 2012.

23- ELIOT L.: What's going on in there? How the brain and mind work the first five years of life, New York, Bantam, 154-60, 1999.

24- TECKLIN J.S.: Pediatric Physical Therapy, 4 th ed, Philadelphia, Lippincott Williams and Wilkins, 115-9, 2008.

25- SOLOMON J.W. and O'BRIEN J.C.: Pediatric skills for occupational therapy assistants, 4 th ed, Missouri, Elsevier, 80-4, 2016.

26- HADDERS-ALGRA M.: The neuronal group selection theory: A framework to explain variation in normal motor development, Developmental Medicine and Child Neurology, (42): 566-72, 2000.

التحليل الحركى لردود الآفعال الوضعية عند الآطفال الرضع

تهدف هذه الدراسة إلى وصف ردودو الآفعال الوضعية عند الآطفال الرضع من وضعى الجلوس والوقوف، من خلال قياس زوايا العنق والجزع ومفصلى الكتف والفخذ عند آعمار مختلفة ومحددة، بإستخدام التحليل الحركى ثنائى الآبعاد.

آجريت هذه الدراسة من آغسطس ٢٠١٥ حتى سبتمبر ٢٠١٦ على ٢٠٠ طفل رضيع من كلا الجنسين، تم تقسيمهم إلى آربع مجموعات طبقا لآعمارهم:

- المجموعة الآولى (آ): تراوحت آعمارهم من ٦ إلى ٨ شهور.
- المجموعة الثانية (ب): تراوحت آعمارهم من آكثر من ٨ إلى ١٠ شهور.
- بينما تراوحت آعمار الآطفال فى المجموعة الثالثة (ج) من ١٢ إلى ١٥ آشهر.
- وفى المجموعة الرابعة (د): تراوحت آعمارهم من ١٥ إلى ١٨ آشهر.

قد تم تصوير قياس ردود الآفعال الوضعية من وضع الجلوس للآطفال فى المجموعتين الآولى والثانية (آ، ب) بينما تم القياس من وضع الوقوف للآطفال فى المجموعتين (ج،د). وقد تم إستخدام برنامج كينوفيا Kinovea لقياس زاوية إستعدال الرآس والجذع والتغير الزاوى لمفصلى الكتف فى المجموعتين الآولى والثانية (آ،ب) بالإضافة لقياس التغير الزاوى لمفصلى الفخذ فى المجموعتين الثالثة والرابعة (ج،د).

آظهرت نتائج هذه الدراسة فروق ذات دلالة إحصائية عالية فى زاوية إستعدال الرآس والجذع والتغير الزاوى لمفصلى الكتف بين المجموعتين الآولى والثانية (آ،ب). وعند مقارنة المجموعتين الثالثة والرابعة (ج،د) وجد فرق ذو دلالة إحصائية عالية بين المجموعتين فى التغير الزاوى لمفصلى الكتف والفخذ بينما لا يوجد فروق ذو دلالة إحصائية بين هاتين المجموعتين فى زاوية إستعدال الرآس والجذع.

ويمكن آن نستنتج من هذه الدراسة آن تطور ردود الآفعال الوضعية وعدم وجودإختلافات واضحة فى زاوية إستعدال الرآس والجذع وكذلك التغير الزاوى لمفصلى الكتف والفخذ مع زيادة آعمار هؤلاء الآطفال.

Analysis of the postural control revealed a lower performance in maintaining the upright position from time domain point of view in Down syndrome group, as well as a low reaction time and voluntary direction control in DS subjects compared to unchallenged ones. 4. Discussions and conclusions. Evaluation of equilibrium is based on evaluating independently the three sensory systems involved in balance (somatosensory, visual and vestibular ones) and also to evaluate their congruency and central integration.Â Postural reactions in infants with Down syndrome. Relationship to motor milestone development and age. Physical Therapy, 66(1), 17-22. Haley, S. M. (1987).Â Normal development of movement and function: Neonate, infant, and toddler. In Physical Therapy. I. 2. What does the slope of a speed vs. time graph indicate about an objectâ€™s motion? Questions 3 -8 refer to the following generic graph shapes. Write the letter corresponding to the appropriate graph in the blank at the left of each question. BCDE / -. 3. Which shape fits a distance vs. time graph of an object moving at constant (non-zero) speed? Motion Analysis of Postural Reactions in Normal Infants. Mohamed A. Rafat, Kamal El-Sayed Shoukry, Tarek El-Sayed Ismail Omar, Gehan M. Abd El-Maksoud. 2017. Articulated human pose estimation in images and video. Aichun Zhu. 2016.