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Original Research Article

A STUDY TO ANALYZE THE RELATIONSHIP BETWEEN THE BODY WEIGHT AND MUSCLE TONE WITH AMIEL-TISON ANGLES IN PRETERM INFANTS FROM 32 WEEKS TO 40 WEEKS OF CORRECTED GESTATIONAL AGE

Arockia Pramila.C [1], Rajeswari.M *[2].

[1] Physiotherapist, Sri Ramachandra University, Porur Chennai, Tamilnadu, India.

*[2] Assistant professor, Sri Ramachandra University, Porur Chennai,Tamilnadu, India.

ABSTRACT

Background: Periodical neurological and neuro developmental assessment is necessary to identify the subtle deficits in preterm infants (PTI). Muscle tone assessment is an integral part of the neurological evaluation which is widely assessed by Amiel-Tison angles (ATA). Passive muscle tone depends on the passive extensibility of muscles which is influenced by size and length of muscle fibers that contributes for body weight. This study aims to analyze the relationship between body weight and muscle tone in PTI from 32 to 40 weeks of corrected gestational age (CGA).

Materials and Methods: This Cross-sectional study was carried out in 22 PTI with CGA of 32 weeks and 23 fullterm infants (FTI) who met the inclusion criteria and were recruited from the Neonatal intensive care unit and postnatal wards. The PTI were assessed for body weight and ATA with Goniometer at 32 weeks ± 2days, 34weeks ±2days and 40 weeks ±2days of CGA. 23 Term infants were assessed within 2 to 4 days of birth for body weight and ATA.

Results: Pearson's correlation was used to analyze the relationship between body weight and muscle tone in PTI from 32 to 40 weeks of CGA and in FTI. The results showed a negative correlation between body weight and Muscle tone in PTI with a significant p value <0.05.

Conclusion: The study concludes that there is an influence of body weight on ATA in PTI which conveys that increased body weight reduces the extensibility of the muscles and thereby reducing the ATA and vice versa. The result emphasizes that clinicians should consider body weight while identifying and interpreting subtle tonal abnormalities and initiating early intervention in the initial period of PTI.

KEY WORDS: Preterm, Passive Extensibility, Amiel Tison angles, Goniometer, Relationship

Address for correspondence: Rajeswari. M, Assistant Professor, Faculty of Physiotherapy, Sri Ramachandra University, Porur, Chennai 600116, Tamilnadu, India. Phone: +919841417473.
E-Mail: rajeswarim2001@gmail.com

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INTRODUCTION

The World Health Organization (WHO) defined Preterm as babies born alive before 37 weeks of pregnancy are complete. In 2010, 14.9 million preterm babies were born among 135 million live births across the world wide out of which 60% of Preterm birth occurred in sub-Saharan Africa and South Asia [1].

Preterm birth, being an important perinatal health problem across the globe is the leading cause of neonatal mortality and morbidity in both high and low income countries which accounts for about 35% of neonatal death in 2014 in India [2,3]. Preterm birth has imposed not only a large burden of mortality but also long term physical, mental health and neuro developmental impairment throughout later life across worldwide [4]. Risk of developmental deficits are found to be high in PTI compared to term birth children though mortality and morbidity rates have significantly reduced due to the progress in neonatology [5].

Maturation of the foetus undergoes rapid changes in the last trimester where cerebral maturation brings about the maturation of autonomic system, tactile, vestibular, gustation, hearing and vision [6]. Once the autonomic stability is achieved the development of motor system starts to occur. Motor system includes maturation and development of muscle tone, movement and reflexes. Cerebral maturation brings about continuous modification of muscle tone in the last trimester of fetal life [7]. At 28 weeks of gestation muscle tone remains flaccid and as infant reach 40 weeks tone increases in caudo cephalic direction and form the flexor hyper tonicity. Infant born as Preterm is flaccid and as they reach term, their flexor tone increases but even at term age PTI tend to have decreased flexor tone compared to FTI [8].

Preterm birth results in an interruption of maturation which leads to several developmental problems like retinopathy of prematurity, auditory, autonomic, motor and sensory impairments [9-12]. According to Lubchenco method Preterm infants can be classified according to their size and weight for gestational age as Small for gestational age (SGA), Appropriate for gestational age (AGA), Large for gestational age (LGA) which has an impact on the neuromotor development [13]. PTI are always assessed for development with corrected age (CA) which refers to the age calculated from the expected date of delivery and not from date of birth. Corrected Gestational age (CGA) refers to the corrected age of a PTI until they reach the expected date of delivery.

Clinicians face difficulty in identifying the PTI who are liable to develop motor deficits and determine the time for intervention in early development. Assessment of muscle tone is an integral part of neurological examination. It includes the study of the resting posture, primitive and righting reflexes, passive tone and active tone [14]. Passive tone is determined by angle of flexion, resistance to extension and passive recoil. Extensibility of muscle reflects the passive tone. The amount and arrangement of connective tissues of the muscle belly and the size and length of muscle fibres influence the passive extensibility of muscles. The amount of contractile and non contractile proteins which has a major contribution for body weight influence the resistance to muscle lengthening [15] and so it is suggested that body weight can also influence the assessment of passive tone.

Amiel-Tison has provided a comprehensive examination for preterm babies in which interpretation of muscle tone is an important feature of examination where ATA are used to assess muscle tone which is found to have excellent reliability [16,17]. Normally ATA are increased in Preterm due to maturation related hypotonia and decreases as the PTI reaches term. Since extensibility of muscles could be influenced by body weight which in turn can indirectly affect the passive tone evaluation as the PTI grows, the relationship of body weight and Amiel-Tison angles need to be evaluated to interpret appropriately and identify the subtle tonal deviations at an early age to initiate intervention.

MATERIALS AND METHODS

This cross sectional study involves preterm newborns of 32 weeks of CGA and FTI as subjects to analyze the relationship between body weight and muscle tone with ATA. This study has been approved by the Ethics committee (CSP/14/AUG/36/149), Sri Ramachandra University.

The subjects were recruited from the Neonatal intensive care units, Post natal wards of Sri Ramachandra Medical Center and Hospital. 22 PTI at 32 weeks of CGA and 23 FTI of both genders with normal ultrasound cranium were included in the study. Subjects who were on mechanical ventilation, had musculoskeletal impairments of lower limbs, neurological impairments and congenital deformities were excluded from the study.

PROCEDURE:

Preterm Infants: PTI at 32 weeks of CGA who were hemodynamically stable and met the inclusion criteria were taken as the subjects for the study. The first assessment was done at 32 weeks preterm or at CGA if the infant is born <32 weeks. Weight of the child was measured in kilograms at every assessment. Muscle tone was evaluated by ATA using goniometer by measuring the following angles- Adductor, Heel to Ear and Popliteal. Three assessments were done at specific CGA.

Assessment	Time of assessment
I	32weeks ± 2days
II	34weeks ± 2days
III	40 weeks ± 2days

Term infants: Twenty three FTI who met the criteria were assessed within 2 to 4 days of birth for body weight and ATA.

Method of measuring the angles: Initial assessment and follow up assessment was done by the same assessor. The child was assessed inside the incubator or warmer without clothing, the follow up assessment of preterm infant at 34 and 40 was done in the hospital and if discharge, was done in the Child Development Unit when they returned back for review. Goniometer was cleaned with sterilium before and after every assessment. The following method was adopted to measure the ATA.

Adductor angle: Infant is placed in supine position, knees were extended and hips gently abducted. The fulcrum of the goniometer is positioned at symphysis pubis and angle is measured between imaginary lines drawn along the both inner aspect of thigh. If this angle is divided, the two angles should be relatively equal.

Heel-to-ear: Infant in the supine position with both legs extended and then moved toward the head. The angle is measured from the surface of table along the back of the leg and pelvis should not lift from the table.

Popliteal angle: Infant in the supine position with the buttocks on the table surface. With the hands placed over the child's knees, the thighs are flexed laterally and then the lower leg is extended. The angle is measured between the thigh and calf. Both legs are measured simultaneously.

METHODOLOGY FLOW CHART

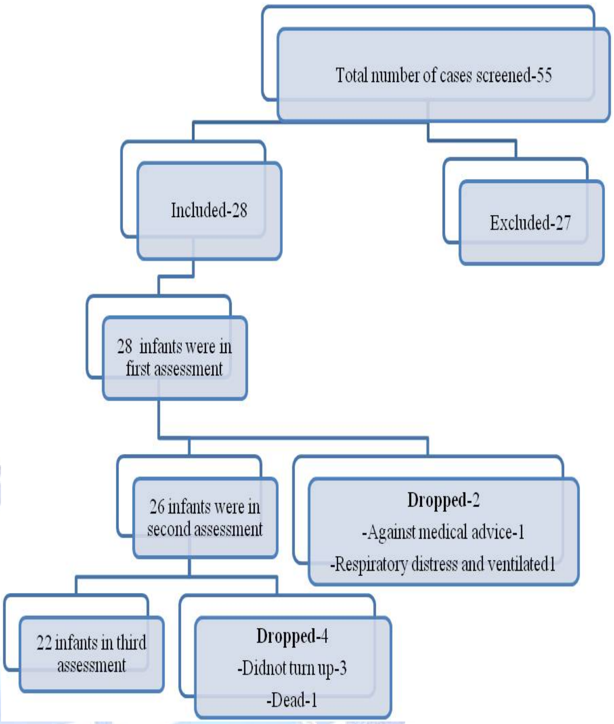
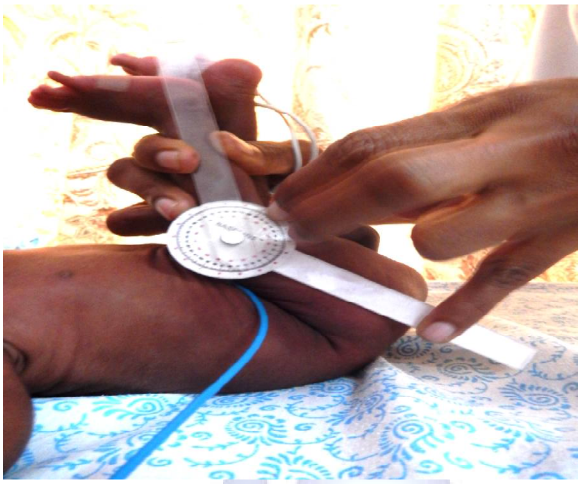


Fig. 1: Showing the Goniometer.

Fig. 2: Showing the measurement of adductor angle.

Fig. 2: Showing the measurement of hell to ear angle.

Fig. 3: Showing the measurement of popliteal angle.



RESULTS

Table 1: Correlation of body weight and ATA in PTI at 32, 34 and 40 weeks CGA.

CATEGORY	AMIEL-TISON ANGLES	N	MEAN	SD	r value (CORRELATION WITH BODY WEIGHT)	p value
BODY WEIGHT (32 W) Mean=1206.36 SD = 254.47	ADDUCTOR ANGLE (32 W)	22	148.36	11.24	-0.904	.000*
	HEEL TO EAR (32 W)		148.5	8.529	-0.905	.000 *
	POPLITEAL ANGLE (32 W)		149.77	10.461	-0.866	.000 *
BODY WEIGHT (34 W) Mean=1504.77 SD = 309.16	ADDUCTOR ANGLE (34 W)		132.09	10.392	-0.929	.000*
	HEEL TO EAR (34 W)		128.77	7.432	-0.967	.000 *
	POPLITEAL ANGLE (34 W)		131.82	6.076	-0.952	.000 *
BODY WEIGHT (40W) Mean=2067.95 SD = 2067.95	ADDUCTOR ANGLE (40 W)		96.95	10.339	-0.921	.000*
	HEEL TO EAR (40 W)		107.41	8.099	-0.763	.000 *
	POPLITEAL ANGLE (40 W)		111.77	7.184	-0.785	.000 *

Table 2: Correlation of Birth Weight and ATA in PTI at 40 weeks and FTI.

CATEGORY	AMIEL-TISON ANGLES	N	MEAN	SD	r value (CORRELATION WITH BODY WEIGHT)	p value
BIRTH WEIGHT (PT) 1142.27(mean) 261.787(SD)	ADDUCTOR ANGLE	22	96.95	10.339	-0.433	.044 *
	HEEL TO EAR		107.41	8.099	-0.426	.048 *
	POPLITEAL ANGLE		111.77	7.184	-0.404	0.062
BIRTH WEIGHT (FT) 3073.87(mean) 362.336 (SD)	ADDUCTOR ANGLE	23	71.3	9.441	-0.871	.000 *
	HEEL TO EAR		97.7	7.437	-0.586	.003 *
	POPLITEAL ANGLE		97.48	6.059	-0.632	.001 *

Data were analyzed with SPSS version 16.0. Pearson correlation was used to find out the correlation between the body weight and ATA in PT and FT infants. Table 1 shows the mean, standard deviation, r value and p value of body weight and ATA (Adductor angle, Heel to Ear, Popliteal angle) of PTI at 32, 34 and 40 weeks of CGA which shows a negative correlation with statistically significant p value <0.05. Table 2 shows correlation of Birth Weight and AT angles in PTI at 40 weeks of CGA which shows a significant negative correlation in Adductor and Heel to ear angles at p value <0.05 but not in Popliteal angle whereas Correlation of Birth Weight and AT angles in FTI shows a negative correlation in all three angles

Table 3 shows the negative correlation of Body Weight and Birth weight with ATA in PTI of AGA at 40 weeks of CGA in Adductor and Popliteal angle at p value <0.05 but not in Heel to ear in body weight whereas it does not have significant correlation in birth weight. Table 4 shows negative correlation of Body Weight and Birth weight with ATA in PTI of SGA at 40 weeks of CGA at p value <0.05 in body weight but does not correlate with birth weight.

Table3: Correlation of body weight and birth weight with ATA in PTI AGA 40 weeks of CGA.

CATEGORY	AMIELTISON ANGLES	N	MEAN	SD	r value (CORRELATION WITH BODY WEIGHT)	p value
BIRTH WEIGHT 1264.38(mean) 176.11(SD)	ADDUCTOR ANGLE	16	94.81	9.167	-0.158	0.559
	HEEL TO EAR		105.38	7.473	-0.059	0.827
	POPLITEAL ANGLE		109.75	6.648	-0.726	0.886
BODY WEIGHT 2199.69 (mean) 413.68 (SD)	ADDUCTOR ANGLE		94.81	9.167	-0.954	.000*
	HEEL TO EAR		105.38	7.473	-0.777	.000*
	POPLITEAL ANGLE		109.75	6.648	-0.726	*001*

Table 4: Correlation of body weight and birth weight with AT angles in PTI SGA 40 weeks of CGA.

CATEGORY	AMIELTISON ANGLES	N	MEAN	SD	r value (CORRELATION WITH BODY WEIGHT)	p value
BIRTH WEIGHT 816.67 (Mean) 140.914 (SD)	ADDUCTOR ANGLE	6	102.67	11.961	-0.649	0.163
	HEEL TO EAR		112.83	7.705	-0.59	0.218
	POPLITEAL ANGLE		116.33	5.888	-0.778	0.068
BODY WEIGHT 1716.67(Mean) 366.970(SD)	ADDUCTOR ANGLE		102.67	11.961	-0.877	.022*
	HEEL TO EAR		112.83	7.705	-0.474	0.342
	POPLITEAL ANGLE		116.33	5.888	-0.919	.010*

DISCUSSION

Clinicians who are involved in early intervention face a challenge in identifying the PTI who are at the risk of developing motor problems and the ideal time to intervene in the development of these infants. Tonal deviations in PTI are considered as the early signs of motor developmental problem which is evaluated periodically by passive muscle tone assessment. Various factors need to be considered while identifying and interpreting subtle tonal abnormalities to initiate early intervention. Body weight is one of the important component which could affect the extensibility of the muscles and thereby the passive muscle tone. This study intended to know the correlation of body weight with passive muscle tone assessed using ATA in PTI at 32 weeks to 40 weeks of CGA and also to compare with FTI. The subjects included in the study were 22 PTI and 23 FTI.

Table 1 shows correlation of body weight and Amiel-Tison angles of PTI at 32, 34 and 40 weeks of CGA which shows that there is negative correlation in all three assessments. This conveys that physiological muscle tone of lower extremities is higher in PTI with higher body weight thereby reduced extensibility than with lower body weight which results in significant reduction of ATA within the same group of CGA. The result is in contrast with the study done by Kato et al 2004 [19]) where muscle tone of lower limb is higher in infants with lower birth weight at 4 month of corrected age. Though normal values of ATA are interpreted within a range, the negative correlation within the same groups insists the clinician to consider the body weight when interpreting the extremes of the range to conclude on subtle tonal deviations.

The mean body weight of FTI is 3073.87 grams and PTI reaching Fullterm is 2067.95 grams. The mean ATA of Adductor, Heel to Ear, and Popliteal in PTI reaching full term are 96.95, 107.41, 111.77 degrees and FTI are 71.30, 97.70,97.48 degrees respectively which says that physiological muscle tone is higher in FTI than PTI, though both show a negative correlation with body weight as seen in Table 2. This finding is similar to the study done by (Palmer et al. 1982(20) which says that PTI reaching 40 weeks showed less flexor tone than full term newborn. This also supports the findings that decreased body weight results in increased extensibility of muscles and thereby significantly increased ATA.

Previous studies done on muscle tone in PTI focused on influence of birth weight but this study looks at the body weight of the infant periodically at 32, 34 and 40 weeks as the infant grows and attains FT because the degree of growth and weight gain might be independent of birth weight. This is supported by the study done by Anchieta et al. 2003[21] which conveys that there is a inverse relationship between birth weight and weight gain during the third week of life in preterm infants.

Muscle tone assessment in preterm does not consistently correlate with birth weight in our study which is similar to the findings of the study done by Elda D Silva 2005 [22] where muscle tone of healthy 42 PT and 47 term newborn was assessed between 7th and 14th day of life and concludes that birth weight does not influence the muscle tone of PTI. But present study shows that muscle tone has significant correlation with body weight in 32, 34 and 40 weeks of CGA which emphasizes that body weight needs to be considered in the evaluation of muscle tone.

Comparison of birth weight and body weight with ATA in SGA and AGA is seen in Table 3 and 4. The results shows that ATA does not correlate with birth weight in both SGA and AGA but it showed negative correlation with body weight in SGA except Heel to Ear and all three angles in AGA though the subjects in both the group were small in number which is in contrast to the result of Elda D Silva 2005 where heel to ear was the only maneuver which was influenced by birth weight.

CONCLUSION

The result of the study concludes that that there is an influence of body weight on ATA in PTI which insists the assessor to consider the body weight of the PTI while performing the neurological assessment during the initial periods and interpreting the subtle tonal abnormalities in identifying the high risk baby and initiating early intervention.

Conflicts of interest: None

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