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*Original Research Article*

# A Study to Compare the Length of the Gastrocnemius-Soleus Muscle Tendon Unit in Full Term and Pre-Term Infants

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## ABSTRACT

**Objectives**: Differences in motor development of preterm and full term infants have been reported that may be related to the muscle tendon unit length. When compared with full term infants, preterm infants commonly demonstrate higher frequency of toe touch when begin to walk which suggests change in the length of muscle tendon unit length, though ankle movement is not related to positive neurological findings. Hence this study was done to compare the length of the muscle length of gastrocnemius/soleus in preterm and full term infants.
**Methods:** A total number of 120 infants were taken for the study where in two groups that is Group A-preterm infants ( below 37 weeks) and Group B (37-41 weeks) were taken, each group had 60 infants which were selected randomly from NICU and gyenaecology ward respectively. Two measurements were taken that is A0 and $A_{max}$ and the difference was calculated that is $A_{max} – A_0$ which gives the length of the gastrocnemius soleus muscle tendon unit.
**Results:** Data analysis and results showed highly significant (p=0.0000) difference in the muscle tendon unit of preterm and full term children. The preterm infants had significantly lower values of $A_{max}$ and $A_{max}$- $A_0$ when compared to the full term infants.
**Conclusion:** In our study, there was no significant difference in the first measurement that is $A_0$ in between the preterm and full term group but a highly significant difference was found in the second measurement $A_{max}$ and $A_{max}$-$A_0$ between the preterm and full term infants.
***Key words:*** Preterm infants, Full term infants, Ankle range of motion, Gastrocnemius-soleus muscle tendon unit.

## INTRODUCTION

Preterm infants have been described as ‘physiologically displaced persons’ born before 37 weeks of gestation. [1] Term babies are born with a gestational age between 37 to 41 weeks (259 – 293 days). [2] Preterm birth is the most significant problem in current obstetric practice and according to the World Health Organization is the direct cause accounting for 24% of neonatal death. Rates of preterm birth range between 7-16% and are similar worldwide. [3] Incidence of preterm labor is 23.3% and of preterm delivery 10-69% in India. [4]

Causes for the onset of premature labor are [1]

- Low levels of progesterone

- Production of prostaglandins
- Cortisol
- Incompetant cervix
- Premature rupture of membranes
- Problems related to the placenta: Placenta previa and abruptio placenta.
- Age of the mother: Mothers under the age of 18 and over 35 are at a risk of premature onset of labor.
- Multiple pregnancy

It was found that incidence of preterm labor was 22% and that of preterm deliveries 20.9% Preterm rupture of membranes and infection were the commonest causes of preterm labor. There is a high incidence of preterm labor and preterm births in our set up, compared to developed countries. [4] Preterm infants have a low birth weight. The World Health Organization estimates that 16% of neonates, or nearly 20 million, are born LBW each year. The relative risk for neonatal death is almost 200 times greater for VLBW infants than for normal birth weight infants and the relative risk for post neonatal death is 20 times greater. Recent advances in neonatal care have improved the chances for both survival and subsequent normal development of VLBW infants. They have developed intervention strategies that lead to better neurological, behavioural and developmental outcomes for these infants. [5]

Problems of premature birth are bronchopulmonary dysplasia, intracranial hemorrhage, retinopathy of prematurity, necrotizing entercolitis and rickets of prematurity. Children born prematurely are more likely than full-term children to develop motor problems during infancy. [6] To check the range of dorsiflexion, a method to clinically assess the relationship between the muscle and tendon was developed by Tardieu et al and has been found to be clinically reliable in infants. Two goniometric measurements are used to determine where in the range. [1] the tendon becomes taut with the muscle shortened and [2] the muscle and tendon are fully lengthened. Muscle extensibility has been defined as the difference between these measures, or the range between the relaxed muscle belly and the lengthened muscle belly. These measurements were reported to be reliable in newborn infants with an interclass correlation coefficient [ICC model[2] of 0.86 and 0.97 for the two measures and test-retest reliability [ICC model[3, 2]] of 0.91 and 0.98 for the two measures of the muscle tendon unit.[7]

Differences in motor development of preterm and full term infants have been reported that may be related to muscle-tendon unit length. When compared with full term infants, preterm infants frequently demonstrate a higher frequency of toe-touch contact when beginning to walk, which suggests changes in the length of the muscle tendon unit length. Ankle movement is not related to positive neurological findings. This suggests that research is needed to examine whether there are differences in development of musculoskeletal system of preterm and fullterm infants. [8]

As there is limited literature in the Indian scenario, a need arises to find the differences in available passive dorsiflexion range which distinguishes between infants who may or may not develop abnormally and this measure could assist in identifying infants who may benefit from early intervention.

## METHODS

Before commencement of the study, an ethical clearance from Shri Dharmastala Manjunatheshwara Institutional Ethical Committee, Dharwad was taken. Prior to the commencement of the study, a written consent letter was obtained from all parents.

***Subjects***

A sample of 60 subjects in each group from SDM Hospital, Dharwad were taken after the clearance from the Pediatrician and the Gynecologist.

***Inclusion Criteria:***

1. For full term infants: Infants born between gestational age of 38 and 42 weeks and normal newborn examined by the Paediatrician.
2. For preterm infants: Infants born with a gestational age of 37 weeks or less and normal newborn examined by the Pediatrician.

***Exclusion Criteria:***

1. For full term infants: Complications during pregnancy or delivery and APGAR score below 7 at 5 minutes of birth.
2. For preterm infants: Musculoskeletal, neurological or genetic abnormalities.

***Procedure***

Ranges of motion at bilateral ankles were measured with a goniometer. Two measurements were taken at each infant's ankle, $A_0$ and $A_{max}$ in either supine or side lying position.

1. $\mathbf{A_0}$ is defined as the point in the ankle range of motion where tendon is taut and muscle belly is shortened. This measure is assumed to reflect a position of no muscle belly stretch.
2. $\mathbf{A_{max}}$ is defined as a position of full stretch into ankle dorsiflexion and reflects a position of muscle belly stretch.
3. **$\mathbf{A_0}$ to $\mathbf{A_{max}}$** is the difference between A0 and Amax. This was calculated and entered as a new variable. This variable measures the distance in degrees that the gastrocnemius-soleus can extend.[8]

Before measurement, the infant's ankle was moved through the full range of dorsiflexion two or three times to prevent creep or lengthening relaxation found after initial stretch of the muscle. Each measurement was taken twice and recorded on a data sheet.

All measurements were taken according to the infant states.[9] All measurements were taken when the infant is in relaxed state, that is state 1 – deep sleep, 2 – light sleep, 4 – quiet and alert. All measurements were taken in a span of 10-15 minutes, stopping only if the infant required assistance to maintain state. Measurements corresponding to plantar flexed position were recorded in negative degrees and those corresponding to dorsiflexion were recorded in positive degrees. The full term infants were measured within 48 hours of birth and the preterm infants were measured prior to term age.

## RESULTS

**Table 1: Distribution of study number of study subjects by groups**

| Group | Male | % | Female | % | Total |
|---|---|---|---|---|---|
| Full term | 26 | 43.33 | 34 | 56.67 | 60 |
| Pre term | 31 | 51.67 | 29 | 48.33 | 60 |
| Total | 57 | 95.00 | 63 | 105.00 | 120 |

Table 1 shows the male and female distribution in both the groups i.e., preterm and full term infant group. In the full term group, there were 60 infants out of whom there were 26 male infants (43.33%) and 34 female infants (56.7%). In the preterm infant group, there were a total of 60 infants out of which there were 31 males infants (51%) and 29 females infants (48.33%).

**Table 2: Comparison of full and pre term groups in boys, girls and total samples with respect to gestational age by t-test.**

| | Group | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| Male | Full term | 38.7633 | 1.2636 | 19.3154 | 0.0000* |
| | Pre term | 33.5183 | 1.6816 | | |
| Female | Full term | 38.4692 | 1.1668 | 11.4665 | 0.0000* |
| | Pre term | 33.8323 | 1.7621 | | |
| Total | Full term | 38.9882 | 1.3049 | 16.1376 | 0.0000* |
| | Pre term | 33.1828 | 1.5511 | | |

*Highly Significant

Table 2 shows the comparison of full term and preterm groups in males, females and total samples with respect to gestational age by T- test. The mean gestational age in males in the full term group was 38.7 weeks with a SD of 1.26 and in females were 38.4 with a SD of 1.16. The mean gestational age of males in preterm group was 33.5 with a SD of 1.68 and in females it was 33.83 with a SD of 1.76. The total mean gestational age of full term infants was 38.9 weeks with a SD of 1.3 and in the preterm group it was 33.18 with a SD of 1.5. The p value was found to be significant in all the groups.

**Table 3: Comparison of full and pre term groups in boys, girls and total samples with respect to A0 by t-test**

| | Group | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| Male | Full term | 2.3833 | 1.7668 | 2.0364 | 0.0439* |
| | Pre term | 1.5167 | 2.7831 | | |
| Female | Full term | 2.3077 | 1.8497 | 1.8698 | 0.0668 |
| | Pre term | 1.1290 | 2.7294 | | |
| Total | Full term | 2.4412 | 1.7266 | 0.8781 | 0.3833 |
| | Pre term | 1.9310 | 2.8276 | | |

Table 3 shows the comparison of full and preterm groups with respect to A0 (the initial measure of dorsiflexion.) The mean of the measure A0 in the full term group males was 2.3 with a SD of 1.7 and in females it was 2.3 with a SD of 1.8. The total mean value in the full term group was 2.4 with a SD of 1.7 and t-value of 0.8. The p-value was found to be non significant for this measure.

**Table 4: Comparison of full and pre term groups in boys, girls and total samples with respect to Amax by t-test**

| | Group | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| Male | Full term | 79.8333 | 3.6553 | 20.2918 | 0.0000* |
| | Pre term | 64.7000 | 4.4733 | | |
| Female | Full term | 80.1923 | 3.5102 | 15.3622 | 0.0000* |
| | Pre term | 64.0000 | 4.3050 | | |
| Total | Full term | 79.5588 | 3.7915 | 13.3439 | 0.0000* |
| | Pre term | 65.4483 | 4.6027 | | |

*Highly Significant

Table 4 shows the comparison of full term and preterm infant groups with respect to Amax by t-test. The mean value of Amax in full term males was 79.8 degrees with a SD of 3.6 whereas in full term female infants the mean value was 80.19 with a SD of 3.5. The total mean value was 79.55 degrees with a SD of 3.7. The mean value of the preterm male infants was 64.7 degrees with a SD of 4.4 whereas in preterm female infant group the mean value was 64 degrees with a SD of 4.3. The total mean value of the preterm infants was 65.44 degrees with SD of 4.6. The p value was found to be highly significant in both the groups.

## DISCUSSION

The present study was aimed at comparing the length of the muscle length of gastrocnemius/ soleus in preterm and full term infants.

Identifying which infants born preterm are at risk for developing motor problems is an important question for clinicians who are determining when to intervene in early development. To address the question of when to intervene in development, investigators have identified early signs of motor development problems in infants born preterm. Ellison developed a shortened version of the Amiel-Tison Neurological Assessment that includes five manipulative tests of the limbs: adductor angle at the hips, heel-to-ear movement, popliteal angle, dorsiflexion of the ankle, and scarf sign. All five of these tests were judged on the passive range of motion available and were statistically significant in separating normal, transiently abnormal, and abnormal infants. Gastrocnemius- soleus measurements were taken by two goniometric measurements $A_0$ and $A_{max}$. Measurements were obtained with a taut tendon and relaxed muscle belly ($A_0$), with taut tendon and elongated muscle belly ($A_{max}$).$A_0$ to $A_{max}$ was the difference between $A_0$ and $A_{max}$ .Statistically significant differences were found for both measures of muscle extensibility. The preterm group demonstrated measures of $A_0$ and $A_{max}$ in more extended ankle positions. [8] Neurological evaluation of maturity of newborn infants states that cerebral maturation during the last 3 months of fetal life brings about constant modification of muscle tone and certain reflexes. Neurologic examination during the first days of life can provide data that is both precise and easy to evaluate. Dorsiflexion angle of the foot is a component of the Amiel-Tison Neurological Assessment which was found to be comparatively less in preterm infants. The interobserver reliability of the Amiel-Tison Neurological assessment for all items including dorsiflexor angle had excellent reliability with a kappa coefficient of 0.76. [10] In a study of passive dorsiflexion movement at the ankle, Harris et al found that passive ankle dorsiflexion, when measured repeatedly over the first year of life, was significantly less in infants born preterm and distinguished between infants born full term and infants born preterm. [11] This lack of ankle dorsiflexion in infants born preterm is consistent with Ellison's finding of less dorsiflexion in preterm infants. [12]

Infants born preterm are significantly different on measures of muscle length when compared with infants born full-term. The infants born preterm demonstrated positions of more plantar flexion on both measures, A0 and $A_{max}$, when compared with the infants born full-term. These mean measures are consistent with previous data suggesting that infants born preterm position their ankles in a more extended or plantar-flexed posture than infants born full-term who have a dorsiflexion maximal range of 40 to 80 degrees at birth. [11] These results suggest that there are differences in the muscle tendon unit, which could affect movement at the ankle. With measurements of $A_0$ and $A_{max}$ in positions of greater plantar flexion, infants born preterm have a stretch exerted on their gastrocnemius-soleus muscle belly earlier in ankle movement from plantar flexion to dorsiflexion. This stretch on the muscle earlier in the range would place the muscle fibers in a midrange stretch earlier and thus set up the muscle to be more efficient to produce force in a position of greater plantar flexion. In addition, the measure of $A_{max}$ suggests that these infants are limited in their maximum movement into dorsiflexion. Thus, infants born preterm cannot move into as much dorsiflexion. [7]

In our study there are differences in the muscle tendon unit in preterm and full term infants and this might be due to confinement in the tight uterine environment during the last few weeks of gestation resulting in lengthening changes in the gastrocnemius-soleus and other muscles of infants born full-term. Lengthening some muscles and shortening others may predispose muscles to produce specific movement's full-term infants use during early motor development and in some ways shape the movement that is produced.

## CONCLUSION

In our study, no significant difference was found between preterm and full term infants with respect to measurement of $A_0$. There was highly significant difference found between the group assessments with respect to $A_{max}$- $A_0$ that is in the full term group there was more ankle range of motion (dorsiflexion) as compared with the preterm group. Thus we conclude by the above results that preterm infants have less muscle tendon unit length as compared with full term infants.

## REFERENCES


1. Harrison H. The Premature Baby book. St. Maruin's Press,175th avenue , New York;1983
2. Parthasarthy A, Nair MKC, Menon PSN. IAP book of Pediatrics. 3rd ed. New Delhi:Jaypee Brothers Medical Publishers(p) Ltd; 2006:39
3. Sonkusare .S, Rai L., Naik P. Preterm Birth:Mode of Delivery and Neonatal Outcome. Med J Malaysia. 2009; 64(4): 303-306
4. Singh U, Singh N, Seth S. A prospective analysis of etiology and outcome of preterm labor. J ObstetGynecol India Vol. 57, No. 1 : January/February 2007 Pg 48-52
5. Bang A,Baitule S, Reddy H,Deshmukh M, Bang R. Low Birth Weight and Preterm Neonates: Can they be Managed at Home by Mother and a Trained Village Health Worker? Journal of Perinatology 2005; 25:S72–S81
6. Van Haastert I.C, De Vries L.S ,Helders P.J.M and Jongmans M.J. Early Gross Motor Development Of Preterm Infants According To The Alberta Infant Motor Scale; J Pediatr 2006;149:617-22
7. Grant Beuttler M, Leininger PM, Palisano RJ . Reliability of a Measure of Muscle Extensibility in Fullterm and Preterm Newborns. Phys Occup Ther Pediatr.2004;24 :173-186.
8. Grant BeuttlerM ,Shewokis P.A. Muscle Tendon Unit Comparisons Between Infants Born Preterm and Infants Born Fullterm : A Pilot Study . PedPhysTher . 2007;19:309-314
9. Levangie P K, Norkin C. Joint Structure and Function. 3rded :2001
10. AmielTison C. Update of the Amiel-Tison Neurologic Assessment for the Term Neonate or at 40 weeks Corrected Age. PediatrNeurol 2002; 27:196-212.
11. Harris MB, Simons CJR, Ritchie SK, et al. Joint range of motion development in premature infants. PediatrPhysTher. 1990; 2:185–191.
12. Ellison P.Neonatal Follow-Up Studies: The Predictive Value of Neurological Abnormalities in the First Year of Life. Pediatrics Update. New York: Elsevier Biomedical;1984:187–202



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