QUADRICEPS MUSCLE THICKNESS AND SUBCUTANEOUS TISSUE THICKNESS IN NORMAL CHILDREN IN TURKISH POPULATION : SONOGRAPHIC EVALUATION

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SUMMARY : *We evaluated the efficacy of real-time ultrasound imaging in order to identify the normal range of mid-thigh muscle thickness and subcutaneous tissue thickness and to assess the standard values for our population. 500 children who had no neurological disorders were included in the study. We did not demonstrate any significant difference in muscle thickness between girls and boys, but girls had a signiicantly greater subcutaneous tissue depth than boys. The standard values that we measured were significantly different when compared with other studies. Quadriceps muscle thickness were found to be lower in our population and no significant difference was demonstrated in subcutaneous tissue depth. Our results show that, we have to use the standard values from our population in order to form the basis of the assessment of neuromuscular disorders.*

Key Words : *Muscle Thickness, Subcutaneous Tissue Thickness, Real-Time Ultrasound, Neuromuscular Disorders, Mucscle Ultrasonography.*

INTRODUCTION

A wide variety of techniques including simple clinical evaluation, biochemical determinations, anthropomorphic measurements, and sophisticated procedures for calculating lean body mass were used in the assessment of nutritional status in both the normal and abnormal individuals (1). Anthropomorphic measurements are subjective and examiner-dependent, making consistency and reproduction difficult (2). There are pathological changes in muscle thickness and subcutaneous tissue thickness in neuromuscular disease in children. In muscular dystrophy, the muscle thickness is proved to be normal or increased whereas in spinal muscular atrophy it is reduced with an associated increase in subcutaneous tissue thickness but not due to obesity (3, 5). Therefore both in diagnosis and in differential diagnosis of neuromuscular diseases, muscle thickness and subcutaneous tissue thickness must be assessed exactly and correctly and the values have to be compared with the standard values of the individual population.

The present study reports the different values for quadriceps muscle thickness in the Turkish population and consequently shows that we have to use our own values while studying children with neuromuscular diseases.

MATERIALS AND METHODS

A total of 500 children who had no neurological disorders were included in this study. They were evaluated for quadriceps femoris muscle thickness and subcutaneous tissue thickness in our institution between 1991-1994. All the sonographic examina-

tions were performed with a 7.5 MHz linear-array real-time transducer (General Electric RT 3600, Milwaukee and Hitachi EUB-515A, Japan). Images were displayed at a field-of-view setting of 60 mm at 2X magnification.

The thickness of the quadriceps femoris muscle and subcutaneous tissue were measured at the mid-thigh, a point halfway between the top of the greater trocanter and the joint line of the knee. Measurements were performed while the child seated, the knee extended, and the muscle relaxed. It is important that the child be relaxed, because the muscle thickness becomes significantly larger with the contraction of the quadriceps femoris muscle. We applied the transducer to the thigh with as minimal pressure as possible. If pressure is applied, the thickness of the muscle is measured as decreased. This could be minimized by using a large amount of transmission gel and by observation of the skin outline in the ultrasound image, which would show any distortion. If we apply minimal pressure, the skin echo is displayed as an undistorted semicircle at the top of the image (Fig 1), but if we press harder, the skin echo is flattened and the distance between the skin and the bone is significantly reduced (Fig 2). It is also important to avoid scanning the thigh obliquely, as the distance between the skin and the bone seems to be increased. In order to avoid this, the transducer must be applied perpendicular to the long axis of the thigh and the angle of the transducer must be altered until the best bone echo is received.

Measurements were analysed for statistical significance using paired t-test and significance was defined as p values less than 0.01.

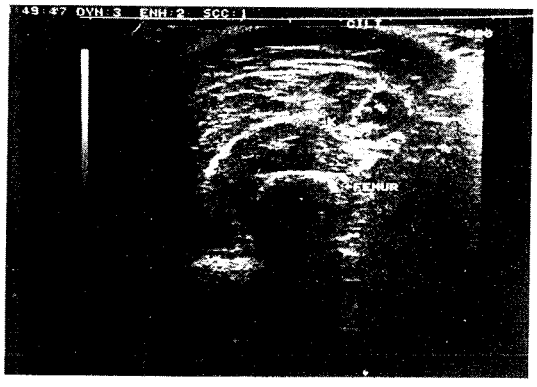

Fig - 1 : Transverse real-time sonogram of the thigh with light pressure. There is no evident distortion and skin echo has dome-shaped appearance.

Fig - 2 : Transverse sonogram of the same thigh with firmer pressure shows distortion with flattening of the skin echo. The distance between the skin and the bone is significantly reduced.

RESULTS

The normal mean values for quadriceps femoris muscle and subcutaneous tissue thickness, according to age and sex were calculated (Table 1). The muscle thickness was found to be increased with age and the greatest increases were in the first three years of life and the ages between 10-12. No significant difference was found in the muscle thickness between girls and boys at any age. However there was a significant difference according to sex in normal mean values for subcutaneous tissue thickness. This was markedly greater in girls than in boys in all age groups ($p<0.01$) (Table 2).

DISCUSSION

Although some authors have contended that clinical assessment of nutritional status is sufficiently accurate, numerous biochemical and anthropomorphic techniques are currently in use. Among the morphometric tests, perhaps the most common are measurement of mid-upper-arm circumference and mid-tight circumference (1).

The thickness of muscle and subcutaneous tissue wire measured by plain X-rays in the past, however because of the irradiation problem it has become very limited in recent years (6). Measurement of thigh muscle thickness with real-time ultrasound imaging can be performed rapidly and non-invasively (2, 3). The current study established the ease

Age yrs	Female n	Female mean (SD) mm	Male n	Male mean (SD) mm
0-1	20	12.3 (2.1)	20	12.5 (2.2)
1-2	21	3.0 (2.3)	20	14.9 (2.5)
2-3	21	15.7 (2.2)	21	16.2 (2.3)
3-4	21	18.0 (2.7)	21	16.7 (2.0)
4-5	21	18.0 (2.8)	21	17.7 (2.3)
5-6	21	18.5 (2.7)	21	19.2 (3.3)
6-7	21	18.5 (3.1)	21	19.4 (3.1)
7-8	21	18.7 (3.2)	21	19.7 (3.5)
8-9	21	19.9 (3.2)	21	19.7 (3.4)
9-10	21	23.2 (4.0)	21	23.7 (4.1)
10-11	21	24.0 (4.2)	21	24.5 (5.0)
11-02	21	25.2 (4.5)	21	25.5 (4.8)

Table 1 : Normal values of muscle thickness in children.

Age yrs	Female n	Female mean (SD) mm	Male n	Male mean (SD) mm
0-1	20	3.5	20	3.1
1-2	21	3.7	20	3.3
2-3	21	3.9	21	3.4
3-4	21	4.2	21	3.7
4-5	21	4.3	21	3.7
5-6	21	4.3	21	3.8
6-7	21	4.4	21	3.8
7-8	21	4.5	21	3.9
8-9	21	5.0	21	4.0
9-10	21	6.8	21	4.1
10-11	21	7.0	21	6.0
11-02	21	8.5	21	6.5

Table 2 : Normal values of subcutaneous tissue thickness in children.

and reproducibility of real-time B-mod sonographic depiction of fat and muscle in the mid-thigh region. There are two methods in determination of muscle growth; measurement of muscle cross sectional area and measurement of muscle thickness (2, 3). We preferred the second method, because the increased muscle echogenity, as in spinal muscular atrophy, makes it difficult to determine muscle contours exactly and correctly to measure cross sectional area. Furthermore, measurement of the muscle thickness is much more easier in routine clinical application.

Muscle is a soft and easily deformable tissue, and we found considerable care had to be taken with the measurements to achieve acceptable reproducibility. The biggest source of error was that of tissue compression by the hand-held transducer, and observation of the skin outline on the image was of critical importance. It was found to be important to get child fully relaxed, because apparent muscle thickness increase with contraction of the quadriceps (3).

The normal values of quadriceps femoris muscle thickness are essential for evaluating muscle atrophy and hypertrophy in neuromuscular disease. When we compared our population's normal values with the results of a study from England (3), we found a significant difference among these two groups. The muscle thickness values of England were significantly greater than our values in all age groups. Therefore, the measurements derived from our own society become more important while evaluating neuromuscular disorders in children.

In conclusion, real-time B-mod ultrasonography, a rapid and noninvasive screening modality, is a successful method for evaluating the muscle

thickness and subcutaneous tissue thickness. It will be helpful in determination of the muscle growth and also in diagnosis of neuromuscular diseases.

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REFERENCES

1. Fried AM, Coughlin K, Griffen WO : The sonographic fat / muscle ratio. Invest Radiol 1986; 21 : 71-75.
2. Heckmatt JZ, Pier N, Dubowitz V : Real-time ultrasound imaging of muscles. Muscle & Nerve 1988; 11 : 56-65.
3. Heckmatt JZ, Pier N, Dubowitz V : Assessment of quadriceps femoris muscle atrophy and hypertrophy in neuromuscular disease in children. JCU 1988; 16 : 177-181.
4. Hecmatt JZ, Pier N, Dubowitz V : Measurement of quadriceps muscle thickness and subcutaneous tissue thickness in normal children by real-time ultrasound imaging. JCU 1988; 16 : 171-176.
5. Kamala D, Suresh S, Githa K : Real-time ultrasonography in neuromuscular problems of children. JCU 1985; 13 : 465-468.
6. Tanner JM, Hughes PCR, Whitehouse RH : Radiographically determined widths of bone, muscle and fat in the upper arm and calf from age 3-18 years. Ann Hum Biol 1981; 8 : 495-517.