RESEARCH ARTICLE

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Tomographic Assessment of Normal Abdominal Muscle Thickness Values in Adolescents

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Abstract

Objectives: The transversus abdominis (TA), internal oblique (IO), and external oblique (EO) muscles comprise the three layers of the abdominal muscles. These muscles contribute to body stability. In the early stages of muscular diseases, low back pain may manifest. The purpose of this study was to use computed tomography (CT) to determine the normal thickness of specific abdominal muscles in adolescents.

Methods: Muscle thickness was measured from a section passing through the umbilicus during CT examination performed for other reasons on 500 adolescent children aged 12-18 years.

Results: The average muscle thickness was greater in boys (mean=28.8, p=0.30). The thickest muscle was the IO in both sexes. Muscle thickness was the thickest in the IO in both genders. Muscle thickness was positively correlated with body mass index (p=0.001).

Conclusion: Understanding the normal thickness of abdominal muscles can guide diagnosis and treatment. Muscle thicknesses are as follows: IO, EO, and TA.

Keywords: Abdominal muscle thickness, normal, computed tomography, adolescent

Introduction

The abdominal muscle planes comprise the lateral abdominal muscles, transversus abdominis (TA), internal oblique (IO), and external oblique (EO) compartments. These muscle structures play a role in body stability. Muscle diseases can present clinically as low back pain. When the previous literature was examined, muscle disease involvement was observed in all age groups. The normal values of muscle diseases in pediatric patients are important for early diagnosis.[1,2]

Ultrasonography (US), magnetic resonance imaging (MRI), and computed tomography (CT) are the basic imaging methods for assessing muscle tissue. US is the most appropriate examination for pediatric patients because of the lack of radiation and cost. However, in some clinics, access to US can be more difficult than access to cross-sectional examination. In addition, in some clinics, muscle planes can be evaluated incidentally in cross-sectional examinations for other reasons. Therefore, measuring the thickness of muscle planes using cross-sectional methods and knowing their normal values in pediatric patients can provide early diagnosis in the future.[2-4]

When the literature data are examined, Rahmani et al.[1] and Aydin and Fatihoğlu,[2] it is understood that the studies are mostly conducted on adult populations. Muscle measurement data obtained via CT examination in adolescents are limited. In our study, we aimed to make measurements by standardizing muscle plans in a certain cross-sectional plane with a CT examination performed for another purpose.

Methods

This retrospective study was approved by the Gülhane Faculty of Medicine Ankara Training and Research Hospital Clinical Research Ethics Committee approval (decision no: AEAH-KAEK-2021/12-15377834.11, date: 07.12.2021). Informed consent was not possible because of the decision's retrospective character.

A total of 520 CT scans performed for other reasons between January 2022 and December 2023 among patients aged 12-18 were retrospectively included in our study. Regardless of whether the examination was contrasted or not, patients with a history of neuromuscular, rheumatological, dermatological, or systemic disease or a history of surgery were excluded from the study. The study included 500 participants who satisfied the exclusion criteria.

The axis perpendicular to the anterior posterior line, which passes through most lateral muscle planes in the axial series and crosses the umbilicus level, was used for the measurement. Both sides of the measurement were measured. The patient's age, gender, and body mass index were also assessed. An example measurement is shown in Figure 1.

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After scouts were acquired, imaging was performed while supine using the following parameters: rotation time=0.33 s, 80/120 Sn kVp, 60 mAs, and cranio-caudal scanning. The slice is 1.5-mm thick. Three planes were used for image reconstruction: axial, coronal, and sagittal.

Statistical Analysis

The Kolmogrov-Smirnov test was employed to evaluate the distribution's normality. To examine the variations in the t-test between the right and left sides, a paired t-test was employed. The Student's t-test was used to evaluate distinctions between males and females. The relationship between abdominal muscle thickness and body mass index (BMI), sex, age, and subcutaneous fat thickness (SFT) was assessed using the Pearson correlation coefficient test. $P<0.05$ on a 2-tailed scale was regarded as statistically significant.

Results

In our study population, the mean age was calculated as 14.55±3.2 years. The mean age of the girls was 15.2±2.5 years, while the mean age of the boys was 15.1±2.1 years. As expected, BMI was significantly higher in boys (p=0.16, Table 1).

The order of thickness of the three defined muscle tissues was the same in both genders. The thickest muscle is the IO, the EO is the medium-sized muscle, and the TA is the small muscle. No significant difference was observed in the measurement of right or left muscle thickness. Subcutaneous fat tissue did not differ between the groups (p=0.001). Average muscle tissue thickness and subcutaneous fat tissue measurements are presented in Table 2.

No significant correlation was observed between age and muscle thickness in any of the three muscle planes (p>0.5). No significant correlation was observed between SF measurement and age (p=0.548). We found a favorable association between BMI values and SFT values (IO, EO, and TA muscle thicknesses) (p<0.5). Correlations of muscle measurements with age and BMI are presented in Table 3.

Figure 1. A) Subcutaneus fat thickness. B) External oblique muscle. C) Internal oblique muscle. D) Transversus abdominis muscle

Table 1. A statement indicating the comparison of age and BMI between sexes

Gender-variables		Mean±SD	p value
Boys (n=250)	Age (year)	15.1	0.16
	BMI (kg/m²)	28.8	0.30
Girls (n=250)	Age (year)	15.2	0.15
	BMI (kg/m²)	22.2	0.33

SD: Standard deviation, BMI: Body mass index

Discussion

The normal dimensions of the abdominal muscle planes are important for the detection of back pain or disability. The normal dimensions of the abdominal muscle should be known so that pathological conditions can be revealed.[5] In this study, we aimed to determine the normative values of normal abdominal muscle planes in adolescence. There are limited studies on this subject in the literature. In the most recent literature, Aydin and Fatihoğlu,[2] found that muscles were thicker in the male population, which is consistent with our study. In addition, similar results were obtained in the study by Rahmani et al.[1] in the literature. As observed in all studies, no difference was observed between the right and left measurements in our study.

In accordance with the literature, the muscle thickness was similar in our study. Accordingly, the thickest muscle was the IO, the median muscle was the EO, and the thinnest muscle was the TA. However, there is no standardized method in the literature regarding where the muscle should be measured. In ultrasound examinations, localization is made by reporting the anterior axillary line and the iliac bone localization. This level is more inferior than our level. In our study, muscle thickness was observed to be more superiorly localized than other measurements in the literature due to the standard section of the level passing through

Table 2. Comparison of muscle planes by sex with the average of both sides

Gender (n=250)	Muscle measurements	Mean±SD (mm)
Boys	Transversus abdominis	5.5±0.9
	Internal oblique	13±1.1
	External oblique	10±0.8
	Subcutaneous fat thickness	9.5±0.6
Girls	Transversus abdominis	4.9±0.5
	Internal oblique	11±0.8
	External oblique	9±0.8
	Subcutaneous fat thickness	9.6±0.6

SD: Standard deviation

Table 3. Correlation of muscle mass with age and BMI

	Age		BMI	
	r	p value	r	p value
Mean TA	-0.059	0.548	0.398	0.001
Mean IO	-0.060	0.538	0.418	0.001
Mean EO	-0.065	0.648	0.338	0.001
Mean SFT	-0.258	0.548	0.378	0.001

TA: Transversus abdominis, IO: Internal oblique, EO: External oblique, SFT: Subcutaneous fat thickness, BMI: Body mass index

the umbilicus. For this reason, the muscle plane thickness was reported to be thicker than that reported by Aydin and Fatihoğlu.[2]

Since studies in the literature are generally conducted on the adult population, a negative correlation has been found between muscle thickness and age. In the present study, no significant relationship was observed between age and muscle thickness. Because the study was conducted on adolescents, our population has a growing structure, and it is naturally accepted that atrophy findings are not observed with age. In addition, the literature mentions the low negative correlation in measurements because the TA muscle planes consist of type 2 fibers, but such a relationship was not observed in our study. In future studies, new study topics can be determined by analyzing the muscle dimension growth by analyzing subgroups according to pediatric and adolescent age.[6,7]

We found a positive correlation between BMI values and all muscle planes and fat tissue. In the study by Aydin and Fatihoğlu,[2] a positive correlation was observed between all muscle planes except the EO and height. Springer et al.[8] found a positive correlation between BMI, as in our study. Our study was similar to that of Springer et al.[8] However, the use of only BMI values in our study prevented detailed analysis specific to height or weight.

Pediatric group measurements differ from adult measurements because of the muscle growth pattern. Knowing the normal values can provide information about possible future musculoskeletal disorders and low back pain. In addition, since there may be differences in follow-up among the athlete population, this can provide information about the degree of hypertrophy. Our study can provide a standard normogram measurement that provides convenience in terms of measurement location, such as the umbilicus.

Study Limitations

There are some limitations to our study. Our study cannot provide a detailed analysis of children aged below 12 years. This is only for the adolescent period. Differences between observers among radiologists were not measured. Due to the insufficient number of MRI examinations, CT examinations were mostly performed in the emergency department. MRI examination would be a more appropriate examination due to soft tissue resolution. Although patients with normal imaging findings from CT examinations performed for any reason were included in the study, the fact that CT was not performed retrospectively from a completely normal population may have misled the findings. Because CT cannot be performed as a priority in future screenings for muscle diseases due to radiation, the rate of diagnosis may be low in patients with this suspicion.

Conclusion

As a result, knowing the normal values of abdominal muscle planes in adolescence can provide information for the diagnosis of low back pain or muscle diseases. It is positively correlated with BMI. The muscle dimensions were determined as the thickest IO, median EO, and thinnest TA.

Ethics

Ethics Committee Approval: This study was approved by the Gülhane Faculty of Medicine Ankara Training and Research Hospital Clinical Research Ethics Committee approval (decision no: AEAH-KAEK-2021/12-15377834.11, date: 07.12.2021).

Informed Consent: Since the study was a retrospective study, informed consent was not required by the ethics committee.

Footnotes

Authorship Contributions

Surgical and Medical Practices - Concept - Design - Data Collection or Processing - Analysis or Interpretation - Literature Search - Writing: H.K.Ö., A.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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