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Adolesanlarda Normal Abdominal Kas Kalınlığı Değerlerinin Ultrasonografik Tespiti

Normal Abdominal Muscle Thicknesses in Adolescents: a Sonographic Study

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Özet

GİRİŞ ve AMAÇ: Abdominal kaslar (eksternal oblik kas, internal oblik kas ve transversus adominis) gövde stabilitesine önemli katkı sağlar. Bu sayede sırt ve bel ağrısının önlenmesinde ve etyolojisinde rol oynarlar. Literatürde erişkinler için normal abdominal kas kalınlığı değerlerini tespit etmek mümkündür. Bu çalışmada tanımlı abdominal kasların normal kalınlıklarının ultrasonografik inceleme ile adolesan popülasyonda tespit edilmesi amaçlanmaktadır.
YÖNTEM ve GEREÇLER: Yaşları 12-18 arasında değişen 200 sağlıklı adolesan çalışmaya dahil edilmiştir. US incelemeleri 7.5 MHz lik lineer pro bile gerçekleştirilmiştir. Kas kalınlıkları istirahat halinde ölçülmüştür. Prob transvers olarak ön aksiller çizgi düzeyine, 12. kosta ile iliak krest arasına yerleştirilmiştir.
BULGULAR: Ortalama kas kalınlıkları erkeklerde daha fazladır. En kalın kas her iki cins için de internal oblik olarak tespit edilmiştir. Kas kalınlıkları her iki cinste de internal oblik > eksternal oblik > transversus abdominis şeklinde sıralanmıştır. Yaş ile internal ve eksternal oblik kas kalınlıkları arasında negatif bir ilişki tespit edilmiş; ancak transversus abdominis için böyle bir ilişki bulunamamıştır.
TARTIŞMA ve SONUÇ: Abdominal kasların normal kalınlıklarını bilmek tanı ve tedavide yol gösterici olabilir. Kas kalınlıkları en kalından başlamak üzere, internal oblik, eksternal oblik ve transversus abdominis şeklindedir. Yaş ile internal ve eksternal oblik kas arasında negatif ilişki vardır.

Anahtar Kelimeler: Abdominal kas kalınlığı, normal, ultrason, adolesan

Abstract

INTRODUCTION: The lateral abdominal muscles, transversus abdominis (TA), internal oblique (IO), and external oblique (EO) contribute to the stability of the trunk. So that, abdominal muscles are important for the management and prevention of low back pain (LBP). In the literature, it is easier to find normal ranges of abdominal muscle thickness for adult population. In the current study, we aim to determine normal values of TA, IO, and EO thickness in adolescents.
METHODS: 200 healthy children between the ages of 12-18 are included into the current study. US exams are performed with a 7.5-MHz linear array transducer. Abdominal muscle thicknesses were measured at rest. The transducer was placed transversely, in the anterior axillary line, between the 12th rib and the iliac crest.
RESULTS: Mean muscle thickness of all three muscles is higher in boys than girls. Mean thickness of IO is the biggest and the order of muscle thickness is the same between boys and girls (IO>EO>TA). There is a negative correlation between age and IO and EO muscle thicknesses. We cannot detect such a correlation between age and TA muscle thickness
DISCUSSION AND CONCLUSION: To conclude, knowing the normal thickness value of abdominal muscles can help diagnosis of pathologies like LBP and follow up of athletic training. Thickness of muscles lines up as IO>EO>TA. BMI, weight is positively correlated with muscle thickness. Age is negatively correlated with IO and EO muscle thicknesses.

Keywords: Abdominal muscle thickness, normal, ultrasound, adolescent

INTRODUCTION

The lateral abdominal muscles, transversus abdominis (TA), internal oblique (IO), and external oblique (EO) contribute to the stability of the trunk. So that, abdominal muscles are important for the management and prevention of low back pain (LBP) (1). LBP is one of the most common musculoskeletal problems worldwide (2-3). It is stated in the literature by different professions that LBP has a high prevalence both in adults and adolescents (4, 5). The assessment of the morphology (size and thickness) of abdominal muscles is crucial for both LBP management and follow up of athletic training (6-7).

Diverse imaging techniques are present for the evaluation of the abdominal muscle morphology and thickness, including magnetic resonance

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imaging (MRI),) and computerized tomography (CT). However, these methods are relatively expensive, and CT also is a source of ionizing radiation. Lately, the use of ultrasound (US) in determining abdominal muscle thickness and morphology has been growing up (8). In children, US is widely used to assess upper and lower limbs muscles size in neuromuscular disorders. Also some studies indicated that US is a more tolerable way to evaluate muscles in children compared to EMG, CT and MRI (5, 9).

In the literature, it is easier to find normal ranges of abdominal muscle thickness for different countries and age groups for adult population. However, there is not sufficient information about pediatric patients. In the current study, we aim to determine normal values of TA, IO, and EO thickness in adolescents. So that, we can both contribute to general literature and define normal values for Turkish population.

MATERIALS AND METHODS

All the participants and their parents received information form about the procedure and aims of the study. Agreed ones signed a consent form to be included into the study. This study is approved by institutional ethics review board.

200 healthy children between the ages of 12-18 (100 males, 100 females) are included into the current study. The children with a history of neurological, neuromuscular, rheumatological, dermatological, or systemic disease; current or previous LBP, spinal or pelvic fracture or lumbar surgery, abdominal incisions; and use of medication that can affect muscle size are excluded.

US exams are performed with a 7.5-MHz linear array transducer by two radiologists. Abdominal muscle thicknesses were measured at rest on both right and left sides. Adolescents were examined in supine crook-lying position (Figure 1). The transducer was placed transversely, in the anterior axillary line, between the 12th rib and the iliac crest. The images are obtained at the end of the expiration (Figure 2). Three different measurements for each muscle are obtained, the mean of the measurements are noted. Age, sex, body mass index, subcutaneous fat thickness (SFT), and height of the patients are also noted.

Figure 1. Supine crook-lying position

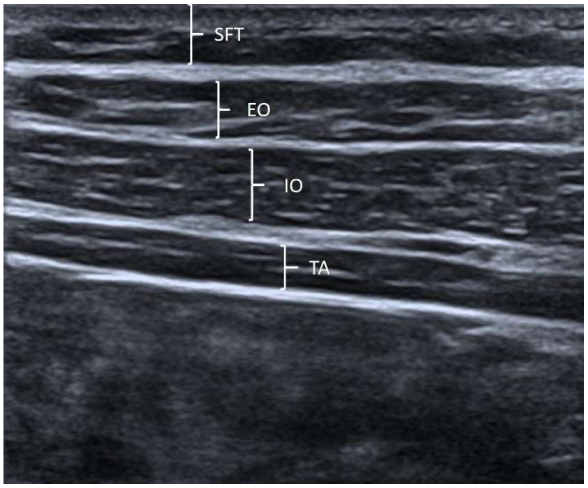

Figure 2. SFT: Subcutaneus fat thickness, EO: External oblique muscle, IO: Internal oblique muscle, TA: Transversus abdominis muscle

STATISTICAL ANALYSIS

Kolmogrov-Smirnov test was used to assess normality of distribution. A Paired t-test was used to analyze the differences between right and left sides. Student's t-test was used to assess the differences between boys and girls. The Pearson Correlation Coefficient test was used to evaluate the association between abdominal muscle thicknesses with gender age, subcutaneous fat thickness and BMI. A 2-tailed value of $P < 0.05$ was considered statistically significant.

RESULTS

Mean age of the population is 15.65 ± 2.25 years. Mean age of boys is 15.1 ± 2.7 years, mean age of girls is 16.2 ± 1.8 years. Weight, height, and BMI values are significantly higher in boys (Table 1).

Table 1. Demographic data of participants

Gender -Variables		Mean	p-value
Boys (n=80)	Age (year)	15.1±2.7	0.17
	BMI (kg/m2)	29.9±3.2	0.40
	Height (cm)	173.98 (7.71)	0.45
	Weight (kg)	170.6±21.1	0.41
Girls (n=80)	Age (year)	16.2±1.8	0.15
	BMI (kg/m2)	21.3±2.8	0.40
	Height (cm)	157.7±19.8	0.31
	Weight (kg)	66.4±5.5	0.18

Mean muscle thickness of all three muscles is higher in boys than girls. Mean thickness of IO is the biggest and the order of muscle thickness is the same between boys and girls (IO>EO>TA). Mean muscle thickness do not differ significantly between right and left sides in both groups. SFT values are similar between groups (Table 2 - 3).

Table 2. Mean muscle thicknesses in boys

Boys		Mean (mm)
Right	TA	2.71±0.13
	IO	5.31±0.87
	EO	3.22±0.56
	SF	3.01±0.21
Left	TA	2.68±0.17
	IO	5.19±0.72
	EO	3.18±0.47
	SFT	3.07±0.30

TA: Transversus abdominis, **IO**: Internal oblique, **EO**: External oblique, **SFT**: Subcutaneous fat thickness, **BMI**: Body Mass Index

Table 3. Mean muscle thicknesses in girls

Girls		Mean (mm)
Right	TA	2.53±0.21
	IO	4.30±0.80
	EO	2.97±0.47
	SF	3.05±0.27
Left	TA	2.55±0.27
	IO	4.23±0.76
	EO	2.95±0.45
	SFT	3.03±0.29

TA: Transversus abdominis, **IO**: Internal oblique, **EO**: External oblique, **SFT**: Subcutaneous fat thickness, **BMI**: Body Mass Index

There is a negative correlation between age and IO and EO muscle thicknesses. We cannot detect such a correlation between age and TA muscle thickness, and age and SFT values. We detect a positive correlation between mean weight - BMI values, and IO, EO, TA muscle thicknesses, SFT values. There is a positive correlation between mean height values and IO and TA muscle thicknesses, but we cannot detect this correlation for EO muscle thickness, and SFT values (Table 4).

Table 4. Correlation between the variables

	Age		Weight		Height		BMI	
	R	p-value	R	p-value	R	p-value	R	p-value
Mean TA	-0.067	0.542	0.479	0.001	0.249	0.003	0.414	0.001
Mean IO	-0.237	0.004	0.574	0.001	0.422	0.001	0.422	0.001
Mean EO	-0.224	0.005	0.400	0.001	0.785	0.681	0.323	0.001
Mean SFT	-0.257	0.675	0.422	0.001	0.347	0.482	0.368	0.001

TA: Transversus abdominis, **IO**: Internal oblique, **EO**: External oblique, **SFT**: Subcutaneous fat thickness, **BMI**: Body Mass Index

DISCUSSION

In the current study, we present a normative data about abdominal muscles thickness of adolescent Turkish population measured with US. Consistent with the literature (8, 5), mean muscle thicknesses are higher in males. We cannot detect any significant difference about muscle thicknesses between right and left sides. In the

literature there are different results. Rahmani et al. stated similar results with us in pediatric population (5), however Tahan et al. (8) stated that there is significant difference between sides in adult population. We believe that the difference might occur with exercise/practice increasing with age.

Regardless of the gender, the thickness order of the measured muscles is similar with the literature (IO>EO>TA). In the literature, studies mainly concentrate on data about adult population (8, 7, 10, and 11), the order of the muscle thicknesses are the same in adolescents with the adults.

We detected a negative correlation between age and abdominal muscle thickness, except for TA. Tahan et al. and Ota et al. reported similar findings (8, 12). Differently, Rankin et al. reported a weak negative correlation between TA thickness and age (1). Seeing our results, aging mainly affects superficial abdominal muscle thickness rather than deep ones (TA). This could be explained with fiber content of the muscles, such as IO and EO consist of mainly type 1 fibers, meanwhile TA mainly consists of type 2 fibers (13).

We detect a positive correlation between weight, BMI values, and IO, EO, and TA muscle thicknesses. Height values are positively correlated with IO, and TA muscle thicknesses, but such a correlation does not exist for EO muscle thickness. In the literature, there are contradictory results. Springer et al. (10) stated that all muscle thicknesses are correlated with BMI. However, Tahan et al. (8) cannot find such a correlation for TA muscle thickness. Scholten et al. studied with adolescents and stated that weight is the best predictor of the muscle thickness (14). Rahmani et al. found a positive correlation between height and all muscle thicknesses (5). Our results are partly similar; we cannot detect this relationship with EO muscle thickness. Similar with the literature (15, 5), we detect a positive correlation between SFT values, and BMI-weight.

Knowing the normal values of muscle thicknesses can help diagnosis of musculoskeletal complaints, such as LBP. It is stated in the literature that, morphological changes of abdominal muscles are related with LBP (16, 17). Also, muscle involvement can be assessed in musculopathies. Rate of hypertrophy, after athletic training or rehabilitation therapy, can also be followed up by using normal muscle thickness values.

The current study has some limitations. First, the population can be larger. Second, left handed /right handed participants might have different results, we cannot detect possible differences. Our results do not give information about children younger than 12 years. We cannot give information about interobserver variability, since not all of the patients were evaluated by both radiologists.

To conclude, knowing the normal thickness value of abdominal muscles can help diagnosis of pathologies like LBP and follow up of athletic training. Thickness of muscles lines up as IO>EO>TA. BMI, weight is positively correlated with muscle thickness. Age is negatively correlated with IO and EO muscle thicknesses.

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