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Araştırma

The Effect of Waist Circumference/Chest Circumference Ratio on Mortality in Intensive Care Units

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ABSTRACT

Objective: *Abdominal obesity causes many health problems such as cardiovascular diseases and metabolic disorders. Body mass index (BMI) does not give us information about body fat distribution. Waist circumference measurements demonstrate abdominal obesity more accurately. Therefore, we think that it will be more accurate to use waist circumference in intensive care scoring systems in predicting mortality.*

Material and Method: *In this study we investigated the patients' ages, BMIs, waist circumference, chest circumference, waist circumference/chest circumference ratio, APACHE 2 scores, SOFA scores, duration of mechanical ventilation and length of stay in ICU. We searched the effects of waist circumference/chest circumference ratio on mortality, and whether this ratio is more sensitive than body mass index by itself in determining mortality and its relationship between length of stay in ICU and duration of mechanical ventilation.*

Results: *We found no statistically significant difference between waist circumference, chest circumference and mortality. Similarly, there was not a significant difference between BMI and mortality.*

Conclusion: *We think that we need large, multi-centered studies to be able to determine the exact relationship between waist circumference and mortality in ICU.*

Keywords: *obesity, waist circumference, body mass index, mortality*

ÖZ

Bel Çevresi Göğüs Çevresi Oranının Yoğun Bakım Ünitesinde Mortalite Üzerine Etkisi

Amaç: *Abdominal obezite metabolik hastalıklar ve kardiyovasküler hastalıklar gibi birçok sağlık sorununa neden olmaktadır. Vücut kitle indeksi (VKİ) bize vücut yağ dağılımı ile ilgili bilgi vermemektedir. Bel çevresi ölçümleri abdominal obeziteyi daha doğru göstermektedir. Bu nedenle mortaliteyi belirlemede yoğun bakım skorlama sistemlerinde bel çevresini kullanmanın daha doğru olacağını düşünmekteyiz.*

Gereç ve Yöntem: *Bu çalışmamızda, hastaların yaşlarını, VKİ'lerini, bel çevrelerini, göğüs çevrelerini, bel çevresi/göğüs çevresi oranını, APACHE 2 skorlarını, SOFA skorlarını, mekanik ventilasyon sürelerini ve yoğun bakım ünitesinde yatış sürelerini inceledik. Bel çevresi/göğüs çevresi oranının mortalite üzerine etkisini, bu oranın mortaliteyi belirlemede VKİ'den daha duyarlı olup olmadığını ve yoğun bakımda kalma süresi ve mekanik ventilasyon süresi ile ilişkisini araştırdık.*

Bulgular: *Bel çevresi, göğüs çevresi ve mortalite arasında istatistiksel olarak anlamlı bir fark saptamadık. Benzer şekilde, VKİ ve mortalite arasında da anlamlı bir fark saptamadık.*

Sonuç: *Yoğun bakım ünitelerinde bel çevresi, göğüs çevresi ve mortalite arasındaki ilişkiyi belirleyebilmek için geniş, çok merkezli çalışmalara gereksinimimiz olduğunu düşünüyoruz.*

Anahtar kelimeler: *obezite, bel çevresi, vücut kitle indeksi, mortalite*

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INTRODUCTION

The prevalence of obesity is increasing all around the world [1-3]. The same increase in the prevalence of obesity is seen in intensive care units (ICUs) either [4,5]. It is more complicated to take care of obese patients in ICUs compared to non - obese patients.There are not enough information about the morbidity and mortality rates of obese patients in ICU. APACHE(Acute Physiology And Chronic Health Evaluation) 2 and 3 score systems do not include morbid obesity and its indicators such as BMI and waist circumference as prognostic indicators [6,7]. Acute postoperative pulmonary complications are more frequent in obese patients than non - obese ones [8]. Morbid obese patients are proned to cardiovascular diseases either [9]. Morbid obesity shortens the lifespan between 8 to 10 years [10].

The increased risk associated with obesity is not only related to the quantity of fat but also to its distribution . Since fat accumulated in central region is more active than fat in peripheral tissues; dyslipidemia, glucose intolerance, metabolic and cardiovascular complications such as diabetes mellitus are more frequently seen in individuals with central fat distribution [11,12]. It has already known that body mass index is associated with the mortality and morbidity rate in chronic diseases like cardiovascular diseases, type 2 diabetes and cerebrovascular events [13]. Furthermore, it is determined that abdominal obesity measured by waist circumference is more sensitive than body mass index in determination of the frequency of health problems associated with obesity [14-17].

In our study, we thought it would be more accurate to determine mortality rates based on waist circumference/chest circumference ratio rather than BMI. Currently, there is no data about the relationship between the chest circumference and waist circumference/chest circumference ratio and mortality. We investigated the effects of waist circumference/chest circumference ratio on mortality, whether this ratio is more sensitive than body mass index by itself in predicting mortality rates and its relationship between length of stay in ICU and duration of mechanical ventilation. We also support the idea that scoring systems used to predict mortality in ICU should include the indicators of obesity such as BMI or waist circumference. Although, we do not have any previous data concerning the relationship with waist circumference/chest circumference ratio and mortality, further studies may reveal a relationship between these parameters and mortality and these parameters may be involved in the mortality scoring systems used in ICU in the future.

MATERIAL and METHOD

We included 100 male patients who were treated in our intensive care unit during 4 - month period in this retrospective study. Female patients were excluded from the study due to the variability of their breast sizes. We did not discriminate our patients according to their comorbidities which is one of the main deficit of our study.

All patients were older than 18 years and they were followed from their admission to death or discharge from intensive care unit. Their height, weight, waist circumference, chest circumference were measured when they were admitted into the ICU before starting fluid treatment. Our study was approved by the local ethics committee.

The data were taken retrospectively from our patients' files and hospital information system. We recorded patient's age, body mass index, waist circumference, chest circumference, length of stay in ICU, duration of mechanical ventilation, APACHE 2 score and SOFA (Sequential Organ Failure Assessment) score in admission to ICU. Then we compared the relationship between these parameters and mortality.

RESULTS

A total of 100 patients were included in the study, and evaluated for descriptive statistics of variables (Table 1).

Body mass indices (BMIs) of the patients were < 20 kgm^{2-1} in 7 (7%), 20-25 kgm^{2-1} in 38 (38%), 25-30 kgm^{2-1} in 35 (35%) and > 30 kgm^{2-1} in 20 (20%) patients.

As for mortality rates of the patients, 73 (73%) patients survived whilst 27 (27%) patients died.

Waist circumference measurements were compared

Table 1. Patients' descriptive statistics of the variables.

	Descriptive statistics of the variables			
N=100	**Mean**	**SD**	**Median**	**Maximum**
Age (years)	58.13	16.57	62.00	91.00
Waist C. (cm)	99.10	14.37	97.00	133.00
Chest C. (cm)	101.99	10.90	99.50	128.00
Waist/Chest	0.961	0.117	0.965	1.185
BMI (kg/m^2)	26.12	4.93	25.45	39.70
APACHE II	14.50	7.72	14.00	32.00
SOFA	4.49	4.06	3.50	17.00
LS ICU	11.24	16.69	5.00	89.00
DMV	8.88	16.43	2.00	89.00

Waist C.: Waist Circumference
Chest C.: Chest Circumference
Waist/Chest: Waist circumference/Chest circumference ratio
LS ICU: Length of stay in ICU (days)
DMV: Duration of mechanical ventilation (days)

in consideration of the mortality of patients (Table 2). When we compared the median and range (maximum and minimum) of waist circumference of the patients who survived (97, 133-63) and exited (98, 123-65), and a statistically significant intergroup difference was not detected (p=0.589, and >0.05, respectively).

Chest circumference measurements were compared in consideration of the mortality of patients (Table 2). When we compared the median and range (maximum and minimum) of chest circumference of the patients who survived (97, 133-63) and exited (98, 123-65), and a statistically significant intergroup difference was not detected (p=0.294, and >0.05, respectively).

Waist circumference/Chest circumference ratios were compared in consideration of the mortality of patients (Table 2). When we compared the median and range (maximum and minimum) of waist circumference/chest circumference ratios of the patients who survived (0.959, 1.185-0.820) and exited (0.970, 1.153-0.789), and a statistically significant intergroup difference was not detected (p=0.686, and >0.05, respectively).

BMIs were compared in consideration of the mortality of patients (Table 2). When we compared the mean±SD of BMIs of the patients who survived (26.39±4.94) and exited (25.39±4.89), and a statistically significant intergroup difference was not detected (p=0.370, and >0.05 ns, respectively).

Duration of mechanical ventilation (days) were compared in consideration of the mortality of patients (Table 3). When we compared the median and range (maximum and minimum) of the duration of mechanical ventilation of the patients who survived (1, 89-0) and exited (8, 46-1), and intergroup difference was statistically significant (p=0.000, and <0.001, respectively ***).

Length of stay in ICU (days) were also compared in consideration of the mortality of patients (Table 3). When we compared the median and range (maximum and minimum) of the length of stay in ICU of the patients who survived (4, 89-1) and exited (8, 47-1), and a statistically significant intergroup difference was not detected (p=0.154, and >0.05, respectively).

Correlations between each variable were analyzed (Table 4). Waist circumference demonstrated strongly positive direct correlation with chest circumference (r=0.855**), waist c./chest c. ratios (r=0.517**), and also a strongly positive (r=0.761**) and statistically

Table 2. The comparison of mortality according to waist circumference, chest circumference, waist c./chest c. ratio, BMI .

	Alive (n=73)				Exitus (n=27)				
Parameters	**Mean**	**±SD**	**Median**	**Min-Max**	**Mean**	**±SD**	**Median**	**Min-Max**	**≥P**
Waist C.(cm)	99.75	14.63	97.00	63.00-133.00	97.33	13.73	98.00	65.00-123.00	p=0,589 ns
Chest C.(cm)	102.71	11.45	100.00	76.00-128.00	100.04	9.19	98.00	80.00-118.00	p=0,294 ns
Waist/Chest	0.958	0.126	0.959	0.820-1.185	0.971	0.089	0.970	0.789-1.153	p=0,686 ns
BMI (kg/m^2)	26.39	4.94	25.60	17.90-39.70	25.39	4.89	24.70	16.50-36.30	p=0,370 ns

*SD: Standard deviation, Min: Minimum, Max: Maximum, ns: nonsignificant, ***: significant*
Mann Whitney U Test
Waist C.: Waist Circumference
Chest C.: Chest Circumference
Waist/Chest: Waist circumference/Chest circumference ratio
BMI: Body Mass Index

Table 3. The comparison of mortality between duration of mechanical ventilation and length stay in ICU.

	Alive (n=73)				Exitus (n=27)				
Parameters	**Mean**	**±SD**	**Median**	**Min-Max**	**Mean**	**±SD**	**Median**	**Min-Max**	**≥P**
DMV	8.22	18.13	1.00	0.00-89.00	10.67	10.68	8,00	1.00-46.00	p=0.000***
LS ICU	11.40	18.47	4.00	1.00-89.00	10.81	10.76	8	1.00-47.00	p=0.154 ns

*SD: Standard deviation, Min: Minimum, Max: Maximum, ns: nonsignificant, ***: significant*
Mann Whitney U Test
DMV: Duration of mechanical ventilation (days)
LS ICU: Length of stay in ICU (days)

Table 4. Correlations between each variable.

		CORRELATION CHART							
N=100		**Waist C.**	**Chest C.**	**Waist/Chest**	**BMI**	**APACHE II**	**SOFA**	**LS ICU**	**DMV**
Age (years)	R	0.219*	0.042	0.258**	0.087	0.462**	0.189**	0.083	0.135
	P	0.028	0.677	0.000	0.392	0.000	0.008	0.240	0.059
Waist C. (cm)	R		0.855**	0.517**	0.761**	-0.077	0.033	0.042	0.021
	P		0.000	0.000	0.000	0.446	0.640	0.555	0.772
Chest C.(cm)	R			0.176*	0.688**	-0.114	0.020	0.047	0.023
	P			0.011	0.000	0.258	0.778	0.510	0.747
Waist/chest	R				0.307**	-0.049	0.035	0.016	0.002
	P				0.002	0.626	0.620	0.822	0.978
BMI (kg/m^2)	R					-0.053	0.026	0.069	0.075
	P					0.600	0.719	0.328	0.295
APACHE II	R						0.600**	0.183*	0.326**
	P						0.000	0.010	0.000
SOFA	R							0.167*	0.290**
	P							0.022	0.000
LS ICU	R								0.665**
	P								0.000

r=correlation in positive direction 0≤r≤0.29 low, 0.30≤r≤0.49 intermediate, 0.50≤r≤1 high
r=correlation in negative direction -0.29≤r≤0 low,-0.49≤r≤-0.30 intermediate, -1≤r≤-0.50 high
**p<0.05, **p<0.01, ***p<0.001*
Kendall'staub, Pearson Correlation
Waist C.: Waist Circumference, Chest C.: Chest Circumference, Waist/Chest: Waist circumference/Chest circumference ratio
BMI: Body Mass Index
LS ICU: Length of stay in ICU (days)

significant (p<0.05*, p<0.01**) correlation with BMI. There was not a statistically significant (p>0.05) correlation between waist circumference and APACHE 2 score, SOFA score, length of stay in ICU and duration of mechanical ventilation.

Chest circumference demonstrated a weakly positive correlation with waist c./chest c. ratio (r=0.176*), but strongly positive direct (r=0.688**) and statistically significant (p<0.05*, p<0.01**) correlation with BMI. There was not a statistically significant (p>0.05) correlation between chest circumference and APACHE 2 score, SOFA score, length of stay in ICU and duration of mechanical ventilation.

Waist c./chest c. ratio had a moderately positive (r=0.307**) and statistically significant (p=0.002<0,01**) correlation with BMI. There was not a statistically significant (p>0.05) correlation between waist c./chest c. ratio and APACHE 2 score, SOFA score, length of stay in ICU and the duration of mechanical ventilation.

There was not a statistically significant (p>0.05) correlation between BMI and APACHE 2 score, SOFA score, length of stay in ICU and duration of mechanical ventilation.

DISCUSSION

Since BMI does not demonstrate the distribution of body fat; we thought it would be more sensitive to predict mortality with waist circumference/chest circumference ratio rather than BMI. Although there is no previous study on the relationship between waist c./chest c. ratio and mortality, we would like to investigate this relationship.

BMIs of our patients were over 30 kgm^{2-1} and 25-30 kgm^{2-1} in 35 % of our patients.When we investigated the relationship between BMI and mortality, we saw that there was not a statistically significant difference between BMIs of our patients who survived and exited. There was a strongly positive and significant correlation between waist circumference and BMI. Similarly, a strongly positive and significant correlation between chest circumference and BMI, but a moderately positive and significant correlation between waist circumference/chest circumference ratio and BMI was observed. When we compared the waist circumferences in consideration of mortality, a significant difference was not found between the median waist circumference values of the patients who survived and exited. Similarly, there was not a significant difference between chest circumferences and waist circumference/chest circumference ratios of the patients who survived and exited.

In a study conducted by Paolini et al. [18], there was not a statistically significant difference between obese and overweight individuals in consideration of their BMIs and their mortality rates. It was concluded that BMI is a poor indicator in the prediction of mortality in obese individuals in ICU. Because BMI could be the same in patients with various fat distribution. Measurement of sagittal abdominal diameter is also being used in determining the distribution of visceral fat. In the same study it was seen that vascular risk profile (hypertension, diabetes) increases when sagittal abdominal diameter increases even in individuals whose BMI is lower than 30 kgm^{2-1}. There is also an increase in the risk of mortality in these patients.

In another study by Pischon et al. [19], where 359.387 patients from 9 European countries were included and BMI, waist circumference, waist circumference/hip circumference ratios of these patients were compared as for the risk of mortality. A total of 14.723 patients died at the end of 9.7 years of the study. When the relationship between BMI and mortality was analysed, the lowest risk of mortality was seen in men, and wome having BMIs of 25,3 kgm^{2-1}, and 24.3 kgm^{2-1}, respectively. When the individuals with the same BMI were compared it was seen that waist circumference and waist circumference/hip circumference ratio had a strong association with the risk of mortality. The risk of mortality was higher in patients with low and high BMI values than medium BMI values. While waist circumference showed a higher correlation with BMI, while waist circumference/hip circumference ratio was weakly correlated with BMI. Therefore waist circumference/hip circumference ratio is important in the demonstration of fat distribution. Adipose tissue, particularly visceral fat, secretes mediators which causes chronic diseases. This situation explains the significant role of abdominal fat played in the risk of mortality independent of BMI. The increased risk of mortality in individuals with low BMI is due to reduced muscle masses. Even in low BMI, waist circumference is positively correlated with the risk of mortality. The risk of mortality in patients with lower BMI is primarily related to respiratory problems. The risk of mortality in patients with higher BMI is associated with cardiovascular problems and cancer. The findings of this study indicate that the increase in the risk of mortality is accompanied by increases in both general and abdominal fat tissue . Results support the use of waist circumference, waist circumference/hip circumference ratio in addition to BMI in the assessment of the risk of mortality.

In our study, there was not a significant correlation between BMI and APACHE 2 and SOFA scores of our patients. There is a significant relationship between APACHE 2 , and SOFA scores and mortality. On the other hand there is not a significant relationship between BMI and mortality. These findings indicate that BMI is not a marker of mortality by itself. Similarly, there is not a significant correlation between waist circumference, chest circumference and waist circumference/chest circumference ratio and APACHE 2, and SOFA scores. Therefore waist circumference,

chest circumference and waist circumference/chest circumference ratio are not a marker of mortality by itself. But further studies with large number of patients may reveal a relationship between these indicators of obesity and mortality and these indicators may be used in mortality scoring systems in the future.

In our study, we found that 16 survived patients whose BMI was over 30 kgm^{2-1}, and the average of duration of mechanical ventilation was 14.68 days. However, there was not a statistically significant correlation between BMI and mechanical ventilation. Similarly, there was not a significant correlation between waist circumference, chest circumference, waist circumference/chest circumference ratio and duration of mechanical ventilation.

The main weak point of our study is the insufficient number of our patients that prevented us to reach statistically significant data. Another weak point is that we did not discriminate our patients according to their comorbidities. A statistically significant data about the effects of waist circumference/chest circumference ratio on mortality can be obtained with larger cohort studies and it will be more sensitive if the patients can be discrimated according to their comorbidities.

CONCLUSION

Not all forms of obesity are pathological and BMI can not provide us information about the distribution of fat, and BMI by itself is not a sufficient indicator to provide information on the mortality of patients admitted to the intensive care units. This is the main reason why we investigated the relationship between waist circumference, waist circumference/chest circumference ratio with mortality. However, due to the insufficient number of patients in this single-center, retrospective study, we found no statistically significant difference between waist circumference/chest circumference ratio with mortality, length of stay in ICU and duration of mechanical ventilation. Similarly, there was not a significant difference between BMIs and mortality rates.

That is why we need large, multi-centered studies to find the exact relationship between waist circumference/chest circumference ratio and mortality in ICU. We believe that our study will shed a light on future studies which may reveal a relationship between waist c./ chest c. ratio and mortality and such obesity indicators can be included in mortality scoring systems in the future.

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