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ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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The Relationship Between Osteosarcopenic Obesity with Frailty, Balance, Hand Grip Strength, Fatigue, Depression and Quality of Life in Geriatric Women

Geriatrik Kadınlarda Osteosarkopenik Obezite ile Kırılganlık, Denge, El Kavrama Kuvveti, Yorgunluk, Depresyon ve Yaşam Kalitesi Arasındaki İlişki

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ABSTRACT Objective: The aim of this study is to investigate the relationship between osteosarcopenic obesity (OSO) with frailty, balance, fatigue, depression and quality of life in the geriatric population. **Material and Methods:** Forty female patients who were over 65 years of age, had a body mass index (BMI) >30 kg/m^2 and were diagnosed with OSO after dual-energy X-ray absorptiometry and muscle strength measurements were included in the cross-sectional study. The demographic characteristics of the patients were recorded, and the parameters of frailty, muscle strength, mobility, balance, fatigue, depression and quality of life were evaluated with questionnaires. **Results:** The mean age of the 40 female patients included in the study was 70.72±5.27, and the mean BMI was 35.51±4.83. They had a mean body fat percentage of 48.48±4.84 and an Edmonton Frailty Scale score of 7.40±3.33. No significant correlation was detected between BMI and any of the clinical parameters. A significant and positive correlation was observed between patients' body fat percentages and frailty, fatigue and depression (r=0.813, r=0.792, r=0.538), while a significant and negative correlation was detected between fat percentage and muscle strength and balance (r=-0.420, r=-0.771). **Conclusion:** Our findings demonstrate that the level of frailty, fatigue, and depression increased, and balance and quality of life were impaired in geriatric patients diagnosed with OSO. In addition, we found that BMI alone was not a significant parameter in the diagnosis of OSO, while the fat percentage was more significant on the clinical parameters. Raising awareness about OSO in the geriatric population is an important step towards healthy aging.

Keywords: Osteosarcopenic obesity; frailty; fatigue; depression

ÖZET Amaç: Bu çalışmanın amacı, osteosarkopenik obezitenin (OSO) geriatrik popülasyonda kırılganlık, denge, yorgunluk, depresyon ve yaşam kalitesiyle ilişkisinin araştırılmasıdır. **Gereç ve yöntemler:** Kesitsel olarak tasarlanan çalışmaya, beden kitle indeksi (BKİ) >30 kg/m^2 olup çift enerjili X ışını absorbsiyometrisi ve kas gücü ölçümleri sonrası OSO tanısı alan, 65 yaş üzerinde 40 kadın hasta dâhil edildi. Hastaların demografik özellikleri kayıt altına alınıp kırılganlık, kas gücü, mobilite, denge, yorgunluk, depresyon ve yaşam kalitesi parametreleri anketlerle değerlendirildi. **Bulgular:** Çalışmaya alınan 40 kadın hastanın yaş ortalaması 70,72±5,27, BKİ ortalaması ise 35,51±4,83 idi. Vücut yağ yüzdesi ortalama 48,48±4,84, Edmonton Kırılganlık Ölçeği puan ortalaması da 7,40±3,33'tü. Hiçbir klinik parametre ile BKİ arasında anlamlı korelasyon saptanmadı. Hastaların vücut yağ yüzdeleri ile kırılganlık, yorgunluk ve depresyon arasında pozitif yönde (r=0,813, r=0,792, r=0,538), yağ yüzdesi ile kas gücü ve denge arasında negatif yönde (r=-0,420, r=-0,771) istatistiksel olarak anlamlı korelasyon saptandı. **Sonuç:** Geriatrik popülasyonda OSO tanılı hastalarda kırılganlık, yorgunluk ve depresyon düzeyinin arttığı, dengenin ve yaşam kalitesinin bozulduğu gösterildi. Ayrıca OSO tanısında BKİ'nin tek başına anlamlı olmadığı, yağ yüzde oranının klinik parametreler üzerine daha anlamlı olduğu belirtildi. Özellikle geriatrik popülasyonda OSO ile ilgili farkındalık yaratmak, sağlıklı yaşlanma için atılacak önemli bir adımdır.

Anahtar Kelimeler: Osteosarkopenik obezite; kırılganlık; yorgunluk; depresyon

Sarcopenia, obesity and osteopenia/osteoporosis are three interrelated clinical conditions which may have common pathophysiological factors. Osteosarcopenic obesity (OSO), which has been associated with some diseases affecting aging and mobility, has recently been described by Illich et al.[1] First, sarcopenic obesity has been described as muscle loss with excess fat, followed by the term osteopenic obe-

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sity, which indicates simultaneous excessive fatness with bone loss.[1,2] OSO, on the other hand, includes three items, 1) deterioration of bone health in the form of osteoporosis/osteopenia, 2) redistribution and infiltration of the increased adipose tissue into muscles and bones, and 3) sarcopenia due to the decrease in muscle mass and strength.[3] In addition, OSO insulin resistance is the result of endocrine imbalances such as decreased anabolic hormone production and the dysregulation of major metabolic pathways due to the increase in proinflammatory factors.[4]

The relationship between obesity and osteoporosis/osteopenia is a U-shaped curve that demonstrates both underweight individuals and those with excess fat are at risk.[3] New data suggest that there is a limit at which excess fat mass turns from being beneficial to being harmful for bone health, after a body fat threshold of 33 percent, visceral fat produces molecules that are harmful to the bone microenvironment.[3,5]

While adipose tissue was previously considered as a region for energy storage, today it is accepted as an endocrine organ that secretes many cytokines including leptin, adiponectin, tumor necrosis factor-alpha, interleukin and CRP.[6] As a result of increased fat infiltration, osteogenesis and myogenesis in the mesenchymal stem cells is suppressed with the increased expression of peroxisome proliferator-activated receptor gamma in the bone marrow, adipogenesis is facilitated, and the cycle results with an increased fat percentage in the bone and muscle.[7] In sarcopenia, which means a decrease both in the number and size of fibers (atrophy), the main cause of muscle mass loss is the imbalance between anabolism and catabolism. The main culprits of this balance problem are endocrine and inflammatory factors and protein loss.[6]

The dual-energy X-ray absorptiometry (DXA) and magnetic resonance imaging (MRI) techniques are the most accurate methods in diagnosing lean mass, bone mass and body fat percentage, which are among the body composition parameters.[8] Although MRI provides a more precise measurement of muscle mass, it is not widely used in diagnosis due to its high cost. Grip strength, single leg stance and gait speed tests are the primary tests to be conducted in clinical evaluation.

Although the pathophysiological mechanisms related to OSO are based on hypotheses, hormonal disorders due to the proinflammatory environment and excessive fat can lead to the loss of both muscle and bone tissue through various mechanisms, leading to an increase in frailty, risk of fall and fracture, and reduced physical activity. This situation increases adiposity in the vicious cycle of progressive muscle and bone loss accompanied by fat gain.[9] As life expectancy and the size of the elderly population increase, this disease will become more common and increase the healthcare costs.[10] Increased loss of balance and falling rates as a result of sarcopenia will trigger a vicious cycle that will result in immobilization, in this case, more bone loss, increased sarcopenia and obesity. Considering these pathophysiological processes, revealing the relationship of OSO with clinical data will be guiding in terms of follow-up and treatment. In this study, we aimed to reveal whether there is a relationship between the presence of OSO and vulnerability, balance, fatigue, depression and quality of life in the geriatric female population.

MATERIAL AND METHODS

This cross-sectional study included 40 female patients diagnosed with OSO, who presented to the Physical Medicine and Rehabilitation Outpatient Clinic of İzmir Kâtip Çelebi University Atatürk Training and Research Hospital between March 2019 and August 2019 and had a body mass index (BMI) >30 kg/m^2, were over 65 years of age, and were found to have an L1-L4 t score <-1.0 and a body fat percentage >32% in the DXA examination requested as a result of anamnesis and detailed examination, and a grip strength of <16 kg measured using a dynamometer.[11-13] The study protocol was approved by the İzmir Kâtip Çelebi University Clinical Research Ethics Committee (decision number: 26/14.03.2019). Written informed consent was obtained from all patients and all steps of the study were conducted according to the Declaration of Helsinki principles. Patients with diseases such as stroke and vertigo, which may affect the balance parameters, patients with prostheses, bone implants or grafts on the skin

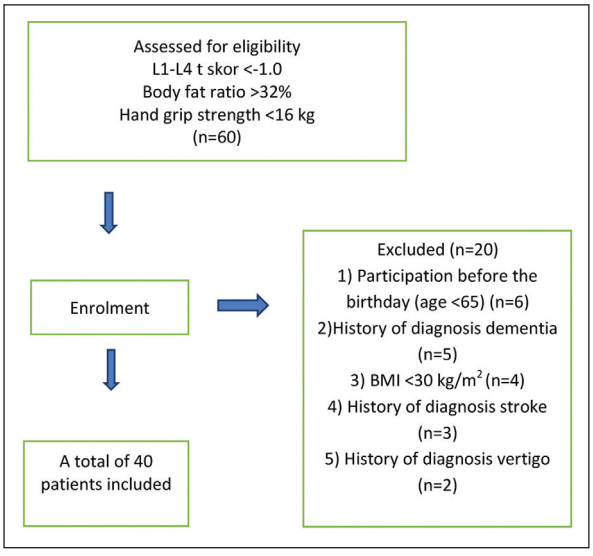

FIGURE 1: Study flow diagram.
BMI: Body mass index.

that may have an impact on whole-body DXA examination, and those diagnosed with cardiac failure, liver cirrhosis, kidney failure or cancer were excluded from the study. Twenty patients who did not meet the inclusion criteria were excluded from the study (Figure 1).

EVALUATIONS

Demographic and disease-related data such as age, height, weight, BMI, marital status, occupation, annual number of falls of the patients included in the study were recorded using an evaluation form. Frailty, muscle strength, mobility, balance, fatigue, depression and quality of life parameters of the cases were evaluated with questionnaires. Bone mineral density and body fat percentage were evaluated with DXA.

The patients' frailty levels were determined using the Edmonton Frail Scale. The scale consists of 11 questions and has nine sub-dimensions, including cognition, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance. The scale can be scored between 0 and 17. A total score of 0 to 4 means "not frail", 5 to 6 "apparently vulnerable", 7 to 8 "mild frailty", 9 to 10 "moderate frailty", and 11 and above "severe frailty".[14,15]

Grip strength of the patients was measured using a Jamar hand dynamometer. While the elbow was in extension and the shoulder and wrist were in neutral position, the patient was asked to squeeze the dynamometer with full strength. The mean value obtained by repeating the measurements made with the dominant hand three times was used for analysis.[16]

Timed Up and Go Test (TUG) was used for mobility assessment. This test measures the time after getting up from a chair, walking 3 meters and returning to the full sitting position on the chair. The time is recorded in seconds. This test has a high sensitivity and specificity for individuals who have the risk of movement disorders and falls.[17] If the measured time is longer than 12 seconds, it indicates the presence of a fall risk.

The Tinneti Balance and Gait Test, which evaluates the balance ability and gait especially in the geriatric population, is a scale that consists of two parts. The total balance parameter score in the scale varies between 0 and 26, and the total gait parameter score varies between 0 and 9. As the score increases, the risk of falling decreases.[18]

The Fatigue Severity Scale was used to measure the effect of fatigue on patients. The scale includes nine statements, scored using a 1-7 points Likert scale; where 1 point means "totally disagree" and 7 points 'totally agree'. Higher scores indicate higher levels of fatigue.[19,20]

The Geriatric Depression Scale consists of 30 easy-to-understand questions based on self-report, generally aimed at the elderly. Answers are given as "yes" and "no". Each given response that indicates depression is worth one point and responses otherwise are worth zero points.[21,22]

The Nottingham Health Profile, which is used to assess the quality of life, was developed as a general health questionnaire to determine the emotional, social and physical effects of diseases on the individual. The tool consists of 38 questions in six categories, including pain, emotional reactions, sleep, social isolation, physical activity, and energy. Questions are answered as "yes" or "no" and are scored between 0 and 100 in each section, where 0 indicates the best health status and 100 the worst health status.[23,24]

STATISTICAL ANALYSIS

Statistical evaluations were made using the SPSS (Statistical Package for the Social Sciences) v.20.0 software. In the evaluation of the obtained data, continuous variables were presented as mean±standard deviation and categorical variables as frequency and related percentage. The relationships between the continuous variables were evaluated using Spearman's correlation test.

RESULTS

The demographic characteristics of the 40 female patients included in the study are presented in Table 1.

TABLE 1: Socio-demographic characteristics of the participants.

	Mean±SD
Age (year)	70.72±5.27
Height (cm)	155.52±5.43
Weight (kg)	85.37±12.91
BMI (kg/m^2)	35.51±4.83
Menopausal age	46.37±5.28
The number of drugs used	2.85±1.84
Falling number per year	1.57±1.10
	n (%)
Job	
Housewife	33 (82.5)
Retired	7 (17.5)
Level of education	
Illiterate	11 (27.5)
Primary-high school	28 (70)
University	1 (2.5)
Marital status	
Married	20 (50)
Widow	20 (50)
Calcium replacement	
Yes	17 (42.5)
No	23 (57.5)
Hormone replacement	
Yes	2 (5)
No	38 (95)
Exercise	
Less than 3 days a week	8 (20)
More than 3 days a week	4 (10)
No	28 (70)
Habitual smoking	
Yes	6 (15)
No	31 (77.5)
Use in the past	3 (7.5)

BMI: Body mass index; SD: Standard deviation.

TABLE 2: Clinical characteristics of the participants.

	Mean±SD
T score	-1.82±0.65
Bone (%)	2.47±0.28
Fat (%)	48.48±4.84
Lean (%)	49.06±4.68
EFS	7.40±3.33
Grip strength	10.81±3.38
TUG	13.43±3.41
TBT	19.17±3.75
TGT	6.40±1.61
FSS	5.58±1.45
GDS	13.85±4.64
NHP pain	27.56±14.19
NHP emotional reactions	24.29±16.12
NHP sleep	24.01±16.26
NHP social isolation	25.73±16.08
NHP physical mobility	32.80±15.32
NHP energy	38.74±36.97

SD: Standard Deviation; EFS: Edmonton Frailty Scale; TUG: Time Up and Go; TBT: Tinetti Balance Test; TGT: Tinetti Gait Test; FFS: Fatigue Severity Scale; GDS: Geriatric Depression Scale; NHP: Nottingham Health Profile.

The mean age of the patients was 70.72±5.27 years, and the mean BMI was 35.51±4.83 (Table 1).

When the clinical characteristics of the cases were examined, the mean t score was found -1.82±0.65 and the mean body fat percentage was 48.48±4.84. The clinical characteristics of the patients are given in Table 2.

When the correlations of the patients' clinical parameters were examined, a strong positive correlation was found between fat percentage and frailty, TUG, fatigue, and depression scales, whereas a weak and negative correlation was found between fat percentage and muscle strength and a moderate negative correlation between fat percentage and balance (Table 3). A statistically significant positive correlation was found between the percentage of fat and the parameters of the quality of life scale (Table 4).

DISCUSSION

The aim of this study was to investigate the effect of OSO on frailty, balance, functionality, depression and quality of life. We found that as the fat percentage in patients increased, frailty, fatigue and depression also increased, while muscle strength, gait speed and qual-

TABLE 3: The correlations between fat (%), EFS, grip strength, TUG, TBT, FFS and GDS scores.

	BMI	Fat ratio	EFS	Grip strength	TUG	TBT	FFS
Fat (%)	r=0.217						
	p=0.179	-					
EFS	r=-0.001	r=0.813	-				
	p=0.997	p=<0.001					
Grip strength	r=-0.003	r=-0.420	r=-0.834	-			
	p=0.988	p=<0.001	p=<0.001				
TUG	r=0.084	r=0.709	r=0.800	r=-0.785	-		
	p=0.604	p=<0.001	p=<0.001	p=<0.001			
TBT	r=-0.012	r=-0.771	r=-0.900	r=0.776	r=-0.875	-	
	p=0.940	p:<0.001	p=<0.001	p=<0.001	p=<0.001		
FFS	r=0.029	r=0.792	r=0.875	r=-0.772	r=0.840	r=-0.855	-
	p=0.859	p=<0.001	p=<0.001	p=<0.001	p=<0.001	p=<0.001	
GDS	r=-0.081	r=0.538	r=0.731	r=-0.540	r=0.537	r=-0.644	r=0.682
	p=0.62	p=<0.001	p=<0.001	p=<0.001	p=<0.001	p=<0.001	p=<0.001

Spearman correlation test

BMI: Body mass index; EFS: Edmonton Frailty Scale; TUG: Time Up and Go; TBT: Tinetti Balance Test; FFS: Fatigue Severity Scale; GDS: Geriatric Depression Scale.

TABLE 4: The correlations between fat ratio, grip strength and NHP.

	NHP pain	NHP emotional reactions	NHP sleep	NHP social isolation	NHP physical mobility	NHP energy
Fat (%)	r=0.762	r=0.762	r=0.762	r=0.524	r=0.732	r=0.758
	p=<0.001	p=<0.001	p=<0.001	p=0.001	p=<0.001	p=<0.001
Grip strength	r=-0.744	r=-0.534	r=-0.464	r=-0.573	r=-0.731	r=-0.726
	p=<0.001	p=<0.001	p=0.003	p=<0.001	p=<0.001	p=<0.001

NHP: Nottingham Health Profile.

ity of life decreased. To the best of our knowledge, this is the first study to evaluate the relationship between the OSO and depression and fatigue variables in elderly patients.

Until recently, both osteopenic and sarcopenic obesity were generally overlooked as it was believed that excess fat mass protected the person from loss of muscle, movement and strength. Studies have shown that intramuscular fat infiltration can lead to decreased muscle quality, functionality and ultimately increased frailty.[25] In accordance with the literature, we also showed in our study that increasing fat mass in the body increases frailty. In a study conducted in Canada, it was reported that obesity increases frailty and consequently decreases the quality of life.[26] Frailty, which includes both psychosocial disorder and physical labor loss, is a multidimensional concept, thus, a holistic approach is required for its treatment. During this period, in which the field of geriatrics move towards the detection and treatment of disability in its early stages, frailty, an important health problem, can be reduced with the reduction of obesity and with the reduced rate of falls and fractures as a result of improving the patient's balance.

Adults above 50 years of age, experience a 1-2% reduction in muscle strength and muscle mass on a yearly basis, and this decline tends to accelerate in the following years.[27] Choi et al. reported that visceral obesity was independently associated with skeletal muscle mass loss.[28] In our study, we showed the positive correlation between obesity and sarcopenia (using muscle strength and TUG parameters). Sarcopenia can cause obesity by reducing physical activity and energy consumption, while obesity may cause sarcopenia by triggering inflammation.[29] In their study on 423 elderly individuals,

Öztürk et al. found that sarcopenic obesity was prevalent in 11% of the patients, and that this fraction had the lowest hand grip strength and gait speed, and the highest risk of falling.[30] Similarly, Huo et al. showed that the number of falls was higher in older adults with sarcopenic obesity than in the sarcopenic or obese group alone.[31] Although BMI is a predictor of obesity, it does not fully reflect the muscle mass and body fat. Accordingly, no statistically significant correlation was found between fat percentage and BMI in our study. We believe that when evaluating obesity and its risks in the elderly, taking the muscle function and mass into account is absolutely necessary. When the aim is to prevent obesity and sarcopenia, a healthy lifestyle that includes interventions regarding nutrition and exercise should be promoted. The effectiveness of physical activities to be performed within the programs to improve balance, ankle flexibility, muscle strength of the lower extremities and the ability to get up from the ground has also been demonstrated by studies.[32]

For patients diagnosed with osteopenic obesity, the increased risk of falls and fractures is one of the biggest concerns. Injuries after a fall and the fear of movement can drag patients to immobilization and decrease the quality of life, while increasing the health costs. Immobilization reduces the ability to live independently by worsening the sarcopenia, which is known to be associated with frailty, obesity, osteoporosis, and falls.[33] Ilich et al. compared 32 patients with OSO with 99 only obese patients and reported that OSO patients had a lower grip strength and could spend a shorter time when standing on one leg was.[25] Using computed tomography, Lang et al. demonstrated that fat infiltration increases the risk of hip fractures.[34] It has been shown that the risk of hip fracture increases in patients with a BMI >30 kg/m^2, and that decreased functionality and muscle strength after hip fractures are associated with frailty and increased morbidity.[35,36] Our study showed that the muscle strength and balance parameters, which are more valuable than the chronological age in evaluation of frailty, were impaired in patients with OSO. Again, in accordance with our study, Ma et al. showed that elderly patients who were diagnosed with OSO had low muscle strength and balance scores.[37] while Szlejf et al. reported that OSO was directly associated with frailty and poor physical performance.[38] Since the processes that lead to OSO start earlier, this situation should be considered as an early indicator of frailty and a window of opportunity for interventions, and these individuals should be informed about preventive measures.

Although fatigue may be the only complaint of a geriatric patient with sarcopenia, frailty or depression, the relationship between these findings has not been studied extensively. Patino et al. could not establish a relationship between sarcopenia and fatigue in patients over 60 years of age.[39] In a study conducted on 157 patients with osteoarthritis and rheumatoid arthritis, Vlietstra et al. found no relationship between sarcopenia and fatigue, however, reported the presence of a correlation between sarcopenia and body fat percentage.[40] Although we detected a strong statistically significant correlation between sarcopenia and fat percentage and fatigue in our study, there is a need for studies with larger populations to elucidate the underlying mechanisms in this relationship.

Depression status in patients with OSO has not been evaluated before. In our study, depression was found to be positively correlated with fat mass and fatigue, and negatively correlated with muscle strength and balance. In their study involving 3,862 participants, Hamer et al. showed that sarcopenic obesity is a risk for depressive symptoms.[41] Sarcopenia may cause depression due to reasons such as dependency in daily living activities, decreased food intake, impaired personal care, and immobilization.[41] Consistent with our results, Lino et al. reported that as the grip strength decreased, the level of depression increased, and Olgun et al. reported that the severe sarcopenia and depression were correlated.[42,43] Considering that the skeletal muscle also plays a role in metabolic responses, metabolic and endocrine disorders can be expected to negatively affect the mental functions. In 1,731 geriatric participants, Ishii et al. showed that obesity alone was a risk factor for depression due to insulin resistance, and sarcopenic obesity was correlated with depression.[44] Obesity-related chronic inflammation, imbalance in the hy-

pothalamic-pituitary-adrenal axis, and the stress due to hypermethylation of the glucocorticoid receptors increase the risk of developing depression.[28]

In individuals diagnosed with OSO, changes in the body composition, deterioration in the functional status and activities of daily living due to the increase in the risk of falling and increase in morbidity are expected clinical results. UI Haq et al. stated that there was a negative correlation between BMI and quality of life scores in adults over 65 years of age.[45] The only study evaluating the quality of life due to OSO in the literature is that of Keramidaki et al., in which no difference was observed in terms of quality of life between the group with OSO and without OSO.[46] The results of our study exhibited an increase in frailty, fatigue and depression and a decrease in quality of life in parallel with the increase in body fat percentage.

Our study had some limitations. The lack of a standard definition for OSO was our first limitation. In addition, the cross-sectional analysis prevented the establishment of a causal relationship between OSO and other variables. Although it has been shown in the literature that gender and OSO are not related, the absence of male participants in our study prevented the generalizability of the results.[46] Since only the patients diagnosed with OSO were included, our study did not have the power to show the differences between sarcopenic obesity and osteopenic obesity. The low number of patients and vitamin D level not being checked are other limitations of our study. Undoubtedly, while examining the relationship between balance and mobility with OSO, we think that the volunteers' vitamin D levels are also important due to age group. Although we have ruled out many clinical conditions in the exclusion criteria of the study that may affect balance and mobility, in the light of our current knowledge, the effect of vitamin D levels on these parameters is known.[28] In the geriatric female population, it has been reported that supplementation of a combination of vitamin D and calcium can help significantly reduce the risk of falling, hence significant effects on balance and mobility.[47]

CONCLUSION

In conclusion, we showed that patients with OSO exhibited a positive correlation between fat percentage and frailty, fatigue and depression, and a negative correlation between fat percentage and muscle strength, balance and quality of life. Raising awareness about OSO will help in developing new health policies in terms of healthy and active aging.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

All authors contributed equally while this study preparing.

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