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ORIGINAL ARTICLE

Relationship between thoracic kyphosis angle, dyspnea perception, and disease-specific health status in patients with COPD

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Purpose: This study was carried out to examine the relationship between thoracic kyphosis angle, dyspnea perception, and disease-specific health status in patients with COPD and thus to reveal the postural effect.
Methods: A total of 105 patients (68.10±8.59 years, FEV_1:47.59±21.50%) diagnosed with COPD were included in the study. The thoracic kyphosis angle was evaluated using the Spinal Mouse® device and the dyspnea perception with the Modified Medical Research Council (MMRC) Dyspnea Scale. For the disease-specific health status, the COPD Assessment Test (CAT) and the Clinical COPD Questionnaire (CCQ) were used. The patients were separated into three groups according to the thoracic kyphosis angle as Group 1: 20°-50°, Group 2: 51°-60°, and Group 3: 61°-90° and groups were compared.
Results: While a significant positive relationship at a low level was observed between the thoracic kyphosis angle and the dyspnea perception (rho=0.23, p=0.02), no relationship was determined with the disease-specific health status (rho<0.20, p>0.05). CAT and CCQ scores were similar between groups (p>0.05). In group 3 with thoracic kyphosis angle>60°, the dyspnea perception was significantly higher (p=0.03).
Conclusion: As the thoracic kyphosis angle increase in patients with COPD, the dyspnea perception increases, but the disease-specific health status remains stable. The postures of patients with COPD should be evaluated in detail in physiotherapy and rehabilitation practices due to increased dyspnea caused by thoracic kyphosis. Also, preventive measures such as exercise and ergonomic arrangements should be taken for thoracic kyphosis in the early period.
Keywords: Kyphosis, Dyspnea, Health status, Chronic obstructive pulmonary disease.

KOAH hastalarında torakal kifoz açısı ile dispne algısı ve hastalığa özgü sağlık durumu arasındaki ilişki

Amaç: Bu çalışma, KOAH hastalarında torakal kifoz açısı ile dispne algısı ve hastalığa özgü sağlık durumu arasındaki ilişkiyi incelemek ve böylece postüral etkiyi ortaya koymak amacıyla gerçekleştirildi.
Yöntem: Çalışmaya KOAH tanısı almış toplam 105 hasta (68,10±8,59 yıl, FEV_1: %47,59±21,50) dahil edildi. Torakal kifoz açısı *Spinal Mouse®* cihazı ile dispne algısı *Modified Medical Research Council Dispne Scale* (MMRC) ile değerlendirildi. Hastalığa özgü sağlık durumu için KOAH Değerlendirme Testi (CAT) ve Klinik KOAH Anketi (CCQ) kullanıldı. Hastalar torakal kifoz açılarına göre 20-50° (1. Grup), 51-60° (2.Grup) ve 61-90° (3.Grup) şeklinde üç gruba ayrıldı ve gruplar karşılaştırıldı.
Bulgular: Torakal kifoz açısı ile dispne algısı arasında pozitif düşük düzeyde anlamlı ilişki varken (rho=0,23, p=0,02) hastalığa özgü sağlık durumu ile ilişki yoktu (rho<0,20, p>0,05). CAT ve CCQ puanları gruplarda benzerdi (p>0,05). Torakal kifoz açısı 60°'den büyük olan 3. Grupta dispne algısı anlamlı olarak daha yüksekti (p=0,03).
Sonuç: KOAH hastalarında torakal kifoz açısı arttıkça dispne algısı da arttı, ancak hastaların hastalığa özgü sağlık durumu değişmedi. Torakal kifozun dispneyi arttırması nedeniyle fizyoterapi ve rehabilitasyon uygulamalarında KOAH hastalarının postürleri ayrıntılı olarak değerlendirilmelidir. Ayrıca, erken dönemde torakal kifoz için egzersiz ve ergonomik düzenlemeler gibi koruyucu önlemler alınmalıdır.
Anahtar kelimeler: Kifoz, Dispne, Sağlık durumu, Kronik obstrüktif akciğer hastalığı.

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In the Global Initiative for Chronic Obstructive Lung Disease (GOLD) report published in 2020, Chronic Obstructive Pulmonary Disease (COPD) is defined as a preventable, treatable, and common disease characterized by persistent respiratory symptoms and restricted airflow associated with chronic inflammation created by harmful gas and particles in the airway. Chronic airflow restriction generally leads to coexistence of emphysema and small airway diseases. Today, COPD is the fourth most common cause of death in the world.[1]

Postural changes, including thoracic kyphosis, occur in COPD.[2-4] Physiologically, the thoracic kyphosis angle is defined as the optimal working possibility of the cardiopulmonary organs within the chest wall.[5-7] While the physiological kyphosis angle has been reported as 20°-40° in adolescence, the normal upper limit in the elderly is accepted as 50°.[6-9] The postural changes occurring in COPD include internal rotation of the humerus, elevation of the scapula, and kyphotic spinal deformity together with protraction and abduction.[10,11] The changes occurring over time in the thorax accompanying hyper kyphosis lead to reduced pulmonary capacity.[2-4] An increase in the kyphosis angle can also cause a reduction in aerobic capacity.[5-7]

The symptom most frequently seen in individuals with COPD is dyspnea.[12] As the most common symptom and the reason given by patients for presentation at the clinic, dyspnea is characteristically stated to be persistent and progressive.[13] In patients with severe dyspnea, there are postural changes in the advanced stages.[2-4] Moreover, thoracic hyper kyphosis in addition to dyspnea results in respiratory failure.[3,14]

As several systems are affected, including the musculoskeletal system, naturally the disease-specific health status is affected in COPD, as well. The determination of the disease-specific health status as stated in the GOLD guidelines, allows the comprehensive evaluation of the effects occurring associated with COPD.[1,15] Postural problems can be overlooked in the clinical treatment of patients with COPD. In addition, we did not find any other scientific study in the literature that had the method and parameters we determined. Thus, we aimed both to contribute for the literature and to gain a different perspective for the evaluation and treatment of patients in the clinic. Therefore, the aim of our study was to examine the relationship between the thoracic kyphosis angle, dyspnea perception and the disease-specific health status in patients with COPD and to determine the postural effect.

METHODS

The study was carried out with 105 male patients diagnosed with COPD in the Department of Chest Diseases at the Evliya Çelebi Training and Research Hospital of Kütahya Dumlupınar University between December 2015 and June 2016. Approval for the study was granted by the Clinical Research Ethics Committee of Dumlupınar University (Approval number: 2016-3-21, date: 24.02.2016). Informed consent for participation was obtained from all the patients. The patients included were aged 40-85 years, had not undergone any thoracic surgery, had no neurological, orthopaedical or mental problems. Exclusion criteria were the presence of malignant disease, non-co-operation, illiteracy, being in the exacerbation stage of COPD.

The demographic and descriptive data of all the patients were recorded on an evaluation form. The thoracic kyphosis angle was evaluated with the Spinal Mouse® (SN 200217-2077, Idiag, Fehraltorf, Switzerland, 2012) device and the dyspnea perception with the Modified Medical Research Council (mMRC) Dyspnea Scale. For the disease-specific health status, the COPD Assessment Test (CAT) and the Clinical COPD Questionnaire (CCQ) were used.

Evaluation of thoracic kyphosis angle

The thoracic kyphosis angles were measured with a spinal mouse, which is an objective and reliable device to measure the spinal angle in the sagittal plane. The measurement was repeated 3 times and the highest value was taken for evaluation. With the patient on a flat platform standing in an anatomic position, the measurements were made by marking the thoracic spinal processes taken as reference. The data were immediately transferred to a computer screen.[16-18] In our study, in order to examine more specifically the correlation between thoracic kyphosis and the parameters we determined, the kyphosis angle

was grouped. The patients were separated into 3 groups according to the kyphosis angle as Group 1: 20°-50°, Group 2: 51°-60°, and Group 3: 61°-90°.[6-9]

Evaluation of dyspnea perception

To determine dyspnea perception, the patients were evaluated with the Modified Medical Research Council (mMRC) Dyspnea Scale, which has 5 different dyspnea scores from Grade 0 (totally adequate) to Grade 4 (totally inadequate). The mMRC Dyspnea Scale is the most widely used, reliable scale for the evaluation of dyspnea in the daily life of chronic respiratory patients.[19]

Evaluation of the Disease-Specific Health Status

To acquire information about the disease-specific health status, the patients were evaluated using the CAT and CCQ.

COPD Assessment Test (CAT): This test was created to evaluate the health status in COPD and consists of 8 items with a total score of 0-40. The results obtained after the administration of the test to the patients in the study were interpreted according to the CAT score.[1,20,21] The validity and reliability of the CAT was stated in a study by Yorgancioglu et al. in 2012.[20] CAT is a reliable method in the measurement of the disease-specific health status in COPD.[22]

Clinical COPD Questionnaire (CCQ): The CCQ, which was developed by Thys Van der Mohen, was applied to all the patients in the study. The CCQ consists of 10 items (4 symptom items, 4 functional status items, 2 mental status items) which measure with clinical control to evaluate the functional status, mental status and symptoms.[23,24] In 2010, Reda et al. showed the CCQ to be a reliable and sensitive questionnaire for use with patients with COPD and those at risk of COPD.[25]

Statistical analysis

The data obtained in the study were analyzed using Statistical Package for Social Sciences (SPSS) 21.0 software. Descriptive data were shown as mean ± standard deviation (SD) values, number (n) and percentage (%). Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test and non-normal distribution was determined. Therefore, non-parametric methods were selected. To show the differences between groups, the Kruskal-Wallis test was applied. A value of $p<0.05$ was accepted as statistically significant. To show correlations, Spearman analysis was applied. The results were analyzed with rho coefficients and p values. According to the rho coefficients, 0.00-0.19 showed no relationship, 0.20-0.39 a low (weak relationship, 0.40-0.69 a moderate level relationship, 0.70-0.89 a strong relationship, and 0.90-1.00 a very strong relationship.[26]

RESULTS

The demographic data of the patients in this study were examined to investigate the relationship between the thoracic kyphosis angle and dyspnea perception and the disease-specific health status in patients with COPD. The mean age of the whole patient group was 68.10±8.59 years, height was determined as 1.69±0.05 cm, body weight was 70.87±13.75 kg and body mass index (BMI) were calculated as 24.88±4.77 kg/m^2. The demographic data of the patients according to the kyphosis angle groupings are shown in Table 1. No statistically significant difference was determined between the groups in respect of age, height, body weight or BMI ($p>0.05$). Pulmonary function test results of the patients were FVC (L) 2.41±0.77, FVC 66.93±19.80%, FEV_1 (L) 1.32±0.63, FEV_1 47.59±21.50%, FEV_1/FVC 53.03±12.52% (Table 2).

Smoking and alcohol usages of the patients were examined. One hundred and four patients had smoking usage. When the smoking durations of these cases were calculated as pack-year, it was seen that the minimum 1 pack-year and the maximum 147 pack x year. The cigarette pack-year mean of the cases was determined as 46.24±25.05 pack x year (Table 2). Twenty-four patients with COPD were smoking and their percentage in all cases was 22.9. Only one patient (0.9%) who had never smoked, and the number of individuals with ex-smoker COPD was determined as 80 (76.2%). Six patients (5.7%) were consuming alcohol. Sixty-five patients (61.9%) had never consumed alcohol and 34 patients (32.4%) had quit alcohol.

The mMRC grades were stated as number of cases and percentage of the total cases (Table 3). When the mean values were examined, most of the patients were observed to be Grade 1, 2 or 3. The total number of cases recorded as Grade

0 or Grade 4 was approximately 10% of the whole sample.

The CAT scores and levels of effect were shown in Table 4. In 17 (16.2%) patients with a CAT score of 0-5, there was no effect and in 3 (2.9%) patients with a score of >30, the effect was very severe. The effect on the disease-specific health status was determined to be at a moderate level in most cases (n: 41, 39%). The CCQ symptom, functional status, mental status, and total scores were presented in Table 4.

The patients were compared in respect of the dyspnea perception and the disease-specific health status according to the groupings of the kyphosis angle scores (Table 5). A statistically significant difference was determined in Group 3 in the mMRC in respect of dyspnea perception ($p<0.05$). No statistically significant difference was determined between the groups in respect of disease-specific health status in the CAT, CCQ symptom, CCQ functional status, CCQ mental status and CCQ total scores ($p>0.05$).

The relationships between the thoracic kyphosis angle and the disease-specific health status and the dyspnea perception parameters were shown in Table 6. A significant positive relationship at a low level was observed between the thoracic kyphosis angle and the dyspnea perception (rho=0.23, p=0.02), and no relationship was determined with the disease-specific health status (rho<0.20, $p>0.05$).

DISCUSSION

In our study, evaluating the relationships between the thoracic kyphosis angle and the dyspnea perception and the disease-specific health status in patients with COPD, it was determined that the thoracic kyphosis angle had a negative effect on the dyspnea perception and the disease-specific health status was not affected by the level of thoracic kyphosis. In cases with hyper kyphosis of >60°, the dyspnea perception was found to be at a higher level. As the thoracic kyphosis angle increased in patients with COPD, the dyspnea perception increased, but the disease-specific health status did not change.

Over time, in patients with COPD, with a change in location of the head region towards the anterior, an increase in total kyphosis develops together with shoulder protraction in the upper body quadrant. An increase in thoracic kyphosis, causes severe muscle weakness and a reduction in flexion posture and pulmonary capacity.[27,28] The most striking symptom in COPD is dyspnea[4]. In some patients with hyper kyphosis, several events can develop associated with dyspnea such as acute respiratory failure or chronic respiratory failure which requires long-term respiratory support.[29,30] As a result of respiratory complications, there is a fall in quality of life. Dyspnea and respiratory failure associated with obstructive type or restrictive type diseases have been reported to show a relationship with the severity of thoracic hyper kyphosis.[14]

In a 2014 study, Gaude et al. examined the effect of postural alignment and respiratory muscle training on the dyspnea perception in 122 patients with COPD with thoracic hyper kyphosis, and consistent with the findings of our study, it was determined that there was a significant improvement in dyspnea perception associated with a decrease in the kyphosis angle. However, it was not fully understood from that study to what degree the reduction in kyphosis angle affected the dyspnea perception as respiratory muscle training was given.[31] In our study, as the relationship between the kyphosis angle and the dyspnea perception was examined specifically, it was possible to draw clearer conclusions. In another study which included 51 patients with COPD with thoracic hyper kyphosis at a mean kyphosis angle of 89°, a positive relationship was observed between the severity of kyphosis and respiratory failure.[32]

Another extensive study of musculoskeletal dysfunction in COPD compared COPD patients with healthy individuals. The thoracic kyphosis angle and dyspnea perception were seen to be greater in patients with COPD. However, although these higher values were expected in the patients, no significant difference was observed between the groups.[33] Another cross sectional, randomized, controlled study included 10 patients with COPD and to achieve postural alignment, the hold-relax special technique of the proprioceptive neuromuscular facilitation method (PNF), which is more effective than passive stretching, was applied to the pectoralis major muscle of the patients. The results of the study showed that despite obtaining postural improvement, there was no significant change in

Table 1. Comparison of the demographic data according to kyphosis angle groups.

	Group 1 (20-50°) (N=24)	Group 2 (51-60°) (N=32)	Group 3 (61-90°) (N=49)	
	X±SD	X±SD	X±SD	p
Age (years)	70.25±8.86	67.53±8.92	67.41±8.23	0.38
Height (cm)	1.69±0.04	1.68±0.06	1.69±0.06	0.59
Body weight (kg)	70.46±12.01	74.03±16.57	69.00±12.38	0.45
Body Mass Index (kg/m^2)	24.72±3.98	26.21±5.80	24.09±4.27	0.31

Table 2. Pulmonary function test results and the cigarette exposure.

	Total (n=105) X±SD
Pulmonary Function Test parameters	
FVC (l)	2.41±0.77
FVC %	66.93±19.80
FEV_1 (l)	1.32±0.63
FEV_1 %	47.59±21.50
FEV_1/FVC %	53.03±12.52
Cigarette (Pack x years)*	46.2±25.1

* N=104. FEV: Force Expiratory Volume. FEV_1: Force Expiratory Volume in One Second. FVC: Forced Vital Capacity.

Table 3. Grading of cases with Modified Medical Research Council Dyspnea Scale.

	Total (N=105) n (%)
Modified Medical Research Council Dyspnea Scale Degree	
Degree 0	6 (5.7)
Degree 1	24 (22.9)
Degree 2	31 (29.5)
Degree 3	39 (37.1)
Degree 4	5 (4.8)

Table 4. The Clinical COPD Questionnaire and the COPD Assessment Test scores according to influence levels of the cases.

			Total (n=105) X±SD
Clinical COPD Questionnaire Score	Symptom Score		9.62±4.52
	Functional Status Score		9.69±4.78
	Mental Status Score		4.48±4.08
			n (%)
COPD Assessment Test Score	>30	Very high	3 (2.9)
	>20	High	26 (24.8)
	10-20	Medium	41 (39.0)
	6-9	Low	18 (17.1)
	0-5	None	17 (16.2)

* N=104. FEV: Force Expiratory Volume. FEV_1: Force Expiratory Volume in One Second. FVC: Forced Vital Capacity.

Table 5. Comparison of the dyspnea perception and the disease-specific health status of cases according to the groupings of the kyphosis angle scores

	Group 1 (20-50°) (N=24)	Group 2 (51-60°) (N=32)	Group 3 (61-90°) (N=49)	
	X±SD	X±SD	X±SD	p
Dyspnea Perception (mMRC)	1.88±0.95	1.91±1.03	2.39±0.98	0.03*
Disease-Specific Health Status				
CAT	13.08±7.97	13.38±8.06	15.22±8.14	0.49
CCQ Symptom	9.17±4.31	9.06±4.49	10.20±4.67	0.46
CCQ Functional	8.50±4.96	9.94±4.79	10.10±4.68	0.43
CCQ Mental	4.63±4.37	3.78±3.49	4.86±4.31	0.53
CCQ Total	7.99±4.23	8.36±3.72	9.09±4.01	0.50

* p<0.05. CAT: COPD Assessment Test. CCQ: Clinical COPD Questionnaire. mMRC: Modified Medical Research Council Dyspnea Scale.

Table 6. The relationships between the thoracic kyphosis angle and the disease-specific health status and the dyspnea perception parameters (N=105).

	Kyphosis Angle rho (p)
Dyspnea Perception (mMRC)	0.23 (0.02)*
Disease-Specific Health Status	
CAT	0.04 (0.70)
CCQ Symptom	0.10 (0.29)
CCQ Functional	0.08 (0.42)
CCQ Mental	-0.01 (0.92)
CCQ Total	0.08 (0.43)

* p<0.05. rho: Spearman's rank correlation coefficient. CAT: COPD Assessment Test. CCQ: Clinical COPD Questionnaire. mMRC: Modified Medical Research Council Dyspnea Scale.

the dyspnea perception[11]. In another study, stable COPD patients aged mean 70 years underwent a 12-week course of yoga to increase postural alignment and spinal mobility. Following the yoga training, despite a postural improvement, no significant development was observed in the dyspnea perception evaluated according to the Borg scale.[34]

Several studies have preferred a forward bending position of short duration to be able to obtain kyphotic posture in patients with COPD and it has been concluded that a reduction occurred in dyspnea perception.[35,36] As thoracic hyper kyphosis is included in a chronic process, this position which is formed in a short period cannot be compared with a real full kyphotic posture. In contrast, it is known that a forward bending position allows the respiratory muscles to work more effectively and reduces the dyspnea perception. This can be considered the reason that the results obtained in our study differ from those of previous research. Sharp et al. suggested that the dyspnea perception was decreased due to the forward bending position providing an improvement in the length-tension relationship of the diaphragm which allowed the muscle to work more effectively.[35] In addition, Ogino et al. proposed the view that in this position, breathing was possible in a greater lung volume, and this created relief in dyspnea.[36]

In our study the dyspnea perception was evaluated, and it was understood that approximately 95% of the cases had a certain degree of dyspnea. A significantly positive relationship at a low level was determined between the thoracic kyphosis angle and dyspnea perception. In the comparison of the kyphosis groups, patients with hyper kyphosis of >60° were determined to have an increased

dyspnea perception. Thus, as the thoracic kyphosis angle increased, so there was seen to be an increase in the dyspnea perception felt by the patients.

In the updated GOLD guidelines, it was reported that examination of COPD patients with spirometry measurements only is insufficient, and it is necessary to also take into consideration the disease-specific health status including the functional status, the mental status and symptoms.[20] When the disease-specific health status was examined in our study, most of the patients were determined to be affected at a moderate level according to the CAT results. In the comparison of the kyphosis groups, even though there was a partial increase in the CAT score as the kyphosis angle increased, it was not significant. Moreover, the symptom, functional status, mental status, and total score parameters of the CCQ were similar. It was concluded that the kyphosis angle did not affect the disease-specific health status. In several studies where postural improvement has been occurred as a result of applications made to COPD patients,[37-39] the quality of life has been evaluated rather than the disease-specific health status and an improvement in quality of life has been observed. However, there is no study in literature which has examined the relationship between the disease-specific health status and the kyphosis angle in patients with COPD as in our study.

To evaluate the kyphosis angle in our study, the Spinal Mouse® was selected, which is a non-invasive, ergonomic, valid, and reliable device that does not involve radiation exposure and provides computer-assisted, objective, rapid data flow.[18,40] The thoracic kyphosis angles of the COPD patients were comprehensively compared. In these respects, our study can be important considerably.

However, limitations of our study could be said to be that there was no control group, and the groups were not separated according to gender. When it is considered that males and females may show different effects because of physical characteristics, it would have been more correct to have evaluated the patients according to gender. Future studies could be planned according to the gradings of the COPD patients to create homogenous distribution. Comparisons could also be made with healthy individuals and patients with different respiratory diseases to determine the effect of COPD.

In the clinic, symptomatic treatment is given with medical treatment for COPD patients. However, thoracic kyphosis, which has a negative effect on dyspnea perception in COPD, must not be ignored. It is thought that the information obtained as a result of our study will be of benefit to physiotherapists and healthcare professionals working in the field of Cardiopulmonary Rehabilitation on subjects such as reducing the negative effects associated with thoracic kyphosis in patients with COPD, slowing down the progressive course of the disease, providing the highest possible level of independence for the patient and improving quality of life.

Limitations

The limitations of our study are not having a control group and equal numbers of male and female cases.

Conclusion

The results of our study demonstrated that as the thoracic kyphosis angle increases in patients with COPD, the dyspnea perception increases. Patients with hyper kyphosis of >60° had severe levels of dyspnea perception. However, the change in the kyphosis angle was not determined to affect the disease-specific health status. In physiotherapy and rehabilitation practices, the postures of patients with COPD should be evaluated in detail, and in the early stage, protective measures should be taken for thoracic kyphosis in respect of exercises and ergonomic arrangements.

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