The Effect of Water-Based Pulmonary Rehabilitation on Anxiety and Quality of Life in Chronic Pulmonary Obstructive Disease Patients

Kronik Obstrüktif Akciğer Hastalığı Hastalarında Su İçinde Yapılan Pulmoner Rehabilitasyonun Anksiyete ve Yaşam Kalitesi Üzerine Etkisi

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ABSTRACT Objective: To investigate the effects of water-based pulmonary rehabilitation program on pulmonary functions, exercise capacity, anxiety and depression level and quality of life (QoL) in patients with chronic obstructive pulmonary disease (COPD). **Material and Methods:** Fifty moderate or severe COPD patients without respiratory failure were included. They were randomized either to water-based exercise (WE) group (n= 25) or to control group (n= 25). Spirometry and 6-minute walk test (6-MWT) were performed. QoL was assessed by the Chronic Respiratory Disease Questionnaire (CRDQ). Level of anxiety and depression was assessed using the Hospital Anxiety and Depression (HAD) Scale. WE group received 4-week water-based pulmonary rehabilitation program including shoulder girdle and upper extremity strengthening exercises for 35 minutes, three times a week (totally 12 sessions) in addition to medical therapy. Control group received only medical therapy. All the assessments were repeated one month after intervention in both groups. **Results:** The mean ages of the patients in WE and control groups were statistically not different (respectively 60.9 ± 8.8, 64.1 ± 8.9, p= 0.207). All the patients in both groups were males. No significant improvements in pulmonary functions and 6-MWT distance were observed at one month compared to baseline in both groups. We observed statistically significant decrease in anxiety scores and significant increases in dyspnoea, emotional function and patients' feeling of control over the disease scores of CRDQ at one month compared to baseline in WE group. In control group, no significant differences in anxiety and CRDQ scores were observed at one month compared to baseline. **Conclusion:** Pulmonary rehabilitation is known to be cost-effective in patients with COPD. Water-based exercises are effective in improving QoL and anxiety level in COPD patients, thus it can be supposed as an alternative to land based pulmonary rehabilitation programs.

Key Words: Rehabilitation; respiratory function tests

ÖZET Amaç: Kronik obstrüktif akciğer hastalığı (KOAH) olan hastalarda su içi pulmoner rehabilitasyon programının pulmoner fonksiyonlar, egzersiz kapasitesi, anksiyete, depresyon düzeyi ve yaşam kalitesi üzerindeki etkilerini araştırmak. **Gereç ve Yöntemler:** Solunum yetmezliği olmayan 50 orta veya ağır KOAH hastası alındı. Hastalar su içi egzersiz (SE) (n= 25) veya kontrol (n= 25) gruplarına randomize edildi. Spirometre ve 6-dakika yürüme testi (6-DYT) uygulandı. Yaşam kalitesi, Kronik Solunum Hastalıkları Anketi (KSHA) ile değerlendirildi. Anksiyete ve depresyon düzeyleri, Hastane Anksiyete ve Depresyon (HAD) ölçeği ile değerlendirildi. SE grubu, medikal tedaviye ek olarak dört hafta boyunca, haftada üç kez 35 dakikalık (toplam 12 seans) omuz kuşağı ve üst ekstremite güçlendirme egzersizlerini içeren pulmoner rehabilitasyon programı uyguladı. Kontrol grubu ise sadece medikal tedavi aldı. Her iki grupta tüm değerlendirmeler müdahaleden bir ay sonra tekrarlandı. **Bulgular:** SE ve kontrol gruplarındaki hastaların yaş ortalamaları istatistiksel olarak farklı değildi (sırasıyla 60.9 ± 8.8, 64.1 ± 8.9, p= 0.207). Her iki gruptaki tüm hastalar erkekti. Her iki grupta birinci ayla başlangıçtaki ölçümler karşılaştırıldığında pulmoner fonksiyonlarda ve 6-DYT mesafelerinde anlamlı düzelme saptanmadı. SE grubunda, birinci ayda başlangıca göre anksiyete skorunda istatistiksel anlamlı azalma ve KSHA'nın nefes darlığı, emosyonel fonksiyon ve hastalığı kontrol edebilme yeteneği skorlarında anlamlı artış gözlendi. Kontol grubunda ise birinci ayda başlangıca göre anksiyete ve KSHA skorlarında anlamlı farklılık saptanmadı. **Sonuç:** KOAH hastalarında pulmoner rehabilitasyon tedavisinin maliyet-etkin olduğu bilinmektedir. Bu hastalarda su içi egzersizler yaşam kalitesini ve anksiyete düzeyini düzeltmede etkilidir ve bu yüzden kara egzersizlerine alternatif bir rehabilitasyon programı olarak düşünülebilir.

Anahtar Kelimeler: Rehabilitasyon; solunum fonksiyon testleri

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Chronic obstructive pulmonary disease (COPD) is one of the leading causes of morbidity and mortality. COPD is a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases.[1,2] Its chronic, progressive nature and acute exacerbations influence the quality of life of COPD patients and increases the treatment costs.

Pulmonary rehabilitation is an evidence-based, multidisciplinary and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often with decreased daily life activities. Integrated into the individualized treatment of the patient, pulmonary rehabilitation is designed to reduce symptoms, optimize functional status, increase participation, and reduce health care costs through stabilizing or reversing systemic manifestations of the disease.[3]

Pulmonary rehabilitation is conventionally performed on land using exercise bicycles, treadmills and strengthening equipment alone or in combination. Water-based exercises can be an alternative component of pulmonary rehabilitation as they combine elements of strength, endurance, mobility training, psychosocial and low-cost benefits of group training. For decades, water exercises have been used as a part of rehabilitation medicine and their physiologic effects are well known. Water establishes a supportive training environment, provides a new therapeutic activity, decreases the risk of peripheral joint injury, and allows a return to prior activity. Rehabilitation programs offer advantages that are directly related to the intrinsic properties of water-namely, buoyancy, resistance, viscosity, hydrostatic pressure, temperature, turbulence and refraction.[4] Immersion in water leads to a higher stroke volume, a lower heart rate, and an increased work of breathing due to hydrostatic pressure. So, a higher intensity of training at a lower or unchanged circulatory load can be achieved.[5] In addition, water environment decreases the fear of falling and improves participation and adherence.[6] Water-based exercises were shown to be effective for COPD patients.[7,8] However, there are a few studies investigating the effects of water-based pulmonary rehabilitation programs on pulmonary functions and quality of life (QoL) in COPD patients.

After pulmonary rehabilitation programs in COPD patients, improvements in Chronic Respiratory Disease Questionnaire (CRDQ) scores,[9,10] in 6-minute walk test (6-MWT)[11,12] and in Hospital Anxiety and Depression (HAD) scale scores[9,13] were reported.

In a retrospective study performed to compare quality of life and physical performance in land- and water-based pulmonary rehabilitation in COPD patients, no difference was found between the two groups.[8]

The objective of this study was to determine whether water-based pulmonary rehabilitation program resulted in improvements in vital signs, pulmonary functions, arterial blood gas parameters, exercise capacity, anxiety and depression scores and QoL in patients with moderate or severe COPD.

MATERIAL AND METHODS

Fifty stable COPD patients, followed in Chest Diseases Outpatient Clinic between April 2006 and November 2006, were included in the study. The study protocol was approved by our Institutional Research Ethics Committee. All reported research involving 'Human beings' conducted in accordance with the principles set forth in the Helsinki declaration. The patients were graded according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) Diagnosis and Treatment Guidelines.[1] The patients with moderate COPD (FEV_1/FVC <70% and FEV_1%= 50-80) or severe COPD (FEV_1/FVC <70% and FEV_1%= 30-50) and patients without respiratory failure (PO_2 >65, SaO_2 >90) were included in the study.

Exclusion criteria were a) severe hypertension b) dizziness or fainting during exercises c) severe

congestive heart failure which could not be controlled under treatment d) unstable coronary artery disease e) terminal liver failure f) psychiatric instability g) behavioral disorder h) suspected bronchial asthma i) ongoing infectious disease.

The patients were randomized either to water-based exercise (WE) group or to control group according to 'Tables of random numbers'. All of the subjects gave written informed consents.

WE group received 4-week water-based pulmonary rehabilitation program for 35 minutes three times a week (totally 12 sessions) in addition to medical therapy. Control group received only medical therapy.

The demographics and data related to their disease (disease duration, smoking history, symptoms, physical examination findings, therapies they were administered) were recorded for each patient.

Arterial blood pressure, pulse/min, breathing frequency arterial O_2 saturation (SaO_2) were recorded at rest, and spirometry, arterial blood gas examination and 6-MWT were performed before the intervention.

WALKING TEST

In 6-MWT, the subjects were asked to walk as far as they could in six minutes with standardized encouragement.[14] To assess dyspnoea before and after 6-MWT, a visual analogue scale from 'nothing at all' (0) to 'maximal' (9) (Modified Borg Scale) was used.[15]

LUNG FUNCTION

Spirometry was performed by chest physician according to the 1994 American Thoracic Society (ATS) recommendations,[16] using the same type of spirometer (Model Zan 200 Prov Air II, Germany) for all subjects. During the testing, each subject was in an upright position and wearing a nose clip. At least three acceptable spirograms were obtained from a minimum of five forced expirations. The best single spirogram was identified by computer and confirmed by a technician. Several measures of lung function were used: the forced expiratory volume in 1 second (FEV_1), the forced vital capacity (FVC), and the FEV_1/FVC ratio.

ARTERIAL BLOOD GAS EXAMINATION

Radial artery was cannulated for blood sampling. Blood was anaerobically drawn from the cannulated radial artery and was tested for $PaCO_2$, PaO_2, SaO_2 and pH with a blood gas analyser (Roche OMNI S).

QUALITY OF LIFE

QoL was assessed by the CRDQ.[17] It evaluates four domains such as dyspnoea, fatigue, emotional function and patients' feeling of control over the disease (mastery).

ANXIETY AND DEPRESSION

Level of anxiety and depression was assessed using the HAD Scale[18] (which is specific for distress in physical ill subjects). The HAD Scale has been used in a number of clinical situations and found to be feasible, acceptable and reliable for patients with asthma.[19] The maximum score is 21 for depression and 21 for anxiety.

One month later physical examination, all tests and investigations were repeated for each patient in both groups.

WATER-BASED EXERCISE PROGRAM

WE group (n= 25) received a 4-week water-based exercise program conducted by a physiotherapist and chest physician at in aquatic centre, for 35 minutes, three times a week. The program lasted for four consecutive weeks in groups of varying in number eigth to nine participants. The water temperature was 32ºC, classified as thermoneutral. The patients were immersed into the water reaching the xiphoid level. The class composed warming-up, stretches and strengthening exercises. The aims of these exercises were to strengthen shoulder girdle and upper extremity muscles. The exercises consisted of shoulder flexion and extension, shoulder abduction and adduction, shoulder elevation, scapular protraction and retraction, scapular and pectoral stretches. Floatation devices such as noodles and foam barbells were used for resistance training.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS 10.0. Data are expressed as mean ± standard deviation. X^2 analysis was performed for evaluation of differ-

ences in frequencies of non-parametric variables. The variables were checked for normality before testing. Paired t-tests were used for analyzing repeated measurements and t-test was used for comparison of two groups, if the data showed normal distribution. Wilcoxon test was used for repeated measurements that did not show normal distribution. The power of the study was found to be 100% by power analysis. A *p* value <0.05 was considered as significant.

RESULTS

There were twenty-five patients in each group. The mean ages and BMI of the patients in WE group and control group were statistically not different. All the patients in both groups were males. The rates of smokers and alcohol users were not different between WE and control groups (Table 1).

No significant differences were found in both groups between the baseline and 1 month measurements of systolic and diastolic blood pressure, pulse/min and SaO_2. The medicines, the patients were administered, were statistically not different between two groups.

There was no statistically significant difference between baseline and 1 month pulmonary function test (PFT) measurements in both groups. There were no difference between WE and control groups in respect to PFT measurements both at baseline and 1 month. Among arterial blood gas parameters, there was significant increase only in SaO_2 in WE group at 1 month compared to baseline. On the other hand, there were no significant differences in arterial blood gas parameters between baseline and 1 month measurements in control group (Table 2).

TABLE 1: Demographics of the subjects in both groups.

	Water- exercise	Control	P value
Age (years) (Mean ± SD)	60.9 ± 8.8	64.1 ±8.9	0.207
Smoker n (%)	5 (20%)	6 (24%)	0.733
Ex smoker n (%)	20 (80%)	19 (76%)	
Alcohol user n (%)	7 (28%)	6 (24%)	0.747
*BMI (Mean ± SD)	26.2 ± 4.3	26.1 ± 4.1	0.960

*BMI: Body mass index.

TABLE 2: Comparison of baseline and one month PFT and arterial blood gas measurements.

	Water-exercise			Control		
	Baseline (Mean ± SD)	1 month (Mean ± SD)	p value	Baseline (Mean ± SD)	1 month (Mean ± SD)	p value
FVC%	76.6 ± 16.1	76.1 ± 18.5	0.726	75.8 ± 18.8	72.6 ± 16.5	0.086
FEV_1%	54.5 ± 15.6	54.5 ± 15.6	0.980	54.1 ± 20.2	52.7 ± 16.9	0.236
FEV_1 FVC	56.0 ± 10.5	56.5 ± 9.9	0.682	54.6 ± 9.1	52.7 ± 7.9	0.558
PEF %	53.4 ± 12.6	51.0 ± 14.7	0.338	52.3 ± 17.5	50.7 ± 15.9	0.505
pH	7.47 ± 0.0	7.48 ± 0.0	0.179	7.46 ± 0.0	7.48 ± 0.0	0.100
$PaCO_2$ (mmHg)	32.5 ± 4.9	32.1 ± 5.1	0.219	33.8 ± 4.1	33.7 ± 4.0	0.851
PaO_2 (mmHg)	65.9 ± 6.7	69.2 ± 11.3	0.082	67.0 ± 8.6	65.2 ± 10.4	0.411
SaO_2 (%)	92.4 ± 3.9	94.2 ± 3.0	0.002	93.2 ± 2.7	93.2 ± 2.8*	0.933

* p< 0.05 at 1 month when WE and control groups are compared.

FVC: Forced vital capacity, FEV1: Forced expiratory volume in 1 second, PEF: Peak expiratory flow, $PaCO_2$: Partial pressure of carbon dioxide in arterial blood, PaO_2: Partial pressure of oxygen in arterial blood, SaO_2: Arterial oxygen saturation of haemoglobin.

There were no differences in 6-MWT distances at baseline between two groups. At one month, 6-MWT distance was found to be significantly more in WE group compared to control group. However, no significant difference was found between baseline and one month 6-MWT distances in WE group. On the other hand, 6-MWT distance was found less at one month compared to baseline in the control group. There was no significant difference at baseline and one month between pre-test and post-test borg dyspnoea scores in WE and control groups (Table 3).

In control group, there were no statistically significant differences in HAD anxiety and HAD depression scores at one month compared to baseline (Table 4). In WE group, there was statistically significant decrease in HAD anxiety scores at one month compared to baseline. HAD depression scores also decreased, but the difference was not significant (Figure 1).

In control group, there were no statistically significant differences in CRDQ scores at one month compared to baseline (Table 4). Furthermore, in WE group, dyspnea, emotional function, mastery and total scores of CRDQ significantly increased at one month compared to baseline (Figure 2).

DISCUSSION

The results of this study demonstrate that clinically significant improvements in quality of life and anxiety level are achievable by a 4-week water-based pulmonary rehabilitation program in COPD patients.

On the other hand, we could not observe any improvement in pulmonary functions. In the literature, there are a number of studies investigating the effects of land-based pulmonary rehabilitation programs in COPD patients, but there are a few studies performed in water. The effect of pulmonary rehabilitation on pulmonary functions in COPD patients is controversial. In some studies, pulmonary rehabilitation was found effective in improving pulmonary functions,[20,21] but in some studies not.[22] It was of interest that no improvements in pulmonary functions could be achieved with the programs that did not include any respiratory exercises in COPD patients.[23,24] Casaburi et al. reported a 9% increase in FEV_1 with a 6-week pulmonary rehabilitation program that included respiratory exercises in moderate to severe COPD patients.[25] Vogiatzis et al. achieved significant increase in both FEV_1 and FVC by 4% and 6%, respectively with a 12-week pulmonary rehabilitation program that included modalities of exercise training and breathing control techniques in patients with a wide variation of airflow limitation.[26]

In Chest guidelines for pulmonary rehabilitation, 6 to 12 weeks of pulmonary rehabilitation is recommended to achieve benefits in several outcomes.[27] Our pulmonary rehabilitation program was relatively shorter than recommended in the guideline. Probably this can be the reason why we could not achieve improvements in PFT results and 6-MWT distances.

In the present study, we observed significant increase only in SaO_2 among arterial blood gas parameters in WE group at one month compared to baseline. However, there were no changes in arterial blood gas parameters in control group at one month. With some water-based pulmonary reha-

TABLE 3: Comparison of baseline and 1 month 6-MWT parameters in WE and control groups.

	Water-exercise			Control		
6-MWT	Baseline (Mean ± SD)	1 month (Mean ± SD)	p value	Baseline (Ort ± SD)	1 month (Ort ± SD)	p value
Distance (m)	425.0 ± 44.3	431.1 ± 61.4	0.557	383.9 ± 98.6	344.7 ± 107.8*	0.004
Pre-test dyspnoea	3.4 ± 1.4	2.7 ± 1.7	0.074	2.7 ± 1.7	2.9 ± 1.7	0.504
Post-test dyspnoea	4.0 ± 2.2	3.4 ± 2.1	0.168	3.7 ± 2.0	4.0 ± 2.2	0.271

* $p<0.05$ at 1 month when WE and control groups are compared.

TABLE 4: Comparison of baseline and one month HAD scores in control group.

	Control group		
	Baseline (Mean ± SD)	1 month (Mean ± SD)	p value
HAD			
Anxiety score	7.1 ± 4.9	6.6 ± 4.8	0.324
Depression score	7.0 ± 4.6	7.0 ± 4.4	0.983
CRDQ			
Dyspnoea	15.3 ± 7.6	15.0 ± 7.3	0.908
Emotional function	34.0 ± 10.0	32.4 ± 10.1	0.595
Fatigue	16.7 ± 5.9	16.7 ± 5.8	0.981
Mastery	21.0 ± 6.7	20.5 ± 7.1	0.769
Total score	86.4 ± 24.3	85.2 ± 24.7	0.865

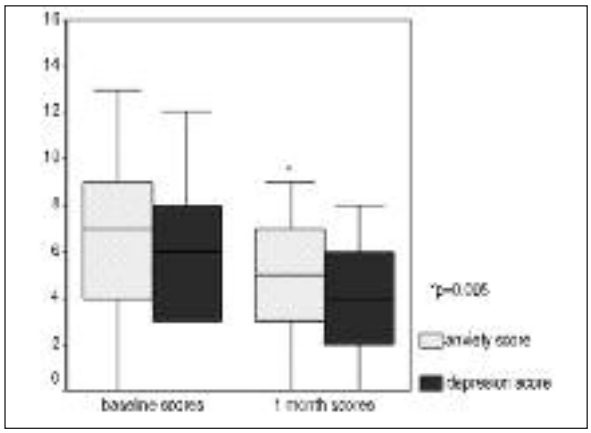

FIGURE 1: Comparison of baseline and one month HAD scores in WE group.

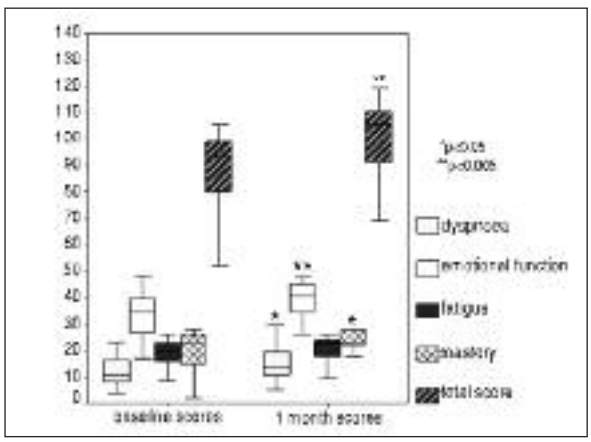

FIGURE 2: Comparison of CRDQ scores at baseline and one month in WE group.
(Mastery: patients' feeling of control over the disease).

bilitation programs, significant increases in PaO_2 and significant decreases in $PaCO_2$ were reported.[20] In COPD patients with chronic respiratory failure, 3.0 mmHg increase in PaO_2 and 3.3 mmHg decrease in $PaCO_2$ was achieved after pulmonary rehabilitation.[28] In our study, there was a 3.3 mmHg increase in PaO_2 at one month in WE group.

We did not observe significant improvement in 6-MWT distance in this study. There are studies, however, reporting improvements in 6-MWT distance after pulmonary rehabilitation either in the land- or water-based programs.[8,29] Wadell et al. observed significant increases in the distance in endurance shuttle walking testing in water-based exercise group compared to both land-based exercise and control groups in their study examining the effects of high intensity physical group training in water and on land for patients with COPD.[7] The reason why we did not achieve significant increase in 6-MWT distance may be due to the absence of lower extremity strengthening exercises in our water-based exercise program. Therefore, in Chest guidelines for pulmonary rehabilitation, a program of exercise training of the muscles of ambulation is recommended as a part of pulmonary rehabilitation for patients with COPD.[27] Lotshaw et al. included both upper and lower extremity strengthening exercises in both water-based and land-based pulmonary rehabilitation programs.[8] They observed significant improvements in 6-MWT distances after water- and land- based programs.

In our study, we did not observe significant difference in pre- and post- 6-MWT borg dyspnea scores at baseline and one month between WE and control groups. In some studies investigating the effects of land-based or water-based exercises for COPD patients, decreases in borg dyspnea scores were reported.[28,30]

We observed statistically significant decrease in HAD anxiety scores at one month compared to baseline in WE group. In a review in which 6 randomized controlled trials (RCTs) that compared pulmonary rehabilitation with standard care (with or without education) were included, three studies (n= 269) showed that comprehensive pulmonary rehabilitation was significantly more effective than

standard care in reducing short-term anxiety and depression.[31] Studies that included long-term follow-up data showed that gains in both psychological health status and health-related quality of life (HRQoL) were not sustained at 12 months. Sustained gains in psychosocial parameters can only be achieved by pulmonary rehabilitation programs with longer duration.[32,33]

In the present study, the baseline CRDQ scores were comparable in both groups. In WE group, we observed significant increases in dyspnea, emotional function, patients' feeling of control over the disease and total scores of CRDQ at one month compared to baseline. On the other hand, there were no significant changes in CRDQ scores in control group when baseline and one month scores were compared. In a Cochrane review investigating the impact of rehabilitation on HRQoL in patients with COPD, a total of 31 RCTs were included.[34] They found statistically significant improvements for all the outcomes in four important domains of QoL (CRDQ scores for dyspnea, fatigue, emotional function and mastery). Lacasse et al similarly also reported significant improvements in another review in daily symptom burden, emotional function, patient's control over disease, disease-specific health status, and exercise tolerance after pulmonary rehabilitation in patients with moderate to very severe airflow limitation compared to COPD controls receiving usual care.[35]

The limitations of our study were that the exercise duration and the follow-up were relatively short. Comparison of land-based and water-based exercises would be more accurate to be able to suggest water-based exercise as an alternative to land-based exercise. Additionally, the changes in quality of life and anxiety level in WE group could be due to the group therapy effect and attention by the therapist.

CONCLUSIONS

Water-based exercises are effective in improving QoL and anxiety level in COPD patients and water-based exercises can be alternative pulmonary rehabilitation programs. However studies comparing land-based and water-based exercises are needed to be able to suggest water-based pulmonary rehabilitation program as an alternative to land-based programmes. Water environment may have some advantages for COPD patients since a higher intensity of training at a lower or unchanged circulatory load may be achieved. Further studies including programs with longer duration, longer follow-up and comparing water- and land-based exercises in COPD patients are required to confirm our findings.

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Statement of submission: They state that the article is original, has not been submitted for publication in other journals and has not already been published. They state that they are responsible for the research that they have designed and carried out; that they have participated in drafting and revising the manuscript submitted, which they approve in its contents. They also state that the research reported in the paper was undertaken in compliance with the Helsinki Declaration and the International Principles governing research on animals.

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