Original Article

DOI: 10.14235/bas.galenos.2021.5339
Bezmialem Science 2022;10(3):346-52

Physiotherapy Program Applied After Liver Transplantation: Its Effect on Physical Fitness and Mobility

Karaciğer Transplantasyonu Sonrası Uygulanan Fizyoterapi Programı: Fiziksel Uygunluk ve Hareketlilik Üzerine Etkisi

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ABSTRACT

Objective: To investigate the effects of therapeutic exercises added to the comprehensive chest physiotherapy program after liver transplantation on physical fitness, movement level and kinesophobia.

Methods: Forty individuals with liver transplantation were included in the study. Individuals were divided into two groups by using simple randomization method. The first group was included in the comprehensive chest physiotherapy program. In addition to the comprehensive chest physiotherapy, combined therapeutic exercises with respiration were added to the program of the second group. The patients were included in the treatment program for 4 weeks, 1 session a day, and 5 days a week. Physical and demographic characteristics of the individuals were recorded. "Senior Fitness Test", "Patient Mobility Scale and Observer Mobility Scale", "Tampa Kinesophobia scale" were used to evaluate physical fitness, movement level and kinesophobia, respectively.

Results: Physical and demographic characteristics of the individuals were recorded. "Senior Fitness Test", "Patient Mobility Scale and Observer Mobility Scale", "Tampa Kinesophobia scale" were used to evaluate physical fitness, movement level and kinesophobia, respectively. According to the results of "Senior Fitness Test" aerobic endurance, lower extremity muscle endurance, dynamic The improvement in balance and agility parameters was significantly higher in group 2 ($p<0.05$). Results of the "Patient Mobility Scale" showed significant improvements in post-treatment measurements in both groups ($p<0.001$). The development in the 2nd group showed a significant difference compared to the 1st group ($p<0.05$). While a significant improvement was observed in both groups in

ÖZ

Amaç: Çalışmanın amacı; karaciğer transplantasyonu sonrası kapsamlı göğüs fizyoterapi programına eklenen terapötik egzersizlerin fiziksel uygunluk, hareket düzeyi ve kinezyofobi üzerine olan etkilerini araştırmaktır.

Yöntemler: Çalışmaya karaciğer nakli olan 40 birey dahil edildi. Bireyler basit randomizasyon yöntemi ile iki gruba ayrıldı. Birinci grup kapsamlı göğüs fizyoterapi programına alındı, 2. grubun programına kapsamlı göğüs fizyoterapisine ek olarak solunumla kombine terapötik egzersizler ilave edildi. Hastalar tedavi programına 4 hafta boyunca, günde 1 seans, haftada 5 gün alındı. Bireylerin fiziksel ve demografik özellikleri kaydedildi. Fiziksel uygunluk, hareket düzeyi ve kinezyofobiyi değerlendirmek için sırasıyla "Senior Fitnes Test", "Hasta Hareketlilik Ölçeği ve Gözlemci Hareketlilik Ölçeği", "Tampa Kinezyofobi Ölçeği" kullanıldı

Bulgular: Fiziksel uygunluk, hareket düzeyi ve kinezyofobiyi değerlendirmek için sırasıyla "Senior Fitnes Test", "Hasta Hareketlilik Ölçeği ve Gözlemci Hareketlilik Ölçeği", "Tampa Kinezyofobi Ölçeği" kullanıldı. "Senior Fitness Test" sonuçlarına göre, aerobik endurans, alt ekstremite kas enduransı ve dinamik denge ve çeviklik parametrelerinde gelişme 2. grupta anlamlı şekilde yüksekti ($p<0,05$). "Hasta Hareketlilik Ölçeği" sonuçlarında her iki grupta da tedavi sonrası ölçümlerde anlamlılık gösteren gelişmeler kaydedilmiştir ($p<0,001$). İkinci gruptaki gelişim 1. gruba göre anlamlı farklılık göstermiştir ($p<0,05$). "Gözlemci Hareketlilik Ölçeği" ve "Tampa Kinezyofobi Ölçeği" skorlarında tedavi sonrası her iki grupta da grup içi anlamlı bir gelişme görülürken ($p<0,001$), gruplar arasında anlamlı bir farklılık bulunmamıştır ($p>0,05$).

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Received: 16.09.2020
Accepted: 06.03.2021

Cite this article as: Bayraktar S, Atıcı E, Safran ES, Safran E. Physiotherapy Program Applied After Liver Transplantation: Its Effect on Physical Fitness and Mobility. Bezmialem Science 2022;10(3):346-52

the "Observer Mobility Scale" and "Tampa Kinesophobia Scale" scores after treatment (p<0.001), no significant difference was found between the groups (p>0.05).

Conclusion: The therapeutic exercise program added to breathing exercises after liver transplantation increased physical fitness, and also had positive effects on movement level and kinesophobia.

Keywords: Exercise therapy, liver transplantation, movement, physical fitness, respiratory therapy

Sonuç: Karaciğer transplantasyonu sonrası solunum egzersizlerine eklenen terapötik egzersiz programı fiziksel uygunluğu artırmıştır, ayrıca hareket düzeyi ve kinezyofobi üzerinde olumlu etkilere neden olmuştur.

Anahtar Sözcükler: Egzersiz tedavisi, fiziksel uygunluk, hareket düzeyi, karaciğer transplantasyonu, solunum terapisi

Introduction

Liver transplantation is a treatment method that is widely used in patients with acute or chronic liver failure, significantly increasing the life span (1). Decrease in skeletal muscle mass and muscle function is quite common in patients awaiting liver transplantation. This situation significantly reduces the quality of life of patients before and after transplantation and negatively affects the prognosis (2). Acid accumulation and edema accompanying the disease negatively affect ambulation, reducing physical activity and performance levels (3). Fatigue associated with low daily physical activity can lead to decreased exercise capacity, avoidance of activities and increased complaints (4).

Physiotherapy has an important role in increasing the activity level of the patient in the postoperative period and preventing complications due to inactivity. Activity planning based on the general condition of the patient, surgical intervention, hemodynamic-metabolic and functional status increases the success of surgical intervention and the quality of postoperative care (2). In the literature, the importance of an exercise program, which is started in the preoperative period and continued in the postoperative period, in terms of improving the health of the individual, has been emphasized in addition to the surgical success (1,4-6). However, the number of studies investigating the effectiveness of exercise program, especially in the early period, is limited.

In this study, we investigated the effects of an exercise program including active joint movements, posture exercises, sitting and walking training in addition to comprehensive chest physiotherapy on physical fitness, movement level and kinesophobia in patients who underwent liver transplantation. Movement level was examined in two ways, both for the patient and the physiotherapist.

Methods

Study Design

This clinical trial was designed as a prospective, randomized controlled trial. This study was conducted in Acıbadem Mehmet Ali Aydınlar University Atakent Hospital. Acıbadem Mehmet Ali Aydınlar University Medical Research Evaluation Board (ATADEK) approved this study with the decision number 2019-05/20. Participants were informed about the purpose of the study and the evaluations to be made, and the "volunteer informed consent form" was received.

Participants

Sixty seven patients who underwent liver transplantation in Atakent Acıbadem Liver Transplantation Center between March 2019 and November 2019 were included in the study. Patients over 18 years of age, spontaneously breathing, hemodynamically stable, conscious, cooperative and oriented were included. Patients with uncontrolled arrhythmia problems, progressive lung disease, multiorgan transplantation, neurological or neuropsychiatric problems, musculoskeletal problems that prevent exercise, and patients undergoing hemodialysis were excluded from the study. Individuals were randomly divided into two groups with the help of the Random Allocation Software program (Figure 1).

Outcome Measures

"Senior Fitness Test" (SFT), "Patient Mobility Scale (PMS) and Observer Mobility Scale" and "Tampa Scale of Kinesiophobia"

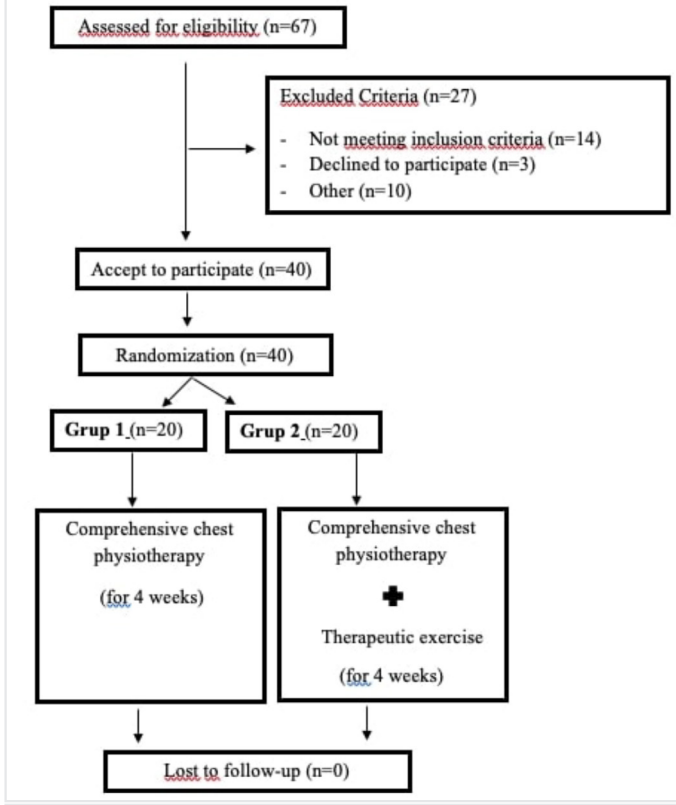

Figure 1. Flow diagram of the study

were used to evaluate physical fitness, movement level, and kinesiophobia, respectively.

The SFT, consisting of six test batteries, was used to assess physical fitness. 1: "Chair Stand Test" to evaluate lower limb muscle strength, 2: "Arm Curl Test" to evaluate upper-limb muscle strength, 3: "Chair Sit and Reach Test" to assess lower limb flexibility, 4: "Two Minutes Step Test" to evaluate aerobic endurance and lower limb muscle endurance, 5: "Eight Foot Up and Go Test" to assess dynamic balance and agility, 6: "Back Scratch Test" to evaluate upper limb flexibility (7).

The PMS evaluates pain and difficulty level caused by four activities performed after surgical intervention through the patient's perception; 1- Turning from one side to the other side of the bed, 2- Sitting at the bedside, 3- Standing up at the bedside, 4- Walking in the patient room. The numerical value of the degree of pain and difficulty was determined by measuring the distance between the sign the patient placed on the scale and 0 with a calibrated ruler. The scale score increase for the answers to the questions in the study indicated that pain and difficulty increased concerning the activity (8).

The Observer Mobility Scale (OMS) evaluates the patient's addiction-independence status by the observer during the four activities after surgery; 1- rotation, 2- sitting, 3- standing, 4-walking. The increase in the score indicates that the patients 'mobility skills are insufficient, and the decrease in the score indicates that the patients' mobility skills are good/sufficient (8).

The Tampa Scale of Kinesiophobia (TSK) is a questionnaire consisting of seventeen questions evaluating pain-related fear. High scores are indicative of the presence of high kinesiophobia. The fear assessment was based on fear of movement and avoidance behavior toward physical activity or fear of re-injury (9).

Follow-up

Hemodynamic and respiratory values were measured before and after treatment: Heart rate (pulse/min), respiratory rate (breath/min), systolic blood pressure (mmHg), diastolic blood pressure (mmHg), peripheral oxygen saturation (%).

Interventions

The patients were randomly divided into two groups: Group 1 received comprehensive chest physiotherapy, Group 2 received comprehensive chest physiotherapy plus a combined breathing exercise program. Exercises were performed for 4 weeks, 5 days a week, 1 session a day. All exercises were done under the supervision of a physiotherapist.

Comprehensive Chest Physiotherapy Program: A comprehensive chest physiotherapy program was applied to both groups. The program included standard breathing exercises, diaphragmatic breathing exercises, thoracic dilation exercises, stimulating spirometry training, cough training, postural drainage and percussion practices. Breathing exercises were taught in a sitting position on the bed and performed under supervision. During the exercises, the patients were asked not to be in a relaxed position and not to shrug their shoulders. The exercises were performed in a single set, 8-10 repetitions (Figure 2).

Therapeutic Exercise Program: In addition to comprehensive chest physiotherapy, a standardized therapeutic exercise program compatible with the clinical characteristics of the patients in the second group was applied. The program was combined with

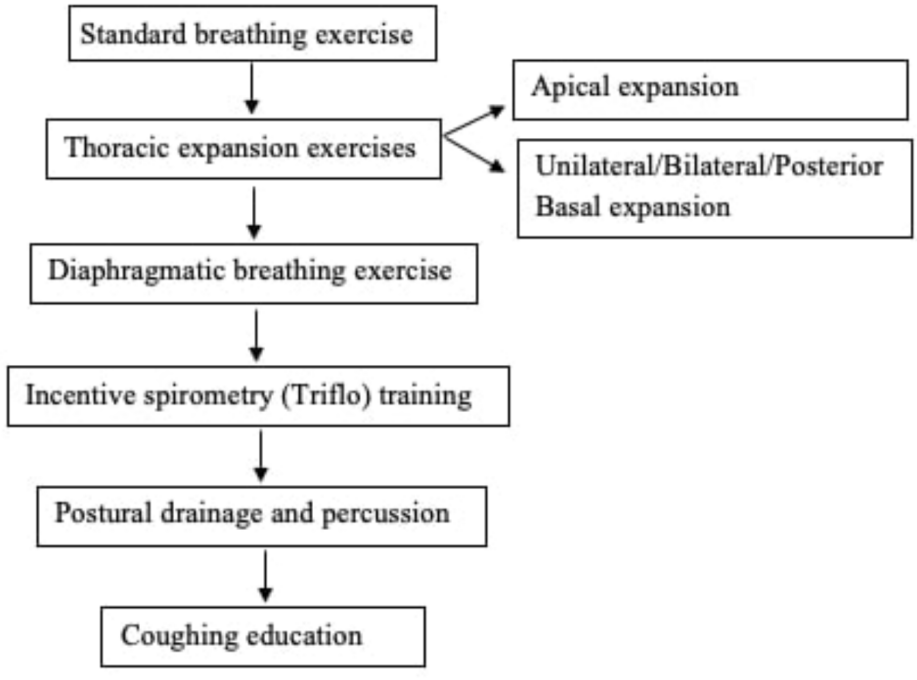

Figure 2. The comprehensive chest physiotheraphy program

breathing. Exercises including active joint movements, posture exercises, sitting and walking training were performed with a set of 8-12 repetitions (Figure 3).

Statistical Analysis

Statistical analyses were performed using SPSS 20.0 statistical program (SPSS Inc., USA). The data were analyzed with the Kolmogorov-Smirnov test to determine the distribution characteristics. In group comparisons: Paired Sample T-test was used for numerical data with normal distribution, and the Wilcoxon test was used for non-normal or ordinal data. In comparisons between groups: Independent Samples T-test was used for numerical data with normal distribution, and the Mann-Whitney U test was used for non-normal or ordinal data. The relationship between the data was evaluated by Pearson or Spearman correlation analysis according to the distribution characteristics. The chi-square test was used for categorical variables. A repeated measures analysis of variance test (ANOVA) was performed to compare the changes in physical fitness, mobility, kinesiophobia. The significance level was accepted as $p<0.05$ for all analyzes.

Sample size calculation was based on post-operative mean values Patient Mobility Scale score (8). We estimated that a sample size of 20 patients in each group would have a power of 95% with α value of 0.001.

Results

The demographic characteristics of the groups were similar ($p>0.05$). Considering the clinical features, the presence of diseases affecting systems such as diabetes mellitus and hypertension did not differ significantly in both groups ($p>0.05$). There was no surgical history in most patients (Table 1). Description of donors is shown in Table 1.

When looking at the SFT sub-items, there was a difference between the baseline scores of the groups in terms of the "Two minutes step test" and "Eight foot up and go test" ($p=0.029$, $p=0.025$), there was no significant difference between the two groups in terms of the initial evaluations of other sub-items ($p>0.05$). Intragroup comparisons of both groups were found to be highly significant between pre- and post-treatment values ($p<0.001$). Considering the evaluation between the groups, a significant difference was found in the improvement in the "Two minutes step test" and "Eight foot up and go test" values ($p=0.026$; $p=0.001$) (Table 2).

There was no significant difference between the groups in terms of the PMS and OMS test scores ($p>0.05$). In PMS, when the development in Group 2 was compared with Group 1, there was a significant difference in pain total score, experiencing difficulty level total score, and overall total score. ($p<0.05$). There was no difference between the baseline values of the

Table 1. Demographic and clinic characteristics of training and control groups*

	Grup 1 (n=20)	Grup 2 (n=20)	p
Demographic features			
Age (year)	53.25 (8.08)	54.05 (11.39)	0.79[a]
Female/male (n)	8/12	4/16	0.17[b]
BMI (kg/m²)	28.13 (4.04)	28.31 (4.79)	0.89[a]
Risk factors			
Duration of symptoms (months)	50.55 (66.34)	39.30 (34.30)	0.73[a]
Hypertension (n)	3 (15%)	2 (10%)	0.97[a]
Diabetes (n)	6 (30%)	8 (40%)	0.97[a]
Other surgical history			
None (n)	16 (80%)	15 (75%)	0.85[a]
Gall bladder (n)	2 (10%)	5 (25%)	0.85[a]
Inguinal hernia (n)	2 (10%)	- (0%)	0.85[a]
Donor selection			
Cadaveric organ	- (0%)	2 (10%)	0.15[a]
Living donor	20 (100%)	18 (90%)	
Relation to recipient			
Child	10 (50%)	12 (60%)	
Sibling	4 (20%)	3 (15%)	
Far relative	3 (15%)	2 (10%)	
External donor	3 (15%)	1 (5%)	0.85[a]
Cadaveric organ	- (0%)	2 (10%)	

BMI: Body mass index, ANOVA: Analysis of variance.
*Data are reported as mean (standard deviation) or n (%).
[a]One-way ANOVA.
[b]Chi-square test.

Exercise	Time	Activity
Warming	5-10 min	Active range of motion exercises
		(1 set of 8-12 reps)
Posture exercises	10-15 min	Thoracic mobility, Stretching exercises to the pectoral muscles
		(1 set of 8-12 reps)
Sit to stand exercise	5-10 min	Sit to stand on the bedside and in the chair
Walking exercise	15-20 min	Walking in the room and corridor

Figure 3. Standardized therapeutic exercise program suitable for the clinical features of the patients

OMS and post-treatment values between the groups (p>0.05) (Table 2).

When the initial and posttreatment values of TSK scores were compared, a significant decrease was observed within the groups (p<0.001), but there was no significant difference between the groups (p>0.05) (Table 2).

A negative correlation was found between TSK and lower extremity muscle strength, aerobic endurance, and lower extremity muscle endurance values which evaluated by Physical fitness test. (r_p=.560, p<0.001; r_p=.409, p<0.05). There was a positive significant correlation between TSK and dynamic balance and agility (r_p=.499, p=0.001, Table 3).

There was a highly significant correlation between TSK and PMS and OMS (r_p=.474, p=0.002; r_p=.574, p<0.001). Also a significant correlation was found between PMS and OMS (r_p=.815, p<0.001) (Table 4).

Discussion

In our study, we aimed to investigate the effects of a physiotherapy program, which included active joint movements along with breathing, posture exercises, sitting, standing and walking training, on physical fitness, movement level and kinesophobia, in addition to comprehensive chest physiotherapy in patients with post-operative liver transplantation. Considering physical fitness parameters, improvement in both groups was one of the main results of our study. However, the second group had better improvements in aerobic endurance, lower limb muscular endurance, dynamic balance, and agility. Neither treatment program was superior to each other in terms of improving patient mobility and fear of movement. The motion perception of the patients improved in both treatment programs, but the patient mobility perception was better in Group 2. OMS scores of the patients were similar after both trainings. Although kinesiophobia decreased in both groups, there was no difference

Table 2. Comparison of scales within the groups and between groups

Assessment	Group	Baseline	After treatment			
		Mean	Mean	Within-group score change	p[a]	p[b]
Senior fitness test						
Chair stand test (repetition)	Group 1	4.75±2.67	11.05±3.64	6.30±3.13	**0.001**	0.32
	Group 2	3.55±1.93	10.75±3.49	7.20±2.58	**0.001**	
Arm curl test (repetition)	Group 1	5±4.40	10.25±5.93	5.25±3.16	**0.001**	0.91
	Group 2	5.10±4.64	10.45±3.41	5.35±2.60	**0.001**	
Two minutes step test (repetition)	Group 1	25.95±25.25	56.50±28.68	30.55±25.95	**0.001**	0.02
	Group 2	8.95±11.39	59.85±31.47	50.90±29.48	**0.001**	
Eight (8) foot up and go test (sec)	Group 1	16.92±4.42	11.35±3.11	-5.56±2.92	**0.001**	0.001
	Group 2	20.25±4.63	11.04±2.02	-9.21±3.15	**0.001**	
Chair sit and reach test (cm)	Group 1	-15.65±14.97	-7±9.66	8.65±6.59	**0.001**	0.27
	Group 2	-16.85±11.25	-6±7	10.85±5.79	**0.001**	
Back scratch test (cm)	Group 1	-17.45±10.14	-8.55±6.77	8.90±4.88	**0.001**	0.91
	Group 2	-15.35±8.94	-6.3±6	9.05±4.32	**0.001**	
Patient Mobility scale						
Pain total score	Group 1	11±3.64	5.8±2.28	-5.20±2.41	**0.001**	0.042
	Group 2	12.4±3.15	5.5±1.5	-6.90±2.69	**0.001**	
Difficulty Total score	Group 1	13.3±3.29	6.55±2.81	-6.75±2.04	**0.001**	0.030
	Group 2	15.1±2.73	6.8±1.73	-8.30±2.29	**0.001**	
Total score	Group 1	24.3±6.48	12.35±4.74	-11.95±4.03	**0.001**	0.022
	Group 2	27.5±5.41	12.3±2.92	-15.20±4.53	**0.001**	
Observer Mobility scale						
Total score	Group 1	14.1±3.24	5.8±2.56	-8.30±2.92	**0.001**	0.107
	Group 2	15.2±2.82	5.45±1.7	-9.75±2.63	**0.001**	
Tampa scale of kinesiophobia						
Total score	Group 1	45.30±3.62	36.55±4.40	-8.75±3.98	**0.001**	0.06
	Group 2	48.50±4.85	37.25±3.90	-11.25±4.37	**0.001**	

Values are expressed as mean ± SD for within-and between-group score changes.
[a]Indicates a statistical significance of within the groups from the baseline to the after-treatment (paired-sample t-test)
[b]Indicates a statistical significance of between-group differences from the baseline to the after-treatment (repeated measures analysis of variance: ANOVA)

Table 3. Relationship between the Tampa Scale of Kinesiophobia and Senior Fitness Test scores

		Tampa scale of kinesiophobia	
		p	r_p
Senior Fitness Test	**Chair stand test (repetition)**	<0.001	-0.560**
	Arm curl test (repetition)	0.341	-0.154
	Two minutes step test (repetition)	0.009	-0.409**
	Eight (8) foot up and go test (sec)	0.001	0.499**
	Chair sit and reach test (cm)	0.106	-0.260
	Back scratch test (cm)	0.309	-0.165

r_p: Pearson correlation coefficient, **Significance of the relationship at 0.01 degrees

Table 4. Relationship between Observer Mobility Scale, Patient Mobility Scale and Tampa Scale of inesiophobia

	TSK		OMS		PMS	
	p	r_p	p	r_p	P	r_p
TSK	-	1	0.002	0.474**	<0.001	0.574**
OMS	0.002	0.474**	-	1	<0.001	0.815**
PMS	<0.001	0.574**	<0.001	0.815**	-	1

TSK: Tampa scale of kinesiophobia, OMS: The Observer Mobility scale, PMS: Patient Mobility scale
r_p: Pearson correlation coefficient, **Significance of the relationship at 0.01 degrees

between the groups. There was also a significant relationship between the motion perception of the patients and kinesophobia.

Physical fitness decreases in liver transplant patients (10). It is emphasized that rehabilitation programs should be planned to increase physical fitness after transplantation (11). In our study, when the sub-items of SFT, which evaluated physical fitness, were examined, a significant improvement was observed between the first and last values in both groups. The improvement in aerobic endurance, lower extremity muscular endurance, dynamic balance and agility in Group 2 was significantly higher than in Group 1. There was no statistically significant difference between the groups in terms of lower extremity muscle strength, upper extremity muscle strength, lower extremity flexibility and upper extremity flexibility. In the study by Ginneken et al. (11) evaluating the physical fitness of liver transplant recipients, it was reported that sedentary individuals showed a 16-34% deficiency in $VO2_{max}$ compared to those who exercised more than 1-2 hours a week. In another study, lower and upper extremity muscle strength, dynamic balance and agility values were found to be lower in patients who underwent liver transplantation compared to healthy sedentary individuals (12). Beyer et al. (13) reported that the exercise program applied after liver transplantation improved physical fitness, muscle strength and functional performance.

Promoting early postoperative ambulation plays an important role in achieving early independence and preventing complications. The patient is moved as much as he/she can tolerate and encouraged in his/her movements (14). In a study evaluating the movement levels of patients in the post-operative period, it was reported that patients had difficulty turning from one side to the other during their in-bed mobilization and needed help (15). In our study, we found that patients had more difficulty in turning from side to side in the bed compared to sitting by the bedside, standing by the bedside and walking in the patient's room during the pre-treatment period. OMS scores were similar to PMS scores. After the treatments we applied, we reduced the difficulties experienced by the patients.

Kinesiophobia leads to the disuse of muscle. This situation affects patients' quality of life negatively, resulting in various degrees of disablement and participation problems (16). In a study in which liver transplant patients were evaluated, the presence of kinesiophobia was reported in 68.8% of the patients (12). In our study, there was a significant decrease in TSK in both groups after exercise training, but no superiority was found between the groups. The most common situation in liver transplant patients before and after transplantation is the decrease in functional capacity. Also, we anticipate that the decrease in physical fitness and movement level has an impact on kinesiophobia. In our study it was found that in both groups, the levels of movement before treatment decreased and their perception of kinesiophobia increased. Significant improvements were noted in both groups after treatment. Stephenson et al. (10) reported that $VO2_{max}$ was 40-60% lower than estimated in liver transplant recipients. Since our patients were in the post-op period, we could not perform a pulmonary function test. However, we think that the main reason for the improvement of movement levels in both groups is primarily due to the increase in oxygen intake.

A negative correlation was found between post-transplantation kinesiophobia scores and the "Chair stand test", which evaluated the lower extremity muscle strength, one of the physical fitness score sub-parameters, and the "Two-minutes step test", which evaluated aerobic endurance and lower limb muscle endurance. Also a positive correlation was found between "Sit in a chair test"

and "Eight foot up and go" which assess agility and dynamic balance. The increase in physical fitness levels of the individuals participating in the study reduced the fear of movement. In the literature, there are no studies evaluating the effect and relationship of the physiotherapy program applied after liver transplantation on physical fitness and kinesiophobia. In this sense, our study carries the importance of being the first study to evaluate the effect and relationship of the physiotherapy program applied to patients after liver transplantation, on physical fitness and kinesiophobia.

Study Limitations

Our study also had some limitations. The patients could not be evaluated before transplantation. The condition of patients before transplantation could change the effectiveness of treatment. Short-term effects after rehabilitation were evaluated in the study. More studies are needed with long-term follow-up.

Conclusion

Physiotherapy program applied in patients whose clinical condition stabilizes after liver transplantation has been deemed important in terms of maintaining the physical fitness of the patients. Early mobilization plays a role in preventing complications that may occur. Breathing exercises and therapeutic exercises applied to patients in the early postoperative period improve the movement level of the patients.

In our study, only breathing exercises were given to the first group, while the second group was given a therapeutic exercise program in addition to these exercises. As a result, all patients showed significant improvements in mobility and fear of moving. There was no significant difference between the two groups in terms of the observer rating scale. There was a better improvement in the scores of the patient's self-assessment scale in the group to which therapeutic exercise was added. We think that this difference is due to the fact that patients feel better after exercise, and these findings will shed light on the rehabilitation programs to be developed for liver transplant recipients.

Ethics

Ethics Committee Approval: Acıbadem Mehmet Ali Aydınlar University Medical Research Evaluation Board (ATADEK) approved this study with the decision number 2019-05/20. **Informed Consent:** Participants were informed about the purpose of the study and the evaluations to be made, and the "volunteer informed consent form" was received.

Peer-review: Internally and externally peer reviewed.

Authorship Contributions

Concept: S.B., E.A., Design: S.B., E.A., E.E.S., Data Collection or Processing: S.B., Analysis or Interpretation: S.B., E.A., E.E.S., E.S., Literature Search: S.B., E.A., E.E.S., E.S., Writing: S.B., E.A., E.E.S., E.S.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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