P-60

Effects of Postoperative Pulmonary Tele-Rehab in Elderly Lung Cancer: A Randomized Controlled Trial

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Introduction

In previous studies on postoperative rehabilitation, exercise intervention was performed for 3 to 8 weeks after surgery, and significant improvements in exercise capacity and quality of life were confirmed. However, due to the long intervention period, outpatient supervised training has limitations that make it difficult to prescribe it in clinical practice. Therefore, in this study, we aim to examine effects of postoperative pulmonary tele-rehabilitation (PTR) using a well-known mobile instant messenger in elderly with lung cancer.

Participants and Methods

In the study, ambulatory participants aged 65 years or older who were diagnosed with lung cancer and were scheduled to undergo VATS were recruited. Eligible subjects were randomly assigned to the intervention group (IG) and control group (CG) in equal proportions. Participants in the IG utilized a mobile instant messenger (KakaoTalk) and phones for PTR three times a week for four weeks. The CG received only education on the home-based PR program on the second and third visit. Both groups maintained their exercise routine at least three times a week during a four-week follow-up period.

Results

Table 1 displayed comparable clinical variables between groups , with no statistically significant differences observed. Table 2 and 3 illustrated notable improvements in VO2peak and VO2peak% predicted within the Intervention Group (IG), with increases of 3.34 ml/kg/min and 13.81%, respectively, compared to the Control Group (CG). These enhancements were sustained after the four-weeks follow up period, with VO2peak registering at 3.84 ml/kg/min and 12.66% above than CG. In the within group comparison, significant improvement in the VO2peak was confirmed in the IG, but no significant difference was confirmed in the CG. In the comparison between groups, the IG exhibited a noteworthy decrease of 1.54 points in the EQ-5D index score during the intervention, which mean that health-related quality of life has increased, while other variables remained unchanged. In the within-group comparison, significant improvements in lung function parameters (Forced expiratory volume in one second, Forced vital capacity, Peak expiratory flow) over time, with EQ-VAS scores consistently enhanced in the IG.

Table 1. Pre-surgery characteristics

Variables		Overall (n=64)	IG (n=29)	CG (n=35)	†P-value	‡P-value
Sex	Male	36 (56.2)	15 (51.7)	21 (60.0)	0.681	0.615
Age, years		71.91 (4.69)	71.59 (4.52)	72.17 (4.87)	0.623	0.626
BMI, kg/m^2		24.18 (3.12)	24.39 (2.59)	24.00 (3.52)	0.621	0.325
FVC, % predicted		78.70 (11.85)	78.24 (12.08)	79.11 (11.83)	0.774	0.756
FEV1, % predicted		87.07 (14.72)	86.30 (15.87)	87.76 (13.83)	0.700	0.838
COPD		10 (15.6)	5 (17.2)	5 (14.3)	1.000	1.000
Heart diseases		9 (14.3)	7 (24.1)	2 (5.9)	0.089	0.068
Diabetes		18 (28.1)	10 (34.5)	8 (22.9)	0.453	0.404
Hypertension		33 (51.6)	18 (62.1)	15 (42.9)	0.201	0.141
mMRC (0-4)		0.83 (0.61)	0.83 (0.60)	0.83 (0.62)	0.995	0.910
Resection	Lobectomy	57 (89.1)	26 (89.7)	31 (88.6)	0.962	1.000
	Wedge resection	5 (7.8)	2 (6.9)	3 (8.6)		
	Segmentectomy	2 (3.1)	1 (3.4)	1 (2.9)		
Histologic type	Adenocarcinoma	52 (81.2)	23 (79.3)	29 (82.8)	0.569	0.654
	Squamous cell carcinoma	5 (7.8)	2 (6.9)	3 (8.6)		
	Others	7 (11.0)	4 (13.8)	3 (8.6)		
TNM_stage	I	39 (60.9)	20 (69.0)	19 (54.3)	0.475	0.566
	II	13 (20.3)	4 (13.8)	9 (25.7)		
	III	11 (17.2)	5 (17.2)	6 (17.1)		
	Unknown	1 (1.6)	0 (0.0)	1 (2.9)		
Neoadjuvant chemotherapy		1 (1.6)	0 (0.0)	1 (2.9)	1.000	1.000
Adjuvant chemotherapy		17 (26.6)	7 (24.1)	10 (28.6)	0.908	0.780
Adjuvant radiotherapy		4 (6.2)	1 (3.4)	3 (8.6)	0.746	0.620

† Independent t-test or Chi-squared test ‡ Wilcoxon rank-sum test or Fisher's exact test
Values are presented as mean ± SD or numbers (%). BMI, body mass index; CG, control group; COPD, chronic obstructive pulmonary disease; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; IG, intervention group; FEV1, forced expiratory volume in 1 s; COPD, chronic obstructive pulmonary disease; mMRC, Modified Medical Research Council dyspnea scale.

Table 2. Between-group differences in outcome measures

Variable		IG-CG: End rehabilitation (post-surgery 8 weeks−4 weeks)	IG-CG: 12 weeks from baseline (post-surgery 12 weeks−4 weeks)
VO_{2peak}, mL/kg/min		**3.34 (1.847, 4.835)***	**3.84 (2.142, 5.531)***
VO_{2peak}, % predicted		**13.81 (6.75, 20.87)***	**12.66 (5.529, 19.8)***
VE/VCO_2 Slope		3.41 (−1.116, 7.937)	−1.42 (−5.07, 2.225)
FEV1, L		0.03 (−0.057, 0.115)	0.04 (−0.086, 0.162)
FEV1, % predicted		4.83 (−0.688, 10.352)	5.52 (−1.356, 12.395)
FVC, L		−0.02 (−0.125, 0.093)	0.03 (−0.126, 0.176)
FVC, % predicted		2.66 (−1.902, 7.219)	5.23 (−0.966, 11.42)
PEF, L/min		−13.24 (−49.817, 23.327)	4.62 (−19.191, 28.431)
MIP, cmH_2O		−3.13 (−11.66, 5.405)	2.53 (−7.317, 12.369)
MIP, % predicted		−1.99 (−15.753, 11.772)	6.5 (−7.796, 20.795)
Grip strength, kg		−0.45 (−2.038, 1.145)	−0.56 (−2.429, 1.312)
BMI, kg/m^2		−0.03 (−0.86, 0.81)	0.35 (−0.468, 1.174)
SMI, kg/m^2		−0.07 (−0.348, 0.209)	0 (−0.148, 0.144)
Whole body phase angle, degree		0.14 (−0.056, 0.334)	0.1 (−0.123, 0.321)
HADS	Anxiety, points	−0.98 (−2.818, 0.853)	−0.83 (−2.367, 0.708)
	Depression, points	−0.48 (−2.292, 1.334)	0.12 (−1.829, 2.065)
EQ-5D	Index, points	**−1.54 (−2.972, −0.1)***	−2.6 (−6.463, 1.266)
	VAS, points	0.98 (−7.134, 9.099)	0.17 (−8.668, 9)

Data are presented as mean difference (95% CI). *P<.05.
BMI, body mass index; CG, control group; EQ-5D, EuroQol 5-dimension questionnaire; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; HADS, Hospital Anxiety and Depression Scale; IG, intervention group; MIP, maximal inspiratory pressure; PEF, peak expiratory flow; SMI, skeletal muscle index; VAS, visual analog scale; VE/VCO2, minute ventilation/carbon dioxide production; VO2peak, peak oxygen consumption.

Table 3. Within-group changes in outcome measures in the IG and CG

Variable	IG: End of rehabilitation (post-surgery 8 weeks−4 weeks)	IG: 12 weeks from baseline (post-surgery 12 weeks−4 weeks)	CG: End of rehabilitation (post-surgery 8 weeks−4 weeks)	CG: 12 weeks from baseline (post-surgery, 12 weeks−4 weeks)
	n=26	n=25	n=33	n=28
VO_{2peak}, mL/kg/min	**2.53 (1.388, 3.679)***	**2.72 (1.422, 4.015)***	−0.81 (−1.817, 0.203)	−1.12 (−2.273, 0.037)
VO_{2peak}, % predicted	**10.96 (5.595, 16.328)***	**10.2 (5.252, 15.148)***	−2.85 (−7.676, 1.979)	−2.46 (−7.848, 2.92)
VE/VCO_2 Slope	**4 (1.064, 6.945)***	−0.05 (−2.531, 2.436)	0.59 (−2.987, 4.175)	1.38 (−1.441, 4.191)
FEV1, L	**0.14 (0.071, 0.213)***	**0.19 (0.092, 0.284)***	**0.11 (0.061, 0.164)***	**0.15 (0.066, 0.234)***
FEV1, % predicted	**8.36 (3.286, 13.43)***	**10.23 (4.197, 16.254)***	**3.53 (1.14, 5.912)***	**4.71 (1.127, 8.285)***
FVC, L	**0.17 (0.085, 0.247)***	**0.25 (0.133, 0.37)***	**0.18 (0.104, 0.259)***	**0.23 (0.127, 0.326)***
FVC, % predicted	**6.77 (2.789, 10.744)***	**9.24 (3.787, 14.685)***	**4.11 (1.693, 6.522)***	**4.01 (0.821, 7.197)***
PEF, L/min	14.17 (−14.844, 43.18)	**28.72 (12.403, 45.037)***	**27.41 (3.796, 51.03)***	**24.1 (6.011, 42.189)***
MIP, cmH_2O	5.22 (−2.212, 12.647)	**7.91 (0.415, 15.411)***	**8.34 (3.8, 12.889)***	5.39 (−1.362, 12.136)
MIP, % predicted	9.46 (−2.778, 21.697)	**12.96 (1.426, 24.495)***	**11.45 (4.598, 18.302)***	6.46 (−2.548, 15.47)
Grip strength, kg	−0.31 (−1.554, 0.929)	−0.73 (−2.297, 0.832)	0.13 (−0.919, 1.187)	−0.17 (−1.269, 0.922)
BMI, kg/m^2	−0.16 (−0.888, 0.559)	0.27 (−0.295, 0.838)	−0.14 (−0.586, 0.308)	−0.08 (−0.702, 0.539)
SMI, kg/m^2	0.06 (−0.172, 0.3)	0.1 (−0.012, 0.22)	0.13 (−0.025, 0.291)	**0.11 (0.013, 0.2)***
Whole body phase angle, degree	0.04 (−0.088, 0.16)	−0.02 (−0.174, 0.134)	−0.1 (−0.258, 0.052)	−0.12 (−0.285, 0.048)
HADS Anxiety, points	−0.35 (−1.835, 1.143)	−0.92 (−2.23, 0.384)	0.64 (−0.502, 1.774)	−0.09 (−0.959, 0.772)
HADS Depression, points	−1.12 (−2.435, 0.204)	−1.04 (−2.548, 0.471)	−0.64 (−1.939, 0.666)	−1.16 (−2.455, 0.142)
EQ-5D Index, points	**−1.38 (−2.578, −0.191)***	−1.19 (−2.38, −0.005)	0.15 (−0.699, 1.002)	1.41 (−2.302, 5.115)
EQ-5D VAS, points	**6.35 (0.259, 12.433)***	**7.88 (0.655, 15.114)***	5.36 (−0.278, 11.005)	**7.72 (2.323, 13.114)***

Data are presented as mean difference (95% CI). * P within group changes <.05.
CG, control group; EQ-5D, EuroQol 5-dimension questionnaire; FEV1, forced expiratory volume in 1 second; FVC, forced vital capacity; HADS, Hospital Anxiety and Depression Scale; IG, intervention group; MIP, maximal inspiratory pressure; PEF, peak expiratory flow; SMI, skeletal muscle index; VAS, visual analog scale; VE/VCO2, minute ventilation/carbon dioxide production; VO2peak, peak oxygen consumption.

Conclusion

The main finding of this randomized controlled trial was that **mobile messenger-based PTR significantly improved VO2peak in elderly lung cancer patients after surgery**, the effect was maintained 4 weeks later, and also improved quality of life. These findings mean that PTR is a key treatment strategy that is fully feasible even for elderly lung cancer patients.