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SHORT COMMUNICATION

Exergaming in patients with a left ventricular assist device: a feasibility study

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Abstract

Aims Exercise games (exergames) have been recently proposed as a mode of facilitating physical activity in patients with chronic diseases. Although patients supported with left ventricular assist devices (LVADs) benefit from physical activity, specific LVAD-related issues hinder their ability to exercise properly. The objective of this study was to assess the feasibility and safety of exergaming in LVAD-supported patients.

Methods and results Eleven LVAD-supported patients were enrolled in a 4 week exergaming programme using Nintendo Wii console with five sport games. Patients were instructed to play for 30 min a day, 5 days a week. Data on exercise capacity and exergaming were collected by using the 6 min walk test (6MWT) and a daily self-report diary, respectively. Feasibility of using the console and its safety was assessed by a semi-structured patient interview. Quality of life was assessed by the Minnesota Living with Heart failure Questionnaire (MLHFQ) and the Cantril's Ladder of Life. Safety was assessed by patient's report in interview and diary. The study group consisted of 10 male patients and 1 female patient, mean age of 67 ± 7 years, of whom 10 were supported with the HeartMate 3 LVAD for a median of 10 (interquartile range 3, 21) months. Baseline exercise capacity assessed by the 6MWT ranged from 240 to 570 m (mean 448 ± 112). After 4 weeks of exergaming, 6MWT distance increased from a mean of 448 ± 112 (evaluated in six patients) to 472 ± 113 m (P = 0.023). Patients' Cantril's Ladder of Life score improved numerically from an average of 6.13 to 7.67, as did their MLHFQ score from 45.9 ± 27 to 38.7 ± 18, with higher and lower scores, respectively, reflecting higher quality of life. No specific LVAD-related safety issues regarding exergaming were reported.

Conclusions Exergaming was found to be a safe and feasible mode for encouraging physical activity in LVAD-supported patients and carries a potential for improving exercise capacity and quality of life in these patients. Larger scale studies are warranted to further investigate the effect of exergaming in this patient population.

Keywords Exergames; Left ventricular assist device; Heart failure; Exercise; Six-minute walk test

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Background

Left ventricular assist device (LVAD) implantation and heart transplantation are the only available treatment options for selected patients with advanced heart failure (HF). Given the increasing prevalence of HF worldwide alongside the stagnant availability of donor hearts, LVAD implantation has become a much more common and feasible option for these patients.[1]

Although the introduction of newer generation continuous flow LVADs has significantly improved patients' outcomes, a significant proportion of these patients still struggle with LVAD-related complications.[2,3] The post-operative recovery period after LVAD implantation is especially challenging, given

the significant physical deconditioning most advanced HF patients present before the operation. A multi-disciplinary rehabilitation team approach and a strong motivation on the patient's side are usually required to overcome this hurdle.[3]

Although physical activity has long been considered essential for patients with HF, patients after LVAD implantation often experience difficulties in complying with exercise training programmes aimed at improving their functional capacity, and most programmes have shown only modest efficacy.[4–6] Exergames, defined as videogames that require rigorous physical exercise, are a novel approach to encourage physical activity in several patient populations in general and specifically in patients with HF.[7,8] Given the difficulties patients face while trying to establish an exercise routine, exergaming could potentially overcome some of these barriers and promote physical activity.[9,10]

Aims

The aim of this study was therefore to examine the feasibility and safety of using exergaming to improve exercise capacity in patients after LVAD implantation.

Methods

Study design and patients

Included were 11 patients who underwent LVAD implantation between December 2019 and August 2020, who were routinely followed at our institution. All participants were treated with medical therapy according to their HF cardiologist instructions and had no neurologic or orthopaedic disability, which might have limited their ability to participate in the study. A 6 min walk test (6MWT) was performed at time of consent and 4 weeks after the intervention. All patients provided written informed consent prior to enrolment in the study. The trial protocol was approved by the local ethics committee and fulfilled all principles of the Declaration of Helsinki.

Game device

For this study, we used the Nintendo Wii game computer. Each patient received the exergame computer, two remote controls, and the Nintendo Wii Sports game, which is a collection of five sport simulations: baseball, bowling, boxing, golf, and tennis. Patients were instructed to move the exergame remote in similar ways the sport is played in real life, for example, holding and swinging the remote as a bowling ball or tennis racket. In general, they were instructed to play the sport games with the computer game for 30 min a day, 5 days a week, and to report their daily activity and LVAD-related issues using a daily self-report diary.

Data collection

Baseline characteristics were collected at screening, and haemodynamic parameters were collected at each visit. Exercise capacity was evaluated by the 6MWT and exergaming time and specific LVAD-related issues by a daily self-report diary. Feasibility of using the console was assessed by a semi-structured patient interview performed at the end of the study by a study coordinator (after 4 weeks of exergame use). Quality of life (QOL) was evaluated by the 21-item Minnesota Living with Heart failure Questionnaire (MLHFQ)[11] and by the Cantril's Ladder of Life (10-point scale).[12] Each patient was evaluated on the day of consent and 4 weeks after intervention.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation or median [interquartile range (IQR)] and qualitative variables as number and percentage. A paired sample *T*-test was used to compare results at baseline with those at 4 weeks after exergaming. All statistical analyses were performed with IBM SPSS Version 28. A P value of <0.05 was considered statistically significant.

Results

Of the 11 patients, 10 were males (91%), mean age was 67 ± 7 years, and 10 (91%) were supported with the newest generation HeartMate 3 LVAD for a median of 10 (IQR 3, 21) months. Baseline characteristics of the cohort are reported in *Table 1*. At baseline, nine patients (81%) had grandchildren, six patients (54%) reported a background of high degree education, and five patients (45%) had their LVAD implanted as destination therapy (DT). The pre-LVAD HF aetiology was ischaemic in seven patients (63%), and nine patients reported New York Heart Association (NYHA) functional class of II (81%). There was a high variability in terms of time spent exergaming with some patients complying with the instructions given and others not.

Exercise capacity was significantly improved from a mean of 448 ± 112 m in the 11 patients who completed the 6MWT at baseline to 472 ± 113 m in the 6 patients who completed the test after 4 weeks of exergaming (P = 0.023) (*Figure 1*). To note, of the five patients who did not complete their 4 week 6MWT, four patients would not come in for their repeat visit because of the ongoing coronavirus disease

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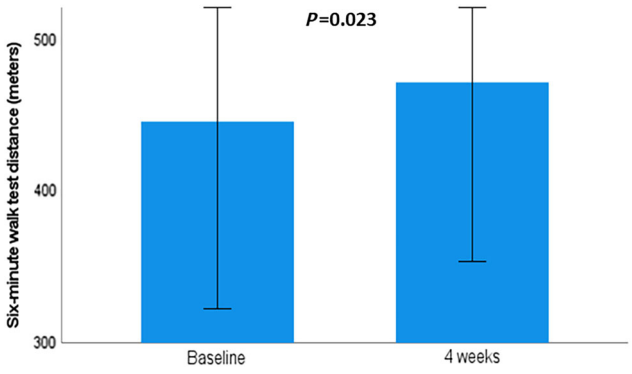
Table 1 Baseline characteristics

Variable	Total (n = 11)
Age, years	67 ± 7
Male gender	10 (91)
Married	9 (81)
Having grandchildren	9 (81)
Education	
Low–medium (high school)	5 (45)
High (university/college degree)	6 (54)
NYHA functional class	
II	9 (81)
III	3 (27)
Cardiomyopathy aetiology	
Ischaemic	7 (63)
Non-ischaemic	4 (36)
Type of LVAD	
HeartMate 3	10 (91)
HeartWare	1 (9)
LVAD indication	
Bridge to transplant	5 (45)
Destination therapy	6 (54)
Months since LVAD implantation	10 (3, 21)
Body mass index (kg/m^2)	27 ± 5
Medications	
ACE inhibitor/ARB	6 (54)
Beta-blocker	5 (45)
MRA	9 (81)
Diuretics	7 (63)
Co-morbidities	
COPD	5 (45)
Diabetes mellitus	5 (45)
Peripheral vascular disease	1 (9)
History of cerebrovascular disease	1 (9)
Labs	
Haemoglobin (g/dL)	12.9 ± 1.6
Creatinine (mL/min)	1.5 ± 0.4

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; COPD, chronic obstructive pulmonary disease; LVAD, left ventricular assist device; MRA, mineralocorticoid receptor antagonist; NYHA, New York Heart Association.
Values are presented as n (%), mean ± SD, or median (interquartile range).

Figure 1 Six-minute walk test distance at baseline (n = 11) and 4 weeks after incorporating exergaming into lifestyle (n = 6).



2019 (COVID-19) pandemic, and one patient preferred not to perform the test because of general fatigue and shortness of breath. QOL measures were numerically improved at 4 weeks compared with baseline—6.13 vs. 8.00 on the Cantril's 'Ladder of Life' scale, with higher values reflecting higher QOL, and 45.9 vs. 38.7 on the MLHFQ, with lower scores reflecting a higher QOL. No specific LVAD-related safety issues regarding exergaming were reported in the interview or in the diaries.

In the interview, patients reported they most often played bowling or tennis. Some played alone and some with neighbours or grandchildren. Several patients felt they improved and experienced it as exercise. Others commented that the game needed to be more sophisticated and should include total body movement.

Conclusions

In this feasibility study, we present a novel method of encouraging engagement in regular exercise for patients after LVAD implantation. Given the specific barriers these patients face with relation to exercise performance (such as carrying a heavy controller, stinging sensation on driveline exit site when sweating, and fear of battery running out while outdoors), exergaming provides an opportunity to integrate a home-based safe exercise plan with an enjoyable experience for the patient himself and for his family. This advantage of being able to exercise at home is particularly significant in the setting of challenging weather, an ongoing pandemic,[13] or simply the unwillingness of the patient to leave his house. Furthermore, exergaming is fun and does not mandate specific physical abilities or fitness on the patient's side, a characteristic most LVAD patients lack. The fact that children and grandchildren are ideal co-players for exergaming might even increase the patient's motivation, and, indeed, many of the patients commented on how fun it was to play with their grandchildren.

In our study, exercise capacity has improved significantly after 4 weeks of exergaming, as were a few measures of QOL (although numerically only). On top of the possibility of pure improvement in exercise capacity, exergaming granted an option for an interactive activity during the ongoing COVID-19 pandemic, which in turn might have improved the patients' mood and further motivated them in the 6MWT. Although these data were gathered from a small number of patients, it might serve as a signal for the potential role of exergaming in improving these patients' outcomes. No LVAD-related safety issues were reported, and, hence, this intervention appears to be safe.

In conclusion, exergaming was found to be a safe and feasible mode for encouraging physical activity in LVAD-supported patients and carries a potential for improving exercise capacity and QOL in these patients. Larger scale studies are warranted to further investigate the effect of exergaming in this patient population.

Conflict of interest

None declared.

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