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The Effectiveness of Exergames in Patients with Ankylosing Spondylitis: A Randomized Controlled Trial

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

Abstract

Background. Exergames are a well-known type of game based on a virtual avatar's body movements. This high-tech approach promotes an active lifestyle.
Objectives. The aim of this randomized controlled trial was to evaluate the effects of exergames on pain, disease activity, functional capacity and quality of life in patients with ankylosing spondylitis (AS).
Material and Methods. The study involved 60 patients, who were randomized into either the exergame group (EG) or the control group (CG). The EG patients engaged in exergaming, and CG patients did not engage in any exercises. The exergaming sessions were performed five times a week for eight weeks (40 sessions in total). The patients were assessed before and after the eight-week program on a visual analog scale (VAS), the Bath Ankylosing Spondylitis Functional Index (BASFI), the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and the Ankylosing Spondylitis Quality of Life (ASQOL) questionnaire.
Results. A statistically significant improvement was observed in VAS, BASFI, BASDAI and ASQoL scores in the EG group after completion of the exercise program ($p < 0.05$).
Conclusions. This study is a first step in investigating the possibilities of using an exergame platform to help patients with spondyloarthropathies to adopt a more physically active lifestyle. The results of this study suggest that exergames increase physical activity and decrease the pain scores in AS patients and also could, therefore, be feasible and safe (**Adv Clin Exp Med 2016, 25, 5, 931–936**).

Key words: ankylosing spondylitis, exergame, exercise, quality of life.

Ankylosing spondylitis (AS) is an inflammatory condition that predominantly affects the spine and may cause physical disability [1, 2]. The prevalence of AS is approximately 0.1% in the Caucasian population [3, 4]. Treatment for AS aims to reduce symptoms and to prevent, or at least minimize, spinal deformity and disability, and to maintain healthy physical and psychological states [1–4]. A combination of pharmacological and non-pharmacological treatments is recommended for optimal management [4]. Non-pharmacological treatment should include education and regular exercise. Exercises are prescribed for improving or maintaining joint range of motion, flexibility and balance, as well as increasing muscle strength and aerobic capacity [4, 6].

The effectiveness of exercise and physical activity programs for AS patients has consistently been demonstrated [6–14]. The positive effects of dynamic exercise programs on aerobic capacity, muscle strength, functional ability and the quality of life have been mentioned in many studies [6–14].

The effectiveness of home exercises programs that include strengthening of the paraspinal and abdominal muscles, supervised land- or water-based exercises, individual or group exercises have been investigated in the management of AS [6–14]. All these studies support the principle that exercise should remain as a mainstay of AS treatment [4, 6–14].

Active-play videogames, also known as exergames, are a high-tech approach to fitness that could help some people become more active and stay that way [15, 16]. Rehabilitation and exercises programs based on virtual reality are gaining importance nowadays, and the inclusion or adaptation of exergames in rehabilitation and exercises programs is a popular issue. The potential value of exergames, especially in obesity, cardiology, hemiplegia rehabilitation and in chronic musculoskeletal back and neck pain has been demonstrated [15–20]. But prior to the current study there has been no research investigating the efficacy of exergames in chronic inflammatory conditions. Accordingly, the aim of this study was to investigate the effects of exergames on pain, disease activity, functional capacity and quality of life in patients with AS.

Material and Methods

The study involved 60 patients diagnosed with AS according to the modified New York criteria who were recruited from the Physical Medicine and Rehabilitation Outpatient Clinic of Beyhekim State Hospital (Konya, Turkey), between November 2013 and June 2014. All the subjects were informed about the content, purpose and execution of the study, and submitted informed consent forms. The local ethics committee approved the study.

In addition to their demographic characteristics (age, sex, height, weight, body mass index [BMI] and educational level), the patients were also questioned about the duration of their symptoms, the date of their diagnosis and their drug usage (NSAIDs, disease-modifying antirheumatic drugs [DMARDs], tumor necrosis factor alpha inhibitors [TNFα inhibitors]), and their Bath Ankylosing Spondylitis Radiology Index (BASRI) scores were recorded. Physical examinations were performed by the same physician (AYK).

The inclusion and exclusion criteria were as follows:

Inclusion criteria:

- aged 18–65,
- lack of regular exercise habits during the previous six months,
- ability to understand the content of the questionnaires.

Exclusion criteria:

- the presence of cardiopulmonary dysfunction that hinders aerobic exercise, such as acute congestive heart failure, unstable angina pectoris, third-stage cardiac block, etc.,
- regular exercise habits during the previous six months,
- the presence of central or peripheral neurological disease,
- the presence of issues hindering standing, such as previous surgery on the lower extremities,
- the presence of a diagnosed serious psychiatric disorder,
- the presence of a serious visual disorder,
- the presence of a serious hearing disorder.

After meeting the enrollment criteria, 60 patients were randomly allocated to one of two groups – the exergame group (EG) and the control group (CG) – using sealed envelopes. The structure of the study is outlined in the flow chart in Fig. 1. The patients' medications were not altered in the course of the study.

Initially, all the patients underwent detailed cardiopulmonary examinations to exclude any possible cardiovascular pathology; the assessments described below were then performed for all the subjects before and after the exercise program.

Fig. 1. Exergaming for patients with ankylosing spondylitis

Pain at rest and during activity was evaluated with a visual analog scale (VAS): a 10 cm horizontal line with "0 = no pain" at the left end and "10 = extreme pain" at the right end [21]. The Bath Ankylosing Spondylitis Functional Index (BASFI) was used to assess each patient's functional status. The BASFI consists of ten questions (eight questions on daily activities and two additional questions that assess the patient's ability to cope with everyday life) [22], each of which is answered on a 10 cm horizontal VAS. The mean of the ten scales gives the BASFI score (0–10), with higher scores indicating more severe impairment [22–25]. The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) was used to assess disease activity [26]. The BASDAI is a self-administered questionnaire consisting of six questions relating to the five major AS symptoms (fatigue, spinal pain, joint pain or swelling, areas of localized tenderness and morning stiffness) measured in terms of both severity and duration [26–28]. The questions are answered on a 10 cm visual analog scale (VAS). The individual scores are averaged, with lower scores indicating less active disease [26–28]. The Ankylosing Spondylitis Quality of Life (ASQOL) questionnaire is a disease-specific, unidimensional measure of quality of the patient's life based on the needs-based quality of life model [21, 29]. It is a self-administered questionnaire comprising 18 items related to the impact of the disease on sleep, mood, motivation, coping, daily life activities, independence, relationships and social life [21, 29].

The Exercise Program

For the EG patients, a game set composed of an Xbox 360 Kinect game console (Microsoft Corporation, Redmond, USA) and a 46-inch LCD TV were placed in a 20 m^2 room. "Kinect Adventures", "Kinect Sports" and "Kinect Sports Season Two" video game programs, which include soccer, table tennis, skiing, tennis, golfing, volleyball and bowling simulations, were described to the patients by physicians. Each subject played games for 30 min, five days a week for eight weeks (40 sessions in total) accompanied by an experienced nurse who could perform cardiopulmonary follow-up (Fig. 1). For CG patients no exercise programs were provided.

Statistical Analysis

The SPSS for Windows 15.0 software package (IBM Corporation, Armonk, USA) was used for the statistical evaluation of the data. The conformity of continuous variables with normal distribution was checked using the Kolmogorov-Smirnov test. All variables were found to be normally distributed. Descriptive data were presented as mean ± standard deviation. Demographic and clinical characteristics were compared using the χ^2 test. Within-group and between-group differences were investigated. The independent samples t-test was used for the comparison of the two groups. Wilcoxon's signed rank test was used to analyze the differences between baseline and after-treatment values. A p-value less than 0.05 was considered statistically significant.

Results

Out of the original 60 participants, 57 patients completed the study. The demographic data, duration of disease, BASRI and TNFα inhibitor usage in each group are presented in Table 1. The groups were similar in terms of demographic and clinical data ($p > 0.05$). Both groups also had comparable VAS, BASFI, BASDAI and ASQoL scores before the beginning of the exercise program ($p > 0.05$).

In the exergame group, VAS, BASFI, BASDAI and ASQoL scores improved significantly after eight weeks of the program ($p < 0.05$) (Table 2). In the control group these values remained unchanged after eight weeks compared to baseline ($p > 0.05$) (Table 2). The intergroup comparison after the eighth week showed significant differences

Table 1. The demographic and clinical characteristics of the patients

	Exergame group (n : 28)	**Control group (n : 29)**	**p-value**
Age in years (mean ± SD)	36.1 ± 12.4	36.6 ± 11.3	0.642
Sex (m/f)	24/6	23/7	0.965
BMI (kg/m^2) (mean ± SD)	27.7 ± 2.1	28.2 ± 3.2	0.343
Disease duration in years (mean ± SD)	88.4 ± 51.2	91.2 ± 47.4	0.312
BASRI score (mean ± SD)	8.1 ± 2.1	8.4 ± 2.1	0.265
TNFα usage n (%)	8 (28.6)	7 (24.1)	0.278

n – number of cases; SD – standard deviation; BASRI – the Bath Ankylosing Spondylitis Radiology Index; TNF – tumor necrosis factor.

Table 2. The patients' BASFI, BASDAI, VAS and ASQoL scores at baseline and after eight weeks

	Exergame group (n : 28)			Control group (n : 29)		
	baseline	after 8 weeks	p-value within group	baseline	after 8 weeks	p-value within group
BASFI	3.7 ± 1.5	2.9 ± 1.3*[a]	< 0.001	3.9 ± 1.6	3.9 ± 1.7	0.812
BASDAI	4.1 ± 1.8	3.2 ± 1.3*[a]	< 0.001	4.2 ± 2.1	4.1 ± 2.1	0.124
VAS	4.9 ± 2.0	3.6 ± 1.7*[a]	< 0.001	5.1 ± 2.2	5.0 ± 2.4	0.241
ASQoL	9.5 ± 6.1	6.8 ± 4.3*[a]	< 0.001	10.2 ± 6.0	10.3 ± 6.4	0.187

Data are expressed as means ± SD; BASFI – the Bath Ankylosing Spondylitis Functional Index; BASDAI – the Bath Ankylosing Spondylitis Disease Activity Index; VAS – visual analog scale; ASQoL – Ankylosing Spondylitis Quality of Life questionnaire; *$p < 0.001$ within groups; [a] $p < 0.05$ between groups.

between the two groups in VAS, BASFI, BASDAI and ASQoL, with the EG patients showing considerable improvement ($p < 0.05$) (Table 2).

No strain, injury or other musculoskeletal complications were recorded during the exergame workouts.

Discussion

This study was performed to investigate the efficacy of exergames in AS patients. The results show that performing exergames on a regular basis provided significant improvements in pain, disease activity, functional capacity and quality of life in patients with AS.

AS is an inflammatory condition that causes significant pain, functional disability and a diminished quality of life [1–3]. Combining exercise therapy with medication is standard for patients with AS, as suggested by the Spondylitis Association of America [4]. Previous studies have documented the beneficial effects of various exercise programs on different aspects of health for AS patients, including quality of life, disease activity, spinal mobility, chest expansion, global well-being, physical function and fatigue, whether the patients were receiving TNFα inhibitors or not [6–14].

Home exercise consisting of both recreation and back exercises can relieve pain and stiffness, and can improve function. Also, home exercise of this kind is time-efficient, economical and convenient [6–10]. Alternative exercise programs such as swimming, spa-exercise therapy and tai chi programs have also been studied in AS patients, and led to a significant reduction in disease activity and improvement in function compared to the control groups [30–33]. But the major challenge is the widely observed fact that most AS patients do not exercise on a regular basis. Various researchers have reported that as many as 82%, 77% and 65.6% of AS patients do not do any regularly exercising [34–37]. The main challenge to the success of exercise programs is declining motivation, which leads to a loss of compliance [4, 34]. Also, the lifelong progress of the disease means patients tend to lose their motivation to exercise [4, 5]. Brophy et al. examined the effect of exercise and motivation to exercise on function, asking study participants about their physical activity, motivation to exercise, function and disease severity [5]. According to their results, AS patients with high intrinsic motivation (driven by pleasure) experienced the most benefits in terms of activity and function. Brophy et al. concluded that motivation might improve function as much as exercising itself, noting that "interventions targeting motivation to exercise would have as much effect on improving function as interventions offering exercise opportunities" [5]. They predicted that any intervention that both improves motivation and increases opportunities to exercise would have a two-fold influence on function [5]. The present study was based on this perspective, positing that exergame devices can create alternative exercise models suitable for home use and allowing for the development of disease-specific games for AS patients.

Previous studies have indicated that exergaming that increased physical activity in geriatric patients with a high risk of falling or with cardiovascular diseases was practical and safe [15–20]. The effects of exergaming on age-related impaired postural control have been examined in some studies [16, 17, 19]. The results showed a significant improvement in balance while walking, which was the main parameter measured by tasks such as the Community Balance and Mobility Scale, the Berg Balance Scale and narrow walk time [16–19, 38–40]. The studies showed that exergaming primarily enhanced the elderly participants' dynamic balance measures in walking, single-leg standing and reaching tasks; their reaction times also improved significantly [16–19, 38–41].

Staiono et al. studied exergames for weight loss and psychosocial improvements in adolescents and concluded that exergames, especially when played cooperatively, can be an effective technological tool for weight loss among young people [42]. Kramer et al. used exergames to improve balance and gait in multiple sclerosis (MS) patients, and wrote that "the integration of exergames seems to have a positive effect on adherence and is thus potentially beneficial for the long-term effectiveness of rehabilitation programs for MS patients" [43].

The present study does have several limitations, primarily the lack of a standard exercise program assigned to the participants in the exergame group, as well as the lack of objective muscle power and balance measurements in the follow-up parameters, and the hospital-dependent setting of the exercises. Nevertheless, the results seem to be significant.

This study is a first step in investigating the possibilities of using an exergame platform to help patients with spondyloarthropathies to adopt a more physically active lifestyle. The results of this study suggest that exergames increase physical activity and decrease the pain scores in AS patients and also could, therefore, be feasible and safe. However, further studies are with a longer follow-up period are necessary to examine the long-term effects of this promising concept.

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