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ORIGINAL ARTICLE

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Effects of home-based daily exercise therapy on joint mobility, daily activity, pain, and depression in patients with ankylosing spondylitis

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Abstract We investigated the effects of home-based daily exercise on joint mobility, functional capacity, pain, and depression in patients with ankylosing spondylitis (AS). The patients were randomly assigned to a wait-list control group or to an exercise-therapy group. The exercise-therapy group performed a 20-min exercise program once per day for 8 consecutive weeks. After 8 weeks, compared with the control group, the exercise group showed improvements in joint mobility (cervical flexion, extension, shoulder flexion, abduction, hip abduction, and knee flexion), finger–floor distance, and functional capacity. Pain and depression scores were significantly lower after the exercise program in the exercise group than in the control group. These findings indicate that exercise therapy increases joint mobility and functional capacity, and decreases pain and depression in patients with AS. Home-based exercise, which is easily accessible to patients, might be an effective intervention for AS.

Keywords Ankylosing spondylitis · Home-based · Exercise · Pain · Joint mobility · Depression · Functional capacity

Introduction

One of several conditions classified as the spondyloarthropathies, ankylosing spondylitis (AS) is the main rheumatic disease of unknown etiology [1–3]. Primarily affecting the mobility of joints and the spine, AS can lead to physical disability. AS involves inflammation and pain in many joints and the spine, which cause physical outcomes such as reduced physical activity, fatigue, sleep disturbances, and psychological consequences such as depression, anxiety, and stress [4–9]. Treatment for AS aims to prevent the stiffness and flexion deformity that accompany AS, and to maintain healthy physical and psychological states [10].

The main treatments for AS have been supportive, consisting of administration of non-steroidal anti-inflammatory drugs (NSAIDs), or anti-tumor necrosis factor (TNF), and physical therapy [11–17]. Physical therapy is important to maintain and improve mobility, physical fitness, and strength, and to prevent joint deformity [5, 18–20]. Although aquatic therapy may be beneficial in reducing pain and pressure at the joints, patients may have difficulty in regularly attending such therapy [21]. Thus, a home-based intervention might help patients with AS maintain a normal lifestyle. However, except for clinical and case reports, there are few studies on home-based exercise in patients with AS in Korea. The aim of the present study was to clinically assess the effects of home-based exercise therapy on joint mobility (cervical, cervical flexion, extension, shoulder flexion, abduction, hip abduction, and knee flexion), finger–floor distance (FFD), functional capacity, pain, and depression in patients with AS.

Materials and methods

Patients

Patients with AS were recruited to participate through bulletin board advertising of an 8-week exercise program at the Rheumatism Center of the University Medical Center. Subjects were eligible to participate in the program if they were: (a) an outpatient without complications, (b) sedentary, as defined by a lack of regular

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exercise during the previous 6 months, (c) able to understand the content of questionnaires and experimental schedules, (d) had no changes in their current prescription medication, and (e) were classified in the functional class II for AS.

Fifty-eight subjects volunteered to participate in the study. Subjects were randomly assigned to either an exercise group ($N = 30$) or a wait-list control group ($N = 28$). Of the initial 58 subjects, eight subjects were excluded at the start of the experiment: two because of changes in their prescription medication (one in the control and one in the exercise group), four because they were unwilling to participate (one in the control and three in the exercise group), one who had transport problems (exercise group), and one because of surgery (control group). Exercise training began 2 weeks after enrollment, and 50 subjects completed the study (Table 1).

The subjects were informed about the exercise therapy when we explained the nature of AS and procedures for the study. The study received institutional approval from the Human Investigation Ethics Committee and administrative approval from the Human Subjects Review Board of the University Hospital and School of Medicine before we approached the subjects; all subjects provided written informed consent.

Wait-list control

The control group was informed that they would participate in exercise therapy after an 8-week baseline period. The control group completed identical assessments according to the same schedule as the exercise group. After the 8-week period, the control group was offered the opportunity to participate in complimentary exercise therapy.

Measurement of joint mobility

We used a ruler to assess FFD and an inclinometer to assess the range of joint mobility in the following movements: cervical flexion, extension, shoulder flexion, abduction, hip abduction, and knee flexion. The inclinometer resembles a flat goniometer with 360° marked in single-degree increments on the circumference. Three measurements were made at each joint angle in random order.

Table 1 Demographic characteristics of subjects

	Control group (N = 25)	Exercise group (N = 25)
Age	28.1 ± 7.5	28.8 ± 9.3
Gender (F/M)	5/20	6/19
Disease duration (year)	8.6 ± 0.72	9.2 ± 0.76

F female; M male

Measurement of functional capacity, depression, and pain

Functional capacity during the previous week was measured with the Bath Ankylosing Spondylitis Functional Index (BASFI), which includes eight items on daily activities and two items assessing the patient's ability to cope with everyday life [22]. Items on the BASFI are scored on a 10-cm visual analogue scale (VAS). The VAS is unmarked, except with the words "easy" and "impossible" at either end of the line to indicate the direction of severity. The mean of the 100 scales yields the total score, which ranges between 0 and 100. Analysis of this experiment indicated a high level of internal consistency (Cronbach alpha = 0.82).

Subjects used the VAS to rate their pain on days before and after the 8 weeks. Subjects rated their current level of perceived pain, on a 0–100 mm horizontal, linear VAS, with 0 (on the left) representing an absence of pain and 100 (on the right) representing an extremely-high level of pain [23]. Numerical scales are commonly used as measures of symptoms, and their reliability and validity have been established.

The Beck Depression Inventory (BDI) is a 21-item self-report instrument designed to screen for depression, primarily for cognitive and affective symptoms [24]. Responses are made on a four-point, minimally-anchored scale, ranging from 0 to 3, with 3 representing the most severe symptoms. A total BDI score is calculated by summing all responses, giving a total BDI score ranging from 0 to 63. Research has provided support for internal consistency. In our study, the Cronbach alpha was 0.87.

Exercise therapy

The exercise program consisted of 16 movements based on the exercise program recommended by the Spondylitis Association of America [10]. The program included exercises for muscle relaxation, flexibility, muscular strength, stronger breathing, and straight posture. The entire exercise duration was about 30 min, which included exercises such as the "stretch out", "cat-back" (sway-back), "hands and knees rock", neck flexion and extension, neck lateral movement, body rotation, hip flexor–quadriceps stretch, hamstring stretch, abdominal strengthening, hip extensor exercise, alternative hip extensor exercise, breathing, "shoulder circle", and pectoral muscle stretch.

An expert and a researcher taught the exercise motions several times to each of the subjects individually. Thus, they could exercise for themselves with a book giving guidance on the motions of exercise therapy. Experimental patients were asked to practice these exercises at home individually for 8 weeks and were telephoned by the researchers every day.

Experimental procedures

All testing was conducted at the Rheumatism Center of the University Medical Center. Before the intervention (before) and 8 weeks after (after), joint mobility was measured by two research assistants who did not know to which groups the patients were assigned. The research assistants also assessed BASFI, VAS for pain, and BDI before and after the 8-week intervention.

Statistical analysis

The results obtained were statistically analyzed using SAS. The unpaired *t*-test and chi-squared test was used to evaluate statistical differences in the demographic data and comparison of group differences between the control and exercise groups. The paired *t*-test was used to analyze the differences between baseline (before) and 8-week (after) values.

Results

Table 1 shows the demographic characteristics for the exercise and control groups. The groups did not differ significantly in age, gender, and disease duration.

Figure 1 presents the changes in joint mobility and spine flexibility. Mean basal values of joint mobility did not differ between the two groups. After 8 weeks of intervention, joint mobility and FFD in the exercise group were significantly different from those of the controls (cervical flexion and extension, shoulder flexion and horizontal abduction, hip abduction, knee flexion, and FFD, all $P < 0.0001$). Joint mobility improved after 8 weeks of exercise, but remained unchanged in the control group. Joint mobility and spine flexibility in the exercise group increased significantly from before to after the 8 weeks (all measured regions of joint mobility, $P < 0.001$; FFD, $P < 0.001$). In the control group, knee flexion decreased significantly over the 8 weeks ($P < 0.05$).

After the 8 weeks of daily exercise, the exercise and control groups differed significantly in functional capacity ($P < 0.0001$), pain ($P < 0.0001$), and depression ($P < 0.0001$) (Fig. 2). In the exercise group, functional

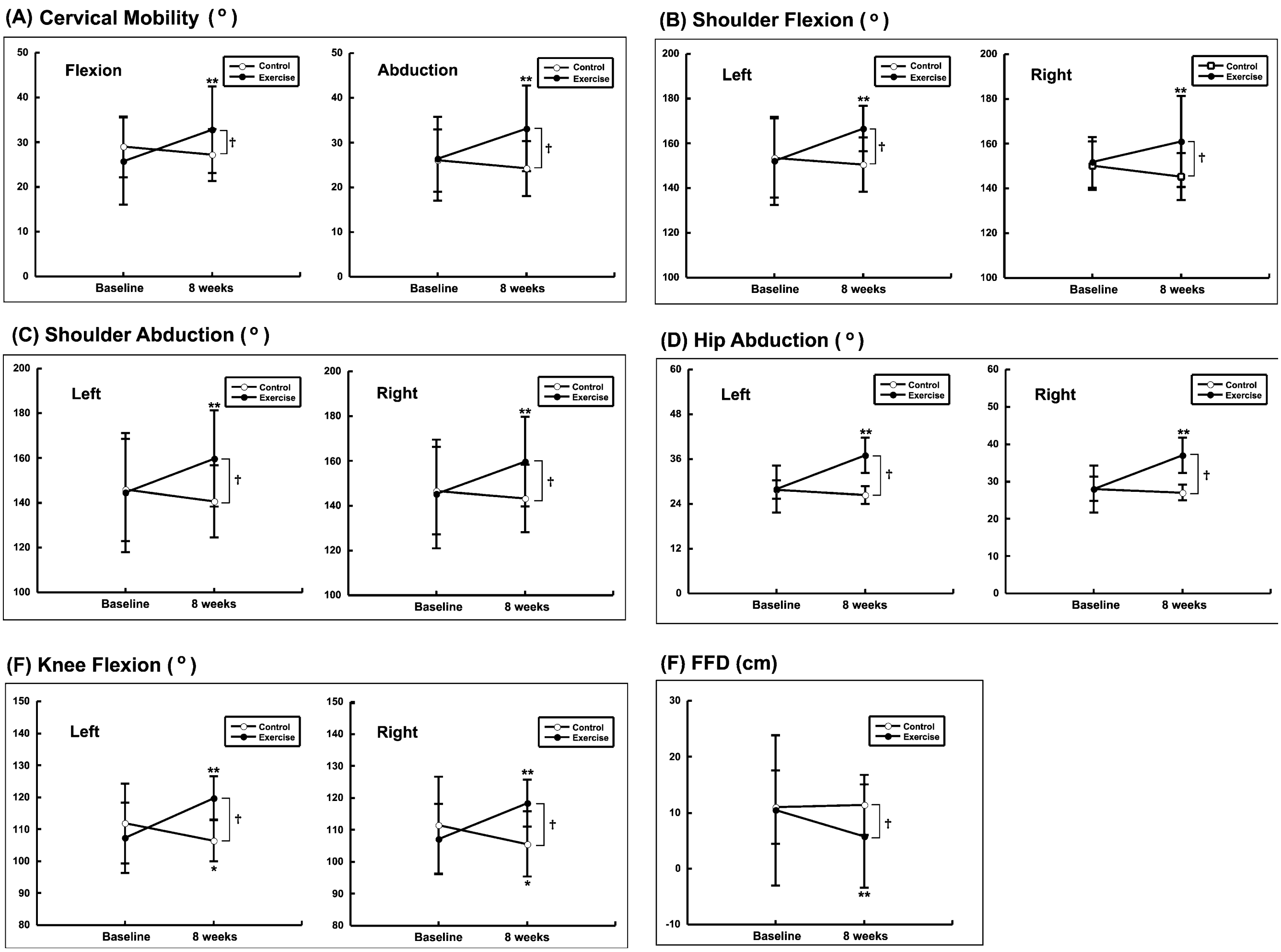

Fig. 1 Baseline and 8-week measures of joint mobility and spine flexibility. $^{*}P < 0.05$, $^{\dagger}P < 0.001$ compared with baseline, $^{\dagger}P < 0.0001$ compared with the control group. Spine flexibility was measured as the distance from the floor (FFD). Values are expressed as mean ± SD

capacity increased significantly from before to after the 8 weeks of intervention ($P < 0.001$), while pain ($P < 0.001$), and depression ($P < 0.001$) decreased significantly. In the control group, pain increased significantly over the 8 weeks ($P < 0.001$). Functional capacity increased 46% after 8 weeks of home-based exercise, but remained unchanged in the control group. Pain level decreased (i.e., subjects reported less pain) by 33% in the exercise group, but increased (i.e., became worse) by 28% in the control group. Depression decreased by 31% after 8 weeks of exercise, and increased by 19% in the control group.

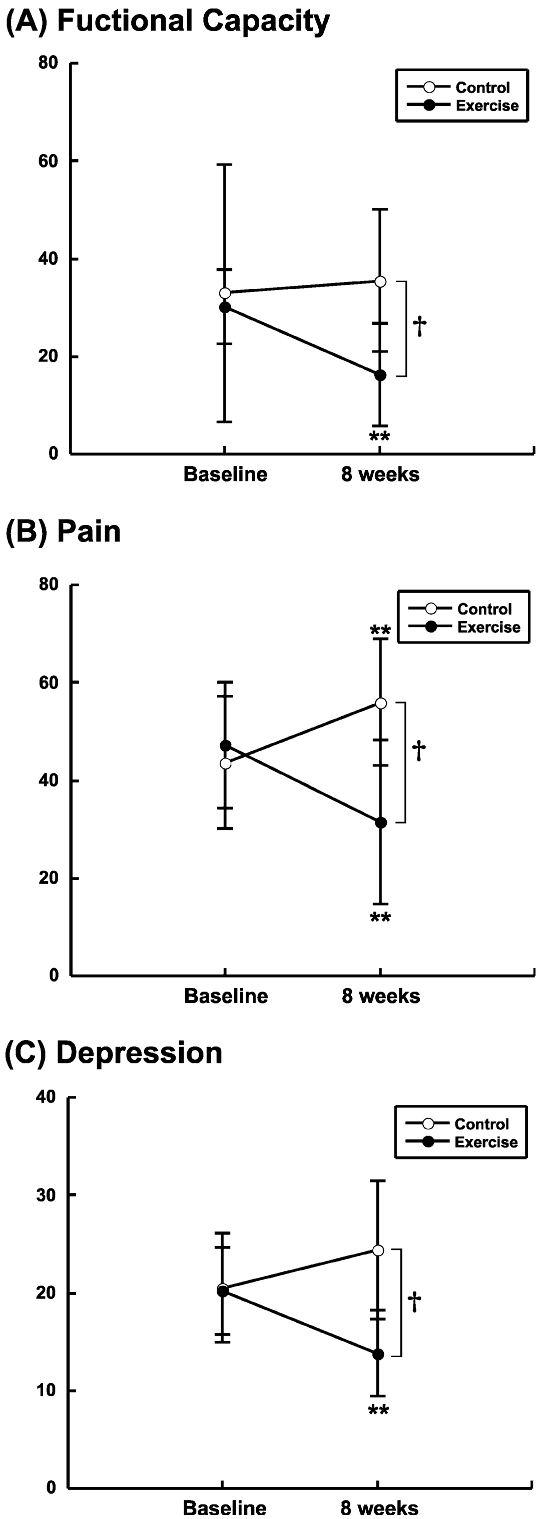

Fig. 2 Baseline and 8-week measures of daily activity, pain, and depression outcomes. $^{**}P < 0.001$ compared with baseline, $^{\dagger}P < 0.0001$ compared with the control group

Discussion

This preliminary randomized study was conducted to investigate the efficacy of home-based daily exercise in patients with AS. The results showed greater improvements in joint mobility, daily activity, pain, and depression in the exercise group.

These results are similar to those reported in other studies. Many groups have assessed the effects of exercise on AS, and have reported that exercise affects joint mobility [5, 19, 20, 25, 26]. Studies using supervised group exercise in randomly-assigned groups have shown that exercise improves the function, cervical rotation and FFD, and that supervised exercise is superior to home-based exercise [27]. Roberts et al. [25] reported improvements in chest expansion, height, and FFD after 3 weeks of intensive physical therapy. Uhrin et al. [12] reported that long-term unsupervised exercise improved function, and relieved pain and stiffness in people with AS.

Hidding et al. [5] reported that 6 weeks of exercise therapy improved the functional capacity. Some studies have suggested that exercise significantly increases the functional capacity of AS patients as evaluated with BASFI [17, 22, 28]. The results showed a 25% reduction in BASFI after intensive exercise, which is similar to the magnitude of improvement produced by intensive physical therapy [28]. The 46% reduction in BASFI after 8 weeks of home-based exercise that we observed is greater than the 23% improvement reported by Analay et al. [17] in AS patients who performed intensive group exercise.

According to Diethelm and Schuler [29], the pain level is an important variable affecting quality of life; pain is also significantly related to daily functional activity, depression, and anxiety. In our study, pain level decreased (i.e., improved) by 33%, compared with an increase of 28% in the control group. However, some studies have failed to find an effect of exercise on pain level. For example, Analay et al. [17] reported no changes in pain level after intensive group exercise (50 min per day, 3 days per week, over 6 weeks). Data from another study also failed to find an effect of exercise on pain level [19].

In our subjects, depression decreased by 31% after 8 weeks of exercise, whereas it increased by 19% in the control group. Analay et al. [17] previously reported a 28% decrease in depression after 6 weeks of exercise, which is similar to the 31% decrease after 8 weeks of exercise in our study. Improved joint mobility and decreased pain may positively affect the mood state of depression after 6 weeks of exercise. Improved joint mobility and decreased pain may positively affect the mood state of depression.

It is difficult to directly compare the effects of exercise on joint mobility and psychological variables in various studies on AS patients, because each used a different exercise protocol for treating AS. However, we believe that improved joint mobility, FFD and functional capacity, and increased relief of pain and depression result from patients' having exercised regularly and daily. Nevertheless, it must be pointed out that our control group was based on a wait-list group; in our opinion, additional evaluation of the effects (both immediate and long-term) of exercise is required to form a solid basis for clinical application. In order to achieve this goal, more objective controls than those based on a wait-list group are required.

In conclusion, the results show that a home-based daily exercise program improved joint mobility (cervical flexion, extension, shoulder flexion, abduction, hip abduction, and knee flexion), FFD and positively influenced the levels of functional capacity, pain and depression in AS patients. Home-based exercise, which is easily accessible to patients, might be an effective intervention for AS. However, we acknowledge that this was a preliminary study with several limiations, such as a small sample number and the lack of an equivalent exercise control group to estimate an expectation effect. Further randomized studies that include more objective measures, larger sample size, measurements after multiple sessions, and long-term follow-up are needed to convincingly show the effects of home-based daily exercise programs on well-being, psychological variables, or other biochemical variables in patients with ankylosing spondylitis.

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