Clinical Rheumatology (2018) 37:389–395
https://doi.org/10.1007/s10067-017-3917-x

ORIGINAL ARTICLE

A resistance exercise program improves functional capacity of patients with psoriatic arthritis: a randomized controlled trial

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Received: 9 August 2017 / Revised: 18 October 2017 / Accepted: 10 November 2017 / Published online: 28 November 2017

Abstract The objective of this study is to assess the effectiveness of resistance training in patients with psoriatic arthritis (PsA). The study is a randomized controlled trial with 41 patients aged between 18 and 65 years with diagnosis of psoriatic arthritis (PsA). The patients were randomized into the following: intervention group (IG) and control group (CG). The IG underwent resistance exercise twice a week, for 12 weeks. The CG remained with the conventional drug therapy. The outcome measurements were the following: BASFI and HAQ-S for functional capacity, one maximum repetition test (1RM) for muscle strength, SF-36 questionnaire for general quality of life, and BASDAI and DAS-28 for disease activity. The evaluations were done by a blinded evaluator at baseline (T0) after 6 (T6) and 12 weeks (T12). At baseline, the groups were homogeneous regarding clinical and demographic characteristics. The IG significantly improved functional capacity measured by HAQ-S and disease activity measured by BASDAI, compared to CG, at week 12. Regarding quality of life, the IG improved the domains "pain" and "general health status" compared to CG ($p < 0.05$). There was improvement in muscular strength in almost all exercises in IG, except in the exercise for biceps. However, there were statistical differences between groups only on exercise "leg extension" in IG compared to CG. Resistance training is effective in improving functional capacity, disease activity, and quality of life of patients with psoriatic arthritis. The clinical improvements were not coupled to significant changes in muscular strength.

Keywords Disease activity · Physical activity · Psoriatic arthritis · Quality of life

Introduction

Psoriatic arthritis (PsA) is a complex inflammatory [1] joint disease affecting 3 to 48% of the patients diagnosed with psoriasis. PsA belongs to the heterogeneous group of spondyloarthritis described by axial inflammatory pain predominantly related to arthritis in the large joints of the lower limbs and peripheral enthesopathies [2, 3].

In addition to pharmacological treatment, moderate evidences have been observed over the years in relation to the benefits of exercise in the treatment of inflammatory arthropathies. However, there is still no consensus as to the best type of exercise, intensity, frequency, and duration, as well as the impact of different exercise protocols on the functional capacity of patients [4].

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Recently, it was conducted a systematic literature review of 24 randomized controlled trials on the effects of physical exercises in patients with ankylosing spondylitis (AS). The authors found moderate evidences supporting exercises in improving physical function and disease activity. However, they concluded that the best exercise protocol for patients with AS is still unknown [5].

It is known that patients who develop PsA have their self-esteem damaged as well as their physical and emotional capacities, which compromises their quality of life and ability to perform daily activities [6]. Despite the lack of studies concerning the effects of physical exercises on patients with PsA, it is believed that exercises can be effective in improving functional capacity and quality of life.

The aim of this study was to evaluate the effectiveness of a resistance exercise program on the treatment of patients with psoriatic arthritis.

Materials and methods

This study is a 12-week randomized control trial with blinded evaluator.

The inclusion criteria were the following: confirmed PsA diagnosis as defined by the CASPAR criteria, ages between 18 to 65 and of both genders, use of disease-modifying anti-rheumatic drugs (DMARDS) and anti-TNF therapy with stable doses for at least 3 months, and stable doses of non-steroidal anti-inflammatory medication and corticosteroids for at least 4 weeks.

We excluded patients with non-controlled cardiovascular diseases, uncontrolled diabetes mellitus, severe psychiatric diseases, fibromyalgia, history of regular exercise (at least 30 min twice a week) in the last 6 months, arthroplasty of hip and/or knee over the last 12 months, and any other medical condition that would prohibit the patient from performing resistance exercises.

This study was approved by the Ethics Committee of our institution by the number 0196/11 and Clinicaltrials.gov with number NCT02598739.

Population

We recruited 41 patients diagnosed with PsA at our institution outpatient clinics and through advertisements in local newspapers. We randomized the participants using an electronic-generated randomization table, which created two distinct groups: intervention group (IG) and control group (CG). We then placed the allocation documents in sealed and secure envelopes in order to maintain confidentiality.

Interventions

Intervention group

The patients in the intervention group (IG) performed resistance exercises for the following muscles group: upper limbs, lower limbs, and trunk. It was used a machine "leg extension" for the training on the lower limbs. For upper limbs, we used a pulley triceps machine and front pull in addition to free weights (dumbbells).

In order to perform the exercise program, the study followed all the recommendations established by the American College of Sports Medicine (ACSM) [7]. It was carried out two exercises for major muscle groups and one exercise for small muscles. The exercises were divided in 3 sets of 12 repetitions for each muscle group and performed twice a week for 12 weeks. The intensity of the exercises was 60% of one maximum repetition (1RM) and the rest interval between exercises was 1–2 min.

The exercise program involved pectoral exercises: crucifix and seat supine, biceps: alternated screw, triceps: triceps pulley, back: standing handsaw and pulled ahead, quadriceps: leg extensor, and finally gluteus: standing hips extension.

Control group

The control group (CG) was kept in a waiting list while continued with the standard pharmacological treatment during all the study. The patients were instructed to maintain their daily activities and to avoid any other non-pharmacological treatment. The exercise program was offered to the control group in the end of the study.

Assessment

Both groups were evaluated by the same blinded evaluator, who had experience with the instruments applied. The evaluations were performed immediately before patients' randomization (T0), 6 weeks (T6), and 12 weeks (T12) after the inclusion in the study.

Assessment instruments

Primary outcome

Functional capacity - Health Assessment Questionnaire (HAQ-S) Functional capacity was evaluated by the Health Assessment Questionnaire (HAQ-S). It was used a modified version for AS (ankylosing spondylitis) patients and validated for the Brazilian population [8].

Secondary outcomes

Functional capacity The Bath Ankylosing Spondylitis Functional Index (BASFI) consists of 10 questions regarding the functional capacity of a patient with AS to perform daily activities. All items are assessed through a visual analogue scale (VAS), which does not contain marks, except for the indications "without any difficulty" and "unable to accomplish" at the beginning and at the end of the line to indicate the direction of the severity. The average of the results of 10 scales is the BASFI score (0–10) with higher scores indicating greater impairment in functional capacity. It was used a validated version for the Portuguese language [9].

Strength It was assessed through the 1RM test consisting in a maximum load a muscle can take at a single time [10, 11]. The evaluation of muscle strength held in T6 was used for adjustments of training loads.

Disease activity The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) consists of 6 questions related to five major symptoms of the patients previous week (fatigue, spinal pain, joint pain/swelling, areas of localized tenderness, and morning stiffness). All items are assessed on a horizontal

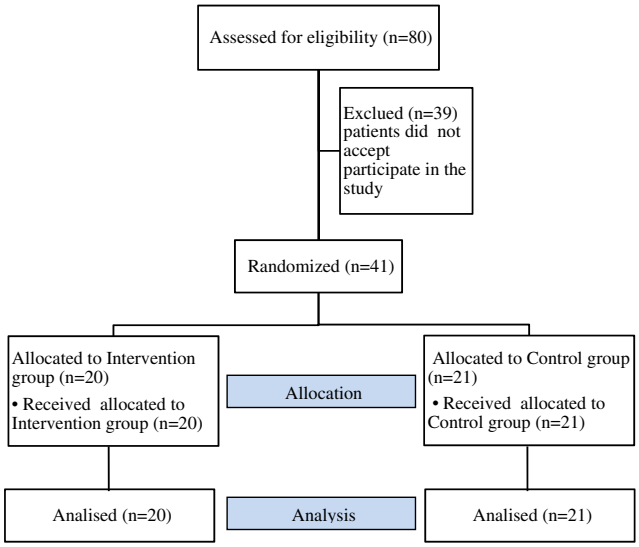

Fig. 1 Flowchart with the selection, randomization, and inclusion of patients with psoriatic arthritis study

10-cm visual analogue scale (VAS) with the symptom morning stiffness being the average of 2 last questions. The BASDAI score was obtained through the sum of the values from the 5 major symptoms. The higher the scores, the higher the disease activity. It was used a validated version for the Portuguese language [9].

Disease Activity Score 28 (DAS 28) is a clinical index activity, which combines information about painful and swollen joints (shoulders, elbows, wrists, metacarpophalangeal-MCP, proximal interphalangeal-PIP, and knees), ERS (erythrocyte sedimentation rate) in the first hour (in mm) or C-reactive protein, and patients overall evaluation measured in visual analogue scale (VAS) of 100 mm. The instrument allowed to classify patients with PsA as follows: in remission (less than 2.6), light activity (2.6–3.2), moderate (3.2–5.1), or intense (up to 5.1) [12].

Table 2 Assessment of functional capacity and disease activity in patients with psoriatic arthritis ($n = 41$) randomized in two groups

Variable mean (SD)	IG ($N = 20$)	CG ($N = 21$)	p intergroup*
BASFI			0.438
T0	4.2 (2.0)	3.9 (2.4)	
T6	3.4 (2.4)	3.8 (2.2)	
T12	2.9 (2.2)	4.0 (2.2)	
p intragroup*	*$p = 0.018$*	$p = 0.548$	
BASDAI			*0.038*
T0	5.3 (2.4)	4.5 (21)	
T6	3.4 (2.4)	4.6 (2.0)	
T12	3.3 (2.1)	4.8 (2.4)	
p intragroup*	*$p = 0.002$*	$p = 0.701$	
HAQS			*0.048*
T0	0.72 (0.45)	0.69 (0.45)	
T6	0.51 (0.42)	0.73 (0.59)	
T12	0.45 (0.43)	0.77 (0.55)	
p intragroup*	*$p = 0.020$*	$p = 0.350$	
DAS-28			0.311
T0	4.1 (1.3)	3.9 (1.1)	
T6	3.1 (1.0)	3.6 (1.1)	
T12	3.1 (1.3)	3.6 (1.1)	
p intragroup*	*$p = 0.001$*	$p = 0.376$	

BASFI The Bath Ankilosing Spondylitis Functional Index, *BASDAI* The Bath Ankylosing Spondylitis Disease Activity Index, *HAQ-S* Health Assessment Questionnaire, *DAS-28* Disease Activity Index

*ANOVA test

Table 1 Demographic and clinical characteristics of the 41 patients with psoriatic arthritis randomized

Variable mean (SD)	IG ($N = 20$)	CG ($N = 21$)	P intergroup (ANOVA)
Age (years)	54.2 (8.2)	50.8 (11.2)	0.269#
Gender (%)			
Male	10 (50%)	9 (45.7%)	0.221§
Female	10 (50%)	11 (54.3%)	
Peripheral manifestation (%)	19 (95.0%)	20 (95.2%)	0.978§
Mixed manifestation (%)	1 (5.0%)	1 (4.8%)	0.978§
Time of disease (years)	10.1 (7.4)	12.1 (8.7)	0.697#
Diseases associated n (%)			
Systemic arterial hypertension	7 (35.0%)	5 (28.0%)	0.431§
Diabetes mellitus	1 (5%)	3 (15.4%)	0.317§
Medications n (%)			
Methotrexate	16 (80%)	15 (72%)	0.523§
Infliximab	4 (20%)	6 (28.8%)	0.523§
Cyclosporine	2 (10%)	0 (0%)	0.138§

SD standard deviation, § chi-square test, # Mann-Whitney test

Table 3 Assessment of general quality of life by SF-36 (Short Form Health Survey) of patients with psoriatic arthritis in the two groups of APs patients, at different times of assessment

Domains—SF36	IG $N = 20$ mean (SD)	CG $N = 21$ mean (SD)	p intergroup (ANOVA)
Functional capacity			0.463
T0	60.8 (25.2)	72.9 (15.5)	
T6	71.5 (23.0)	71.7 (16.0)	
T12	77.2 (22.4)	71.2 (18.4)	
p intragroup	*$p = 0.002$*	$p = 0.771$	
Role physical			0.446
T0	38.8 (44.0)	51.2 (45.7)	
T6	63.8 (40.1)	56.4 (42.5)	
T12	71.3 (45.4)	58.8 (44.9)	
p intragroup*	*$p = 0.006$*	$p = 0.523$	
Pain			*0.017*
T0	47.4 (23.1)	53.2 (15.8)	
T6	69.7 (21.0)	54.6 (21.3)	
T12	72.5 (19.2)	53.4 (22.3)	
p intragroup*	*$p = 0.001$*	$p = 0.946$	
General health status			*0.002*
T0	52.4 (10.2)	50.0 (14.3)	
T6	62.2 (10.6)	49.5 (13.3)	
T12	63.6 (13.1)	53.0 (14.1)	
p intragroup*	*$p = 0.001$*	$p = 0.140$	
Vitality			0.242
T0	53.3 (19.6)	64.3 (20.1)	
T6	68.3 (17.9)	64.8 (20.5)	
T12	70.9 (13.4)	61.4 (19.1)	
p intragroup*	*$p = 0.001$*	$p = 0.324$	
Role social			0.312
T0	68.8 (28.0)	59.9 (27.3)	
T6	86.9 (24.2)	71.2 (27.5)	
T12	79.5 (25.3)	72.0 (30.9)	
p intragroup*	*$p = 0.015$*	$p = 0.309$	
Emotional aspects			0.233
T0	45.0 (44.9)	71.4 (41.2)	
T6	66.7 (43.3)	81.0 (32.6)	
T12	83.3 (35.0)	81.0 (34.3)	
p intragroup*	*$p = 0.004$*	*$p = 0.004$*	
Mental health			0.566
T0	62.6 (16.5)	51.1 (20.2)	
T6	70.0 (13.9)	65.7 (20.6)	
T12	71.1 (14.3)	66.8 (21.7)	
p intragroup*	$p = 0.137$	$p = 0.137$	

*ANOVA test

Quality of life The quality of life was evaluated using the Medical Outcome Study Short Form Health Survey (SF-36). It consists in a generic quality of life questionnaire validated for the Portuguese language. This questionnaire is composed of eight areas for quality of life: functional capacity, physical aspects limitations, pain, general health, vitality, social aspects, and emotional and mental health aspects.

The scores range from 0 (zero) to 100 (one hundred), and the higher the grade, the better the quality of life [13].

Statistical analysis

The statistical analysis was performed using the Software SPSS version 15.0.

Table 4 Assessment of muscle strength by 1 RM test in patients with psoriatic arthritis in the two groups at different follow-up times

	IG $N = 20$ Mean (SD)			*p* intragroup	GC $N = 21$ Mean (SD)			*p* intragroup	p intergroup
	T0	T6	T12		T0	T6	T12		
Crucifix	5.45 (2.46)	6.50 (2.24)	7.30 (2.05)	*p = 0.004*	5.38 (2.20)	5.86 (2.26)	5.81 (2.20)	*p = 0.004*	0.251
Seat supine	22.1 (12.20)	26.0 (9.6)	29.6 (13.1)	*p = 0.001*	25.2 (13.6)	26.5 (10.7)	27.6 (12.6)	*p = 0.052*	0.645
Front pull	27.6 (7.6)	32.0 (7.4)	32.7 (7.4)	*p = 0.004*	27.9 (11.2)	27.5 (10.1)	27.4 (10.6)	*p = 0.894*	0.373
Triceps pulley	23.3 (7.9)	28.4 (8.8)	31.3 (8.3)	*p = 0.001*	24.9 (10.0)	24.8 (8.7)	25.5 (11.5)	*p = 0.717*	0.288
Handsaw (L)	18.0 (9.5)	24.5 (10.0)	27.4 (13.8)	*p = 0.001*	19.3 (9.3)	21.5 (13.0)	22.6 (11.6)	*p = 0.001*	0.513
Handsaw (R)	20.0 (11.2)	24.9 (10.7)	26.3 (13.1)	*p = 0.012*	21.2 (11.2)	23.3 (13.5)	22.6 (13.0)	*p = 0.012*	0.710
Biceps (L)	7.6 (3.5)	7.2 (2.4)	7.5 (2.2)	*p = 0.342*	6.4 (1.9)	6.5 (2.4)	7.0 (2.9)	*p = 0.342*	0.277
Biceps (R)	8.0 (4.1)	7.3 (2.6)	7.7 (2.6)	*p = 0.832*	6.6 (2.4)	7.0 (2.7)	6.8 (2.5)	*p = 0.832*	0.306
Leg extension (L)	20.6 (9.2)	26.7 (13.3)	33.2 (16.6)	*p = 0.001*	22.4 (10.2)	23.6 (9.8)	27.0 (10.2)	*p = 0.001*	0.451
Leg extension (R)	20.3 (7.6)	28.8 (12.7)	36.2 (14.9)	*p = 0.001*	22.4 (10.9)	22.9 (11.5)	26.8 (12.4)	*p = 0.043*	*0.035*
Gluteus	9.6 (2.5)	11.3 (3.0)	12.7 (3.6)	*p = 0.003*	10.3 (4.0)	11.1 (3.6)	11.0 (3.5)	*p = 0.285*	0.516

L left side, *R* right side

*ANOVA test

As statistical method, we used the ANOVA analysis of repeated measures to calculate sample size. It was considered a power of 80 and 5% significance. Using a detectable difference equal to 0.4 points in the variable HAQ-S measured three times over time in two independent groups, we found a $n = 20$ (patients) in each group.

Descriptive statistics (mean, standard deviation, confidence interval 95%) was performed for the characterization of patients within groups. Initial continuous variables of the two groups were compared by Student's *t* test (for variables with normal distribution) and Mann-Whitney test (for variables with abnormal distribution). Categorical variables were evaluated through the chi-square test.

We used intention-to-treat analysis to evaluate the response to intervention. The analysis of variance (ANOVA) for repeated measures was used to evaluate the response to treatment intergroup and intragroup over time. The statistical significance level adopted was 5%.

Results

A total of 80 patients were contacted, although, 39 refused to take part on the study due to different reasons such as the distance between the center and their residencies as well as unavailability of time (Fig. 1).

Following initial contact, we recruited and randomized 41 patients: 21 to the control group and 20 to the exercise group. There were no dropouts in both groups during the course of the study. The groups were homogeneous regarding the clinical and demographic variables. The mean age of the patients was around 50 years old. The drug most commonly used was methotrexate (Table 1).

Regarding the variables of interest, we used ANOVA to evaluate the groups over time and we found significant statistic difference between groups for the BASDAI evaluation ($p = 0.038$) and in the HAQ-S ($p = 0.048$). In the variables, BASFI and DAS28 only IG improved over time; however, without difference between groups (Table 2). For the domains of the SF-36, we found differences only in pain ($p = 0.017$) and general health ($p = 0.002$) in favor of IG (Table 3).

The 1RM test showed improvement intragroup of strength in the exercise group in most of the exercises, except in biceps exercise. However, the control group also improved strength in some exercises (crucifix, handsaw, and leg extension). The only difference between groups found was in the exercise in the leg extension on right side ($p = 0.035$) (Table 4).

No adverse events were reported in both groups.

Discussion

PsA affects the physical capacity of patients due to its progressive inflammatory characteristics. McKenna, Doward, and Walley[14] suggest that patients with severe PsA may have early retirement or unemployment due to the inability to perform physical activities at work.

International recommendations for the treatment of spondyloarthritis suggest that physical exercises are essential in all forms and stages of the disease [15]. However, current evidences are still weak. A number of studies are not well

designed and usually do not describe properly the exercises applied, making them unable of replication [5].

For patients with rheumatoid arthritis, the study of Athan et al. [16] conducted a meta-analysis including randomized controlled studies using resistance exercise programs from 2009 to 2012. A number of ten studies were found and their vast majority showed benefits on the variables analyzed. Similar to our findings, the authors concluded that resistance exercises were safe and effective on the improvement of all variables studied, including functional capacity assessed by the HAQ.

This was the first study to carry out a program of resistance exercises in patients with PsA Additionally, it described in detail exercise series, loads, and all the repetitions applied, making it easy of replication. In order to verify the effectiveness of the program, we used only reproducible and validated instruments for the Brazilian population: BASFI and HAQ-S to evaluate functional capacity and BASDAI, and DAS 28 for disease activity.

At the present study, we found significant improvement on the disease activity, which was measured by the BASDAI in the intervention group following a comparison to the control group. Similar findings were observed in patients with AS, as showed in a study by Rosu et al. [17] which evaluated the combined effects of Pilates, McKenzie, and Heckscher technique in patients with AS. The authors concluded that the above combination of exercises improved significantly the disease activity after 48 weeks of regular training. Similarly, Silva et al. [18] measured the effects of global postural reeducation (RPG) in patients with AS by comparing an autostretching exercise group to a conventional breathing group. The results of this study showed that both methods had a positive effect on the improvement of the disease activity after 16 weeks of intervention.

We have not found any significant difference between groups while analyzing the results of the SF36 regarding quality of life except for the domains pain and general health. Perhaps the above instrument (SF-36) was not sensitive enough to demonstrate the effects of the proposed intervention in our population.

Despite the fact isokinetic test is considered as the "gold standard" in the literature to measure muscle strength, we opted for the 1RM test. The last is also used as a prescription of resistance exercises due to its easy application as well as to the safety features while the patients perform the movements. In addition, it is also a low cost instrument, which contributed to our choice at the present study, [19, 20]. Significant differences were not observed in the evaluation of muscle strength among the groups studied, except on the right leg extensor, maybe because of the short time of the intervention.

We would like to present as factor limitation on this research the heterogeneity of the disease presentation. We believe that the treatment time could have been longer than 12 weeks and the sample size could have been larger as well.

In conclusion, resistance exercises are effective in improving functional capacity, disease activity, and the general quality of life of patients with psoriatic arthritis. However, these improvements were not coupled to improvement of muscle strength.

Author's contributions All authors contribute to the conception and design of the study, or acquisition of data, or analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and final approval of the version to be submitted.

Compliance with ethical standards This study was approved by the Ethics Committee of our institution by the number 0196/11 and Clinicaltrials.gov with number NCT02598739.

Disclosures None.

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