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Type of Activity Pacing Instruction affects Physical Activity Variability in Adults with Symptomatic Knee or Hip Osteoarthritis

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Abstract

Background—In a previous pilot study, the effect of two types of activity pacing instruction, general versus tailored, on osteoarthritis symptoms was examined and fatigue improved in the tailored group. Because activity pacing involves instruction on physical activity engagement, we undertook this secondary analysis to examine how pacing instruction affected physical activity patterns.

Methods—Thirty two adults with knee or hip osteoarthritis, stratified by age and gender, received either tailored or general activity pacing instruction. All participants wore an accelerometer for five days that measured physical activity and allowed for repeated symptom assessment at baseline and 10 week follow-up. Activity patterns were assessed by examining physical activity variability (standard deviation of 5-day average activity counts per minute), and average activity level (5-day average activity counts per minute).

Resuls—Physical activity variability decreased in the tailored group and increased in the general group. No significant group changes in average activity from baseline to 10-week follow-up were found.

Conclusion—In this pilot study, type of activity pacing instruction affected objective physical activity patterns in adults with OA. Tailored activity pacing was more effective at reducing high and low activity bouts corresponding to the message of keeping a steady pace to reduce symptoms.

Keywords

occupational therapy; symptom management; accelerometer

Introduction

Osteoarthritis (OA) affects approximately 27 million adults in the United States (1) and is a leading cause of pain and disability. For people with symptomatic knee or hip OA, the

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disease has a profound effect on daily life, including difficulty in performing activities of daily living (2), decreased participation in work-related activities (3), and diminished quality of life (4, 5).

Adults with knee or hip OA commonly attribute problems with their daily activity performance to their symptoms such as pain (6) and there is a relationship between knee pain and difficulty performing specific activities (7). Despite this, few clinical interventions for OA try to directly impact the *relationship* between symptoms and activity and instead focus on pain only or on reducing risk factors for OA disability such as inactivity or obesity by increasing exercise participation (8) or encouraging weight loss (9). Activity pacing is a strategy specifically geared to disentangle the symptom experience from the activity experience. The goal is to alter the symptom-activity relationship through scheduled rest intervals so that, ideally, symptoms are not influencing activity engagement (10).

Activity Pacing in OA

Although activity pacing is a poorly understood concept (11,12) with various definitions and applications being reported in the literature, in essence it is a plan for alternating active periods with rest periods to attenuate the symptom-activity relationship. The role of activity pacing in OA is most relevant within the context of the “overactivity - underactivity” cycle (13) in which periods of excessive activity result in symptom flares that require an extended recovery period. Over time, the capacity for activity is diminished and recovery periods become longer. To break this cycle and reduce the influence of symptoms on activity, we teach time-contingent activity pacing (10) in which short rest intervals are scheduled throughout an activity and before symptoms flare. Previously we showed that activity pacing improved fatigue in people with knee or hip OA, but only when activity pacing intervention was delivered by tailoring the instruction to an individual's symptom-activity patterns. (14). These findings and others (15,16) provide preliminary support for the use of activity pacing in management of OA symptoms; however, its impact on physical activity is still in question. Considering that activity pacing instruction for OA directly pertains to modulating physical activity patterns, it is necessary to understand how this instruction affects the way people actually engage in physical activity.

As noted, the original report focused on patient reports of symptoms before and after the interventions. The purpose of this secondary analysis was to examine objective physical activity data and to evaluate the effect of the two types of activity pacing instruction on physical activity patterns in people with symptomatic knee or hip OA. We based our hypotheses on how the activity pacing instruction was delivered. We hypothesized that, compared to the general activity pacing group, participants in the tailored activity pacing group would have greater decreases in the prevalence of peaks and valleys in their physical activity patterns (i.e. reduced variability) and have greater increases in average activity level.

Patients and Methods

Sample

Details on this sample have been published elsewhere (14). Participants were recruited using flyers and advertisements in southeastern Michigan. They first underwent an initial phone screening, and if eligible, were further screened by having x-rays taken of their knees or hips to determine the presence and severity of OA. Individuals were eligible for the study if they had symptomatic knee or hip OA defined as 1) radiographic evidence of OA in at least one knee or hip joint (≥ 2 on the Kellgren Lawrence scale), 2) corresponding self-reported joint pain for the previous three months, and 3) a pain score of ≥ 4 out of the 5 items on the pain subscale of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

(17) with 2 items rated moderate pain or more (18). Participants also needed to be over age 50 because we felt that this age range would be inclusive of adults who may be struggling with new OA symptoms, but still leading very active lives, including working part to full time. They also needed to have adequate cognition (a score of ≥ 26 on the Mini Mental Status Exam), and speak English. Exclusion criteria were: 1) non-ambulatory, 2) medical conditions or problems (other than OA, that interfered with daily activity performance or caused pain and fatigue, such as cardiopulmonary problems, neurological conditions, or autoimmune diseases), 3) knee or hip replacement surgery in the previous 6 months, 4) current involvement in OA interventions (e.g., physical or occupational therapy or cortisone injections), other than NSAIDs or other pain relievers, and 5) inability to operate the accelerometer used in this study. Overall, 178 people were screened by phone. Of those, 76 were eligible for x-ray screening, and 42 were randomized. Of the 42, 8 people withdrew from the study and 2 people were pilot participants who participated only to test intervention delivery and tailoring method. The resulting sample had 32 participants.

Procedure

Participants stratified by age and gender were randomized after the baseline assessment into the tailored or the general activity pacing intervention group using a computer-generated randomization schedule known only to the study coordinator (14). Recruitment for this study began in 2007 and ended in 2008. The 2 interventions in this study were equivalent in the amount of treatment time provided (45 minute sessions; 2 times over a 2 week period) and in mode of delivery (i.e., individual sessions with an occupational therapist). There were 2 occupational therapists who delivered the interventions (one for each intervention), and they were blinded to the content of the intervention they were not leading.

Outcome assessments were completed at baseline and at 10-week follow-up. At baseline, participants completed a health history survey, symptom questionnaires [WOMAC (17), the Brief Fatigue Inventory (BFI) (19), the Geriatric Depression Scale (GDS) (20)], and physical performance tests [the Six Minute Walk test (21), the Timed Up and Go test (22)]. They were then instructed on the home monitoring period, in which they were asked to wear an accelerometer and use the accompanying diary and user-input button to record symptoms and daily activities. The accelerometer [Actiwatch-score, Mini Mitter Phillips Respironics, Bend OR], worn on the non-dominant wrist, provided a continuous record of physical activity and allowed the input of symptom severity and activity pacing behaviors at specific time points throughout each day (wake up; +2, +4, +8, +12 hours after waking; and 30 minutes before bed). Participants were prompted to enter responses via an audible alarm on the Actiwatch. A log book was also used to record responses for double data-entry and to record daily activities as well as wake-up and bed times each day. The intervention began within the week after the home monitoring period.

Tailored and General Activity Pacing Content

All participants received the same study-specific education module on activity pacing at the first visit. The module outlined general principles of activity pacing as they apply to OA, and included: 1) the preplanning and prioritizing of activities; 2) alternating active and rest periods before a symptom exacerbation; and 3) changing positions. The principles of this intervention were chosen for their potential to impact the overactivity - underactivity cycle in OA. The education module was the focus of the general activity pacing intervention, whereas in the tailored activity pacing intervention, the focus was on a personalized report that summarized and visually depicted each person's symptom-activity relationship based on their physical activity and symptom data collected during the home monitoring period. In the tailored group, specific examples of where symptoms seemed to affect activity were highlighted within and across the days from the home monitoring period, and individual

goals for pacing were formulated. For both interventions, the second session focused on individual progress with activity pacing and perceived barriers to using the recommended strategies.

Outcome Measures

For this secondary analysis, our outcomes of interest were physical activity variability and average activity level, both of which were derived from the Actiwatch-Score. Physical activity variability was defined as the standard deviation of the 5-day average of daily activity counts per minute. The standard deviation of activity counts has been used as a measure of physical activity variability in previous accelerometry studies (23-25), and represents a way of examining the amount of fluctuation in activity level during the monitoring period. Average activity level was defined as the 5-day average of daily activity counts per minute. We used this measure to examine changes in average activity level from baseline to follow-up period.

A detailed explanation of physical activity assessment using accelerometry (26) and using the Actiwatch-Score specifically has been published elsewhere (25). In brief, the wrist-worn Actiwatch-Score has been shown to have excellent reliability between units (r = .98) and has established preliminary criterion validity among a sample of chronic pain patients (27). In further support of its validity, this wrist-worn device has discriminated between healthy controls and people with OA (28) and fibromyalgia (29) (i.e, activity counts were significantly lower in the disease groups compared to the healthy controls). In addition, peak activity from this device was found to be significantly higher after an occupational therapy intervention promoting physical activity compared to a health education intervention (30).

Data Analysis

Our analyses focused on changes in activity variability and average activity level in response to each intervention. Consistent with other studies, we treated activity as a linear variable (25,28,29,31). To compute physical activity variability, we calculated the standard deviation in average activity counts for each subject prior to the intervention, and then separately for each subject at the follow-up period. Next, we used individual growth models to examine change in physical activity variability from baseline to 10-week follow-up as a function of group status (tailored versus general activity pacing). Specifically, we used hierarchical linear models using SAS proc MIXED, which accounted for the correlated errors due to the within subjects design (32). In these models, variability in the outcome measure is considered to be a function of both between-subject factors (level 2, e.g., intervention group) and within-subject factors (level 1, e.g., change from baseline to follow-up). We also entered an interaction term for time (0=baseline, 1 = follow-up) by group (0=general, 1= tailored). A significant, negative time × group interaction term indicates support for the hypothesis of a larger decline in activity variability in the tailored group. We also used the same structure of individual growth models with the interaction term for time × group to examine the outcome of average activity level from baseline to 10-week follow-up. In the case of a significant interaction effect from these models, we also ran separate models within each group.

Results

The sample (n = 32) was 75% female, 78% Caucasian, and the mean age was 61.9 ± 7.9 years. Table 1 shows the participant characteristics of each activity pacing group. There were no statistically significant differences between the intervention groups at baseline with respect to background characteristics and symptom severity. However, compared to the general activity pacing group, participants in the tailored activity pacing group were slightly older (63.9 ± 7.8 vs. 59.5 ± 6.6, p = .10) and had slightly less reported pain on the WOMAC

at baseline (7.9 ± 3.8 vs. 10.2 ± 3.9) (16). Physical activity levels were similar across groups at baseline. Specifically, physical activity variability as measured by the standard deviation of average activity counts for the general and tailored groups respectively were 148.1 ± 41.1 and 137.6 ± 61.9 ($t = .54$, $p = .60$). Average activity levels across the general and tailored groups were 342.6 + 65.9 activity counts per minute and 364.3 ± 109.3 respectively ($t = -.64$; $p = .52$).

Physical Activity Variability

Table 2 presents the results of the mixed models with the top half of the table showing the random effects and the bottom half showing the fixed effects. For these models, two participants were excluded from the analyses. One participant had missing physical activity data at the follow-up period, and one participant was a shift-worker had physical activity data that were not usable resulting in a sample of $n = 30$. With respect to the outcome of physical activity variability, there is significant variability in the intercepts after considering the level 1 variables included in the fixed part of the model. From the estimates presented, we calculated an intraclass correlation (ICC) of .72. As this analysis involves data at 2 timepoints, we present only the variability in intercepts (representing the tendency for some participants to have more variability in activity than others, over time). The fixed effects reflect our evaluation of the hypothesis. As shown, the time × group interaction is negative and significant, consistent with a larger drop in activity variability in the tailored intervention. Tables 3 and 4 present the change in activity variability within the tailored group, and the general activity pacing group respectively. In these models, we also controlled for overall average activity level (average activity counts per minute). As noted in the tables, there is a significant decrease in activity variability, from baseline to follow up, in the tailored group ($p = .05$), but not in the general activity pacing group. The general activity pacing group shows an increase in activity variability from baseline to follow-up, although this is not statistically significant ($p = .11$).

Average activity level

We also replicated these models with average activity level, rather than variability, as the outcome variable (Table 5). We observed no change in average activity level from baseline to follow-up in either group (both t values < 1.0).

Discussion

Although activity pacing is a strategy which aims to minimize the “overactivity-underactivity” cycle, this is the first study, to our knowledge, to examine the effect of pacing on the actual pattern of physical activity across a 5-day period. Two types of activity pacing instruction were provided (general versus tailored) and each included the message concerning “overactivity” and symptoms. Commensurate with this theme, we hypothesized that both groups would have decreased variability in physical activity from baseline to follow-up with the tailored group having the largest decrease given its personal relevance. We found that our hypothesis was only partially supported. There was a significant decrease in physical activity variability in the tailored activity pacing intervention; however, there was an increase in variability in the general activity pacing intervention ($\beta = 20.47$; though not statistically significant, $p = .11$). There were no significant changes in average activity levels from baseline to follow-up. The decrease in variability within the context of unchanging activity levels suggests that participants actually complied with the notion of frequent, but short breaks in activity and maintaining an even pace throughout. Because this was evident only in the tailored group, it appears that the manner in which the activity pacing message is delivered could be an important consideration when using this strategy. In this study, the tailored activity pacing approach, which was individualized based on the

participant-specific symptom-activity relationship from a 5-day home monitoring period, reduced physical activity variability whereas activity pacing without personally relevant information on individual patterns did not. Interestingly, average activity level did not significantly change from baseline to 10-weeks for either group. It is possible that our time to follow-up was too short to observe an increase in activity as this change could be more gradual as people incorporate activity pacing techniques into their daily routines over time.

Some study limitations should be mentioned. The pilot nature of this study and small sample size did not allow us to include additional subject-level variables in our statistical models. A larger study is warranted to examine subject variables (e.g., gender, age, BMI, symptom severity) that may affect change in activity patterns after an activity pacing intervention. In addition, although physical activity variability decreased for participants in the tailored intervention, it is not clear if effects would be maintained over time since as long term follow-up data were not collected in this study. To better understand the effects of the tailored activity pacing intervention, it will be necessary to examine the natural objective activity patterns (variability and overall activity) over time in this population. This can be evaluated in a larger trial with a usual care control group arm. Another consideration is our choice of a wrist-worn accelerometer to examine physical activity patterns. Whereas this type of measure has been used to examine daytime activity patterns in several populations (33-35), placement of the device (wrist versus hip for example) affects measurement of specific activities (27). The wrist-worn Actiwatch-Score used in this study was the optimal method for data collection of both activity patterns and symptom reporting that occurred several times a day. Lastly, the administration of each activity pacing intervention by one of two occupational therapists is a potential limitation. Although they were each trained in how to deliver the intervention, were highly-qualified, and blinded to the content in the other intervention arm, there is still the possibility that effectiveness of teaching may have differed. A larger study should include more therapists and include more stringent treatment fidelity procedures, including booster training sessions on intervention delivery to prevent therapist deviation from the protocol.

In summary, these preliminary findings showed that an activity pacing intervention tailored to the participant reduced physical activity variability compared to a more general activity pacing approach. Because activity pacing is designed to alter activity patterns, it will be important to measure this outcome in future studies. Although this was a pilot study and a larger trial is needed to fully examine the effectiveness of tailored activity pacing, this is the first study to our knowledge that has examined the effect of activity pacing on objective physical activity levels. For clinicians, our preliminary findings suggest that how activity pacing is delivered has an effect on activity patterns and that tailoring based on client's usual patterns may be optimal.

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Table 1

Group Characteristics

	General Intervention (n=15)	Tailored Intervention (n=17)	p value
Female (n,%)[a]	11 (73%)	13 (76%)	.57
Age (yrs)	59.5 (6.6)	63.9 (7.8)	.10
BMI (kg/m^2)	31.8 (6.0)	32.7 (7.2)	.59
Daily Pain Medication Use[b]	7.2 (8.0)	7.1 (8.2)	.98
Depression (GDS)	1.9 (1.8)	2.4 (2.8)	.56
TUG (sec)	10.3 (2.7)	10.3 (2.0)	.97
6-min Walk (feet)	1203 (257)	1120 (295)	.40
Total Physical Activity[b] (activity counts)	325528.3 (79407.5)	336831.5 (91435.4)	.71
Peak Physical Activity (activity counts)	941.5 (192.6)	911.7 (249.8)	.71

Note: This table was reproduced with permission from the American Journal of Occupational Therapy. Unless otherwise indicated, means and standard deviations are presented.

[a] Due to low cell counts, Fisher exact test was used.

[b] Daily average over the 5 day home monitoring period

BMI = Body mass Index; GDS = Geriatric Depression Scale; BFI = Brief Fatigue Inventory; WOMAC = Western Ontario and McMaster Arthritis Index; TUG = Timed up and go test.

Table 2

Variability in average activity counts before and after intervention (N = 30).

Covariance parameter estimates	**Subject**	**B**	**Std. error**	**Z**	**p**
Random effects: prediction of activity variability					
Intercept	ID	1331.66	466.52	2.85	<.01
Residual	ID	498.50	157.53	3.16	<.01
Predictor variables and control variables	β	Std. error	DF	t	p
Fixed effects					
Intercept	26.64	23.63	28	1.13	.27
Average activity counts per minute (level 1)	0.35	0.06	21	5.87	<.01
Time (baseline = 0, follow-up = 1) (level 1)	21.72	9.44	21	2.30	.03
Group (general = 0, tailored = 1) (level 2)	−20.60	15.71	28	−1.31	.20
Time × Group (level1 × level2)	−37.25	12.84	21	−2.90	<.01

Note. In examining the distribution of the standard deviation of activity level, we observed a tendency toward a slight positive skew (1.54) and some kurtosis (2.70). These tendencies were substantially reduced by transforming this variable by taking its square root. However, doing so did not significantly alter any of the central findings, so for ease of interpretation, we present only the non-transformed variable.

Table 3

Variability in average activity counts before and after intervention: tailored intervention group only (n=16)

Covariance parameter estimates	**Subject**	**β**	**Std. error**	**Z**	**p**
Random effects: prediction of activity variability					
Intercept	ID	1957.33	808.25	2.42	<.01
Residual	ID	276.52	118.67	2.33	.01
Predictor variables and control variables	β	Std. error	DF	T	p
Fixed effects					
Intercept	24.52	31.5	15	0.78	.45
Average activity counts per minute (level 1)	0.30	0.08	11	3.79	<.01
Time (baseline = 0, follow-up = 1) (level 1)	−14.09	6.52	11	−2.16	.05

Table 4

Variability in average activity counts before and after intervention: general activity pacing group only (n=14)

Covariance parameter estimates	**Subject**	**β**	**Std. error**	**Z**	**p**
Random effects: prediction of activity variability					
Intercept	ID	743.74	494.38	1.50	.07
Residual	ID	736.47	328.08	2.24	.01
Predictor variables and control variables	β	Std. error	DF	t	p
Fixed effects					
Intercept	4.65	31.61	13	0.15	.88
Average activity counts per minute (level 1)	0.42	0.87	9	4.80	<.01
Time (baseline = 0, follow-up = 1) (level 1)	20.47	11.39	9	1.80	.11

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Table 5

Average activity counts before and after intervention (N = 30).

Covariance parameter estimates	**Subject**	**β**	**Std. error**	**Z**	**p**
Random effects: prediction of activity variability					
Intercept	ID	5741.81	2195.98	2.62	<.01
Residual	ID	3233.71	999.77	3.23	<.01
Predictor variables and control variables	β	Std. error	DF	T	p
Fixed effects					
Intercept (level 1)	342.60	25.33	28	13.52	<.01
Time (baseline = 0, follow-up = 1) (level 1)	18.64	23.78	22	0.78	.44
Group (general = 0, tailored = 1) (level 2)	21.67	34.69	28	0.62	.54
Time × Group (level1 × level2)	−23.09	32.34	22	−.71	.48