IMAJ • VOL 13 • JANUARY 2011

The Effect of Exercise Cessation on Non-Articular Tenderness Measures and Quality of Life in Well-Trained Athletes

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ABSTRACT: **Background:** The term chronic multi-symptom illness (CMI) refers to a spectrum of pain disorders, such as fibromyalgia and chronic fatigue syndrome, that are characterized by unexplained chronic pain, fatigue, and cognitive and mood complaints

Objectives: To examine the hypothesis that exercise cessation is associated with symptoms similar to CMI in well-trained amateur athletes.

Methods: The study, conducted in running and triathlon clubs in Israel, involved 26 asymptomatic healthy athletes who regularly exercise 6.75 ± 3.65 hours a week. All athletes were instructed to refrain from physical activity for 7 days. All underwent a complete physical exam, rheumatological assessment including non-articular tenderness threshold (using dolorimeter) and tender points. In addition they completed the SF-36 quality of life questionnaire. Assessments were conducted before exercise cessation and 7 days later.

Results: Seven days after sports deprivation all subjects were significantly more tender by all tender measures ($P < 0.001$) (dolorimeter thresholds and tender point count). There was also a significant reduction in the scores for physical role function ($P < 0.001$), emotional role function ($P < 0.001$) and summary subscales of the SF-36 questionnaire after exercise cessation.

Conclusions: Exercise deprivation is associated with change in non-articular tenderness threshold and reduction in quality of life scores. This may be associated with the development of chronic multi-symptom illness.

IMAJ 2011; 13: 44–47

KEY WORDS: exercise, tenderness, quality of life, dolorimetry

The term chronic multi-symptom illness refers to a spectrum of pain disorders, such as fibromyalgia and chronic fatigue syndrome, that are characterized by unexplained chronic pain, fatigue, and cognitive and mood complaints [1,2]. Several hypotheses have been raised to unravel the trigger for the development of CMI. Environmental factors may have a major role in the pathogenesis of CMI [3,4]. Physical trauma, infections, emotional stress and endocrine disorders have also been associated with CMI. Glass et al. [5] suggested that regular exercise may retard the development of pain, fatigue, fibromyalgia and other somatic symptoms in high-risk healthy individuals. On this basis, aerobic exercise is one of the main treatment modalities for CMI and fibromyalgia [6]. Routine aerobic exercise reduces the level of fatigue and overall pain threshold in healthy individuals [7]. In addition, cessation of regular exercise training among healthy individuals has been associated with increased feeling of fatigue and somatic complaints [8]. The data indicate that exercise cessation can lead to the development of CMI-related symptoms. In the present study we explore the effect of exercise cessation on pain threshold, non-articular tenderness, and quality of life.

CMI = chronic multi-symptom illness

PATIENTS AND METHODS

The study group comprised asymptomatic healthy active adults who reported performing at least 4 hours of aerobic activity per week. The participants were recruited through advertisements published at running and triathlon association web sites, and through presentation of the study goals at gathering places (without proposing the study hypothesis). The aerobic fields included were long distance running, cycling and triathlon. We excluded people known to suffer from any chronic illness or CMI.

The quality of life and measures of non-articular tenderness were assessed in all participants at recruitment and after 7 days of exercise cessation. A 7 day break was chosen for pragmatic reasons. We assumed that this would be the maximal period that most individuals would be able to stop their training.

QUALITY OF LIFE ASSESSMENT

Quality of life was assessed using the Medical Outcome Study Short Form 36 physical and health scales [8,9]. The MOS SF-36 has eight health scales; each of which measures a health

MOS = Medical Outcome Study
SF-36 = short form-36

concept: physical functioning, role functioning (physical), role functioning (emotional), social functioning, bodily pain, mental health, vitality, and general health perceptions. The SF-36 multi-items were scored so that the higher score indicated a better health state. After computing the raw scores, they were transformed into a 0–100 scale. In addition, the scores of the eight subscales were computed into two summary scores: the physical component summary and the mental component summary. These two measures represent the entire SF-36 and are derived from all eight subscales; however, the PCS score is based mainly on the physical functioning, role physical, bodily pain, and general health scales while the MCS score is based primarily on vitality, social functioning, role emotional and mental health scales. The scores were computed and standardized to those of the general United States population in accordance with the user's manual instructions [9,10]

NON-ARTICULAR TENDERNESS

Each subject underwent both manual tender points count assessment and a dolorimeter examination to evaluate non-articular tenderness. The manual tender point exam was performed using standardized methodology with digital palpation of approximately 4 kg applied to nine designated bilateral predetermined sites (total 18). Subjects were asked to indicate if they experienced tenderness at a particular site, thus giving a dichotomous "yes/no" response for each anatomical site. A dolorimeter exam was performed with a pressure algometer at nine points and at four control points. The study received approval from the local ethics committee in accordance with local requirements. All subjects signed informed consent before entering the study.

STATISTICAL ANALYSIS

The count of tender points, dolorimeter thresholds, and SF-36 scales as measured before and after one week of rest are presented by medians, means and standard deviations. The Wilcoxon rank test was used for comparison of paired data in the total study population. We then calculated the difference between the before and after of these measures by subtracting the "before" value from the "after" value. Thus, a positive difference in the number of tender points indicates an increase in sensitivity to pain, a positive difference in dolorimeter thresholds indicates a decrease in sensitivity, and a positive difference in SF-36 scores indicates improvement in health-related quality of life. The association between demographic and sports-related characteristics and the before–after difference of each outcome measure was tested using the Mann-Whitney test for dichotomous variables and the Spearman correlation coefficient for continuous variables. Statistical analyses were carried out using the SPSS software version 14.0.

PCS = physical component summary
MCS = mental component summary

RESULTS

Twenty-six athletes were recruited for the study. Table 1 presents the main demographic and sports-related characteristic of the study participants. The mean age was 41.7 ± 11.1 years, and 69% of the athletes were males. The main types of physical activity were running (84.6%) and triathlon (15.4%). The median time for physical activity was 6.25 hours. Fourteen patients (53.8%) had had a sport-related injury.

PAIN THRESHOLD AND TENDERNESS

Table 2 shows the number of tender points and dolorimeter thresholds at recruitment and 7 days after sport cessation. The table shows that 7 days after sports cessation the athletes became

Table 1. Demographics, and sports-related characteristics of the study participants (N=26)

	Mean ± SD	Median	Range
Age (yrs)	41.7 ± 11.1	39	27–73
Male gender (%, n)	69.2% (18)		
Marital status (%, n)			
Single	26.9% (7)		
Married	60.2 (18)		
Divorced	3.8% (1)		
Body mass index (kg/m^2)	23.4 ± 2.4	22.8	19.6–28.7
Main type of physical activity (%, n)			
Running	84.6% (22)		
Triathlon	15.4% (4)		
Hours of physical activity per week	6.75 ± 3.65	6.25	3–18
Years of physical activity	13.0 ± 8.4	13	1–35
Injured in the past (%, n)	53.8% (14)		

Table 2. Measures of tenderness and of health-related quality of life of study participants before and after 1 week of rest (N=26)

	Before Median (mean ± SD)	After Median (mean ± SD)	*P* value*
Tender point count (of 18)	2.0 (3.0 ± 2.5)	5.0 (5.4 ± 2.5)	‹ 0.001
Dolorimeter thresholds (kg) (9 tender sites)	8.2 (8.3 ± 2.1)	7.2 (7.4 ± 2.3)	0.002
Dolorimeter thresholds (kg) (4 control sites)	9.8 (9.8 ± 1.9)	8.0 (9.0 ± 2.4)	0.017
SF-36 scales			
Physical functioning	100 (98.6 ± 3.6)	100 (97.7 ± 5.7)	0.16
Physical role function	100 (91.3 ± 23.4)	100 (69.2 ± 38.3)	‹ 0.001
General health perception	81 (79.7 ± 16.2)	77 (78.2 ± 14.3)	0.43
Emotional role	100 (94.9 ± 12.3)	100 (73.1 ± 37.7)	‹ 0.001
Social functioning	100 (93.8 ± 11.9)	87.5 (86.1 ± 16.3)	0.055
Bodily pain	84 (74.4 ± 16.4)	73 (69.1 ± 18.6)	0.16
Mental health	82 (79.4 ± 10.5)	84 (76.3 ± 15.1)	0.16
Vitality	70 (70.8 ± 11.9)	60 (61.3 ± 17.1)	0.009
PCS**	54.1 (52.2 ± 6.2)	51.3 (50.3 ± 6.1)	0.003
MCS**	55.0 (53.9 ± 4.4)	48.7 (49.3 ± 8.4)	0.009

* Wilcoxon signed-rank test
** PCS and MCS were standardized according to Ware et al., 1994 [9].

Table 3. Association between demographic and sports-related characteristics and change in pain-related outcomes measured before and after one week of rest

	Change in number of tender point sites	Change in mean threshold of pain	
Variable	**Median (mean ± SD)**	**9 tender points Median (mean ± SD)**	**4 control points Median (mean ± SD)**
Gender			
Male	2.50 (2.67 ± 1.88)	-0.83 (-0.97 ± 1.33)	-1.50 (-0.74 ± 2.02)
Female	2.50 (1.88 ± 2.10)	-0.89 (-0.93 ± 1.53)	-0.38 (-0.93 ± 1.15)
Marital status			
Married	3.00 (2.56 ± 1.69)	-0.77 (-0.92 ± 1.46)	-0.63 (-0.60 ± 1.74)
Single or divorced	2.00 (2.13 ± 2.53)	-1.31 (-1.05 ± 1.21)	-1.81 (-1.24 ± 1.91)
Main type of physical activity		-0.69, -0.65 ± 1.10	
Running	2.50, 2.36 ± 2.01	-2.22, -2.63 ± 1.61	-0.78, -0.69 ± 1.76
Triathlon	2.50, 2.75 ± 1.71	*P* = 0.033**	-1.81, -1.40 ±21.02
Past injury			
No	3.00 (2.92 ± 1.98)	-0.77 (-1.07 ± 1.13)	-1.34 (-0.98 ± 1.37)
Yes	2.00 (2.00 ± 1.88)	-1.03 (-0.86 ± 1.57)	-1.06 (-0.64 ± 2.11)
	Spearman's correlation coefficient	**Spearman's correlation coefficient**	**Spearman's correlation coefficient**
Age (yrs)	-0.14 *P* = 0.49	0.26 *P* = 0.20	0.31 *P* = 0.12
BMI (kg/m2)	-0.31 *P* = 0.12	0.44** *P* = 0.026	-0.01 *P* = 0.95
Years of physical activity	-0.44** *P* = 0.025	-0.04 *P* = 0.85	0.14 *P* = 0.49
Hours of physical activity per week	-0.132 P = 0.52	-0.38* *P* = 0.052	-0.07 *P* = 0.75

*$P < 0.1$
**$P < 0.05$

significantly tenderer by all tenderness measures; namely, they had higher mean tender point counts and lower dolorimeter thresholds. The mean tender point counts were 3.0 ± 2.5 and 5.4 ± 2.5 before and after exercise cessation, respectively ($P < 0.001$). The dolorimeter thresholds at all sites were significantly lower after 7 days of sport cessation [Table 2]. The median dolorimeter threshold at the four control sites and nine tender sites changed from 9.8 to 8.0 ($P = 0.017$) and from 8.2 to 7.2 ($P = 0.002$) before and after sport cessation respectively.

QUALITY OF LIFE SCORES

Table 2 also shows the mean scores for eight individual health scales and for the physical and mental health summary scores of the SF-36 scales. All subjects were highly satisfied with their quality of life. They reported maximal scores for social and physical functioning and for emotional and physical role function. Seven days after exercise cessation a significant reduction in the scores of physical role function, emotional role, vitality and summary subscales was observed.

VARIABLES ASSOCIATED WITH TENDERNESS

Table 3 presents the association between demographic and sports-related characteristics and difference in non-articular tenderness-related outcomes. There was a significant correlation between the number of hours of activity per week, number of years of physical activity, and higher tender point and lower thresholds of the dolorimeter ($P = 0.052$, $P = 0.025$) respectively.

DISCUSSION

The study hypothesis was that amateur sportsmen and women develop changes in non-articular tenderness and quality of life after cessation of exercise. Of the 26 subjects 22 went on to develop changes in tenderness thresholds and changes in the physical component summary and mental component summary scale of SF-36.

The study demonstrated increased non-articular tenderness and tender point sites in amateur sportsmen and women after exercise cessation of 7 days. Specifically, exercise cessation increased the median and mean (SD) tender point count (of 18) from 2.0 (3.0 ± 2.5) to 5.0 (5.4 ± 2.5), before and after 7 days respectively ($P > 0.001$). A decrease was observed in median and mean (SD) tender point sites threshold (dolorimeter thresholds) from 8.2 kg (8.3 ± 2.1) to 7.2 kg (7.4 ± 2.3) ($P = 0.002$), and in median and mean (SD) control point sites from 9.8 kg (9.8 ± 1.9) to 8.0 kg (9.0 ± 2.4) ($P = 0.017$), before and after 7 days respectively. Our findings are in accordance with the results of a previous study on the relationship between tenderness and exercise cessation [4]. We also demonstrated an association between the main physical activity, the number of years of physical activity and hours of physical activity per week, and changes in the number of dolorimeter thresholds, but these findings are not absolute [Table 3]. It suggests that more intense and extended physical activity may expose an active person to symptoms of CMI after cessation of activity.

In contrast to the study of Glass et al. [5], but similar to

others [8], our study shows a significant decrease in quality of life and physical perception after exercise cessation, as reflected in the results of the SF-36 questionnaire [Table 2].

Our findings, showing changes in tenderness as well as in mood and physical perception, reinforce the hypothesis that healthy individuals who have hypoactive function of the biological stress response systems unknowingly exercise regularly to augment the function of these systems. Regular physical activity suppresses the symptoms [2,11]. Our results show that people who exercise regularly might develop non-articular tenderness symptoms if and when they reduce or stop exercise activity. This is an important clue to the association linking aerobic training, exercise cessation, tenderness and pain syndromes.

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