Clinical and Experimental Psychology

Wentz and Archer, Clin Exp Psychol 2017, 3:3
DOI: 10.4172/2471-2701.1000168

Research Article Open Access

Exercise Induced Autonomic Disengagement and Pain in Women Presenting FM and Healthy Women: Analgesia and Blood Pressure

Kerstin Wentz[1]* and Trevor Archer[2]

[1]Occupational and Environmental Medicine Sahlgrenska University Hospital, Sweden
[2]Department of Psychology, University of Gothenburg, Box500, Gothenburg, Sweden

Abstract

Objective: The aim of the present analysis was to examine physiological adaptation to a sub-maximal test by measuring blood pressure (BPR) from the perspective of the fibromyalgia (FM) pain experience.

Method: Twenty-four women presenting FM and twenty-six healthy women were education- and age-matched. In their homes, all women completed questionnaires regarding background and health related quality of life (SF-36). All the women performed a stepwise load increment submaximal exercise test on a cycle ergometer to the severe perceived exertion level. Blood pressure was recorded before, during and after the test.

Result: Women presenting FM showed higher baseline resting systolic BPR (SBPR) and diastolic BPR (DBPR) with higher SBPR and DBPR during the recovery phase. In both groups SBPR and DBPR were correlated at base line. Women presenting FM contrasted to healthy women by BPR measures more frequently correlating during workload. In women with FM the correlative relationship between the SBPR and DBPR during recovery was pronouncedly higher. Clinical pain correlated four times more often with BPR measures in the FM study group as compared to the group of controls. In FM higher clinical pain was linked to lower BPR.

Conclusion: In the context of the FM condition, the tests depict a physiologically perseverative pattern concerning SBPR and SBPR measurements. This pattern was pronounced during recovery. A higher level of clinical pain BP corresponded to lower SBPR and SBPR before and after the test confirming an inverse relationship between blood pressure and pain sensitivity in the condition of FM. Parallel, in FM the analgesic effect from BPR was insufficient due to lowered pain thresholds. Pain thresholds linked to dysregulated sympathetic and parasympathetic functions together with psychological functioning and higher levels of brain functioning need further examination.

Keywords: Fibromyalgia; Blood pressure; Bicycle ergometer test; Variability; Autonomic nervous system; Clinical pain

Introduction

Sensitivity to pain relates to interactions between the regulatory pain- and cardiovascular systems. Moreover, from a research design covering the association between blood pressure (BPR) and pain sensitivity [1] concluded that the inverse relationship between blood pressure and pain sensitivity was equally valid across the whole blood pressure spectrum (ranging from hypotension to hypertension). This conclusion relied upon a pioneer comparison between hypotensive and normotensive study groups. Regarding BPR reactivity (BPRR), the analog inverse relationship was identified in terms of weaker BPRR implying greater pain reactivity from a cold pressure test [1]. Concerning musculoskeletal complaints examined from public health perspective Hagen et al. [2] found that a high systolic and diastolic BPR was associated with a 10% to 60% lower prevalence of chronic musculoskeletal complaints irrespective of the anatomical site of pain. The association between prevalence of musculoskeletal complaints and BPR values was linear. In addition, these findings concerned both sexes and all age groups.

Adaptive blood pressure and modulation of the experience of pain

In a review on interactions between the cardiovascular and the pain regulatory systems [3], picture the behavior guiding adaptive signaling functioning of both pain inhibitory and facilatory descending pathways in three steps. In the face of acute pain, these systems act inhibitory in order to facilite a successful escape from further harm. In a second step and in the service of promoting healing, pain perception is instead facilitated. Thirdly in the case of persistent pain with behaviorally adaptive systemic measures implies intensified activity from the descending pain inhibitory pathways. Also Okifuji and Turk [4] relate that a potent acute stress response may be associated with a decrease in sensitivity to pain, so-called stress-induced auto-analgesia. Whether or not this is due to a lower pain threshold is left unexplained. Simultaneously, there is among healthy individuals a variation regarding pain modulation. This modulation implies that healthy individuals who present hypotensive blood pressure show comparatively intensified signaling in the neurological pathways during the pain experience as compared to the suppressed signaling of hypertensive healthy individuals. Bruehl and Chung [3] describe the functional role of blood pressure (BPR) in the endogenous regulation of pain whereby the BPR versus pain sensitivity relationship may be proposed to "reflect a homeostatic feedback loop helping restore arousal levels in the presence of painful stimuli.". Furthermore, e.g. La Rovere et al. [5] described how a blood vessel mechanism in terms of the arterial baroreceptor reflex system prevents short-term extensive fluctuations of arterial blood

***Corresponding author:** Wentz K, Occupational and Environmental Medicine Sahlgrenska University Hospital, Sweden, Tel: +46 (0)31 786 3219; Fax: +46 (0)31 409728; E-mail: kerstin.wentz@amm.gu.se

Received: September 15, 2017; **Accepted:** September 21, 2017; **Published:** September 28, 2017

Citation: Wentz K, Archer T (2017) Exercise Induced Autonomic Disengagement and Pain in Women Presenting FM and Healthy Women: Analgesia and Blood Pressure. Clin Exp Psychol 3: 168. doi: 10.4172/2471-2701.1000168

pressure and how the ANS control of the cardiovascular system may be evaluated through that (barorepceptor) system. The review by Bruehl and Chung [3] suggested also the significance of endogenous cardiovascular regulation for chronic pain mechanisms. Nevertheless, these notions may eventually be found to be mere simplifications of processes that incorporate also higher levels of brain functioning and the immune system.

BPR, clinical pain and stress induced pain in FM

Concerning FM, Thieme et al. [6] found that ANS reactivity in terms of diastolic blood pressure (DBPR) reactivity and HR reactivity corresponded to lower levels of pain arising from mental load. These findings concerning FM are consonant with a design by

Reyes del Paso et al. [7] who examined ANS responses to mental stress in FM patients and observed a blunted reactivity to the stressor of the cardiovascular system including a reduced resting baroreflex sensitivity and the lack of a baroreflex sensitivity to the mental load condition. In both the FM study group and the group of healthy controls lower levels of BPR and baroreflex sensitivity were associated with a higher reported level of pain from the experiment. Importantly, his inverse relationship between baroreflex sensitivity and experimentally induced pain was valid also to every day clinical pain in FM.

Pain and physical load in FM

Black et al. [8] examined a healthy study group and recorded that post-exercise (stress arousal) blood pressure was associated with a generalized inhibitory pain mechanism. In contrast and concerning in women presenting FM, Wentz et al. [9] found that aerobic submaximal ergometer exercise test resulted in an increase in pain from the test in terms of 12 points on a Visual Analog Scale (VAS) (ranging from 1-100) [10]. Parallel, pain reactivity in terms of VAS was not related to BP. Koseck et al. [11] compared FM patients with healthy controls as regards the effect of physical exercise on sensitivity to experimental pressure pain. Pressure pain sensitivity was registered parallel to and also after physical load. In the healthy controls a decrease in pain sensitivity was observed. In contrast, an increased pressure pain sensitivity was observed in the FM study group. Vierck et al. [12] reported similar findings.

Lange et al. [13] investigated the baseline values and the response of HRV to an incremental, aerobic submaximal exercise test in female patients presenting FM and compared the result to a gender- and age-matched healthy control group. The procedure, characteristics, sub maximal test and the data analysis including psychometrics, are described in Lange et al. [13]. In short, Lange et al. [13] observed that HRV values at baseline and the HRV values after an incremental, aerobic submaximal exercise test showed no difference between the groups. Instead, a discrepancy between the groups was observed in HR adaptation to the ergometer sub maximal test wherein the HRV of the healthy reference had been altered significantly through the test. The HRV of women presenting FM showed no statistically significant alteration of HRV measurements. Concerning HR at baseline and during the first three levels of workload (25 W, 50 W and 75 W), women presenting fibromyalgia showed a statistically significantly higher HR than the healthy women, e.g. the mean HR at rest in Women presenting FM was 70 (sd 10) and in controls 63 (sd 8) and at work load level 50 W 111 (sd 13) and 98 (sd10). After the work load level 50 W, the group presenting fibromyalgia decreased from 24 to 13 women at 87, 5 W at which point HR was also no longer statistically different between the groups. In a next step of the analysis, Wentz et al. [9] analyzed pain recordings in terms of psychometric instruments completed in the homes of the study groups. In terms of the Body Pain scale from Health related quality of life Short Form (SF-36) the study group presenting FM recorded a mean value of 24 (SD=13.7) on the scale that ranges from 0-100 and concerns pain during 4 weeks. A low value equals low quality of life (consequently in the case of BP a high level of pain). The corresponding figures concerning healthy controls were M=82, SD= 16.7. In parallel, sum variables concerning heart rate (HR) at two or three levels of work load were all positively related to BP in terms of higher HR meaning worse clinical pain. Parallel, BP was not related to the rise in pain from the test. Instead, pain reactivity was associated with HRV adaptation similar to that of healthy women from the test (an increase LFnu value and an decreased HFnu value) implying that pain reactivity represents in a sense a healthier aspect of ANS functioning than clinical pain. During the test BPR was also registered but these recordings have so far not been included in the analysis of collected measures of clinical pain in terms of (BP) from the perspective of physiological measures.

Methods

Aim

The aim and purpose of the present analysis was to examine the physiological adaptation to a sub-maximal test i.e., moderate intensity exercise in terms of Systolic and diastolic BPR, from the perspective of the everyday fibromyalgia pain experience. Fibromyalgia pain was registered as a health-related quality of life attribute with regard to Bodily Pain (BP) during 4 weeks and recorded before and after the sub maximal test.

Participants

Twenty-four women presenting FM with an interest in participating were recruited from primary health care and rehabilitation centers in the region of Västra Götaland (Sweden). Inclusion criteria were female gender, with the participants aged 20-60 years showing a registered FM diagnosis within the last 7 years. Exclusion criteria were prior trauma to the head, brain damage, severe somatic disease, muscular disease, heart disease or anemia, dependent in personal activities of daily life as well as drugs affecting HR. The healthy control group was age-matched, pairwise ± 3 years, and recruited from employees (volunteers) within the health care service, but was complemented with acquaintances and otherwise in order for achieving age and education matching to the FM patients. The healthy control group was required to confirm their healthy status, and the same exclusion criteria as for the FM patients were used, with one addition: prolonged pain [13] (Table 1).

Study design

Ethics: The cross sectional study was approved by the Regional Ethical Review Boards at the University of Gothenburg as a part of a larger project "Affective, cognitive and defensive interplay in fibromyalgia: from premorbid strain to treatment of somatic manifestations". Informed consent was obtained from all the participants prior to the study. An additional permit was passed by the Regional Ethical Review Boards at the University of Gothenburg prior to analysis of blood pressure data for publication specifically.

Inclusion and exclusion criteria: Inclusion criteria were female gender, with the participants aged 20-60 years showing a registered FM diagnosis within the last 7 years. Exclusion criteria were prior trauma to the head, brain damage, severe somatic disease, muscular disease, heart disease or anemia, dependent in personal activities of daily life as well as drugs affecting HR. The healthy control group was age-matched,

	FM (n=24)	Reference group (n=26)	p-value
	Mean ± SD	Mean ± SD	
Age (years)	49.4 ± 9.8	48.7 ± 9.0	0.799
BMI (kg/m^2)	27.3 ± 6.0	25.1 ± 3.0	0.113
Pain duration (years)	12.7 ± 9.6	NA	
Education (n=22/25)			0.967*
≤9 years	1 (4.5 %)	1 (4 %)	
9-12 years	5 (22.7 %)	6 (24 %)	
>12 years	16 (72.7 %)	18 (72 %)	

Note: *Over all 12 years and beyond. BMI: Body Mass Index; VAS: Visual Analog Scale; NA: Not Applicable; SF36: Short Form 36 health survey

Table 1: Demographic characteristics among FM patients and healthy controls. Values are given as mean ± standard deviation (SD), median (range) and number (percentages).

pairwise ±3 years, and recruited from employees (volunteers) within the health care service, but was complemented with aquantances and otherwise in order for achieving age and education matching to the FM patients. The healthy control group was required to confirm their healthy status, and the same exclusion criteria as for the FM patients were used, with one addition: prolonged pain (as described previously [13].

Procedure

The attending physician for each woman presenting FM either referred the participant to the study or were contacted by the first author to confirm the FM diagnosis and to certify their appropriateness for inclusion in the study. Demographic data were collected through questionnaires sent to the home of each participant together with questionnaires about quality of life and physical activity. Participants were assigned to a rehabilitation center to perform a submaximal exercise test. In conjunction with the test, body weight and height were registered.

Measurements

Current pain, using a visual analog scale (VAS) 100 mm, was measured before and after the test to characterize the women with FM. To assess health related quality of life in the dimension of pain the Short-Form 36 (SF 36) was used. All the scales range between 0 and 100 where a higher value represents a higher estimated quality of life [14] implying that concerning the sub-scale Bodily Pain (BP) a low level of pain is indicated by a higher value and vice versa. The sub-scale, BP, is composed by two items concerning pain during the last four weeks reflecting level of pain and interference from pain, respectively. The SF-36 has been showed to be an appropriate instrument for assessing quality of life in women with FM [15].

The submaximal exercise test including the variety of measurements is described in detail in Lange et al. [13]. In short, the participants performed a stepwise load increment submaximal exercise test on an electronically-braked cycle ergometer to the very hard exertion level. The testing was conducted in the afternoon at least 3 hours after the last meal or coffee and the participants were asked to avoid smoking prior to the test. Before the exercise test, HRVwas recorded over 5 minutes during a supine rest. HRV was recorded using a Polar RS 800CX heart rate monitor (Polar electro, Kempele, Finland) that performs HRV recordings [16]. HR and blood pressure were measured after 10 minutes of supine rest. Blood pressure was further registered in a position of sitting on the ergometer prior to performance. HR was registered from the heart rate monitor and blood pressure was taken manually with stethoscope (Littmann Classic II S.E., 3M, St. Paul, Minnesota) and sphygmomanometer (Welch Allyn, Inc., Skaneateles Falls, New York, USA). HR, blood pressure and rating on the Borg RPE scale (rating of perceived exertion) was collected during the submaximal test that started at a workload of 25 W and was increased with 25 W each 4 minutes. When the subject responded with a score of 17 (very hard exertion) on the Borg RPE scale, she was asked to carry out the remaining minutes at the present workload if possible [17]. Directly after the test, the subjects had 20 minutes of supine rest during which HR and blood pressure were measured repeatedly during 20 minutes and HRV was recorded for the last 5 minutes. Blood pressure was registered at 3, 5, 10 and 20 minutes after the test.

Analysis of data

Originally the BPR recordings were among the safety measures surrounding the submaximal ergometer tests. Parallel the recordings were included in the test protocols together with BMI, height, HR etc. Due to the signification of the BPR recordings they became uneven concerning DBPR. The number of physiological variables was restricted through formation of sum variables concerning BPR at baseline and during recovery from the test. BPR was registered during successive levels of workload in terms of S1, D1 and S2. Two BPR measurement at baseline formed the variable S0 and D0 and blood pressure at 3, 5 and 10 minutes after the test formed the variables SR4 and DR4. The differences between women presenting FM and healthy controls systolic blood pressure (SBPR) and diastolic blood pressure (DBPR) at baseline, during and after the incremental, aerobic submaximal exercise test was examined using one-way ANOVA. The pain index of SF-36 BP concerned both women presenting FM and healthy women. A correlation concerning the pain measures from SF-36 BP, BPR measurement at baseline S0 and D0, BPR from two levels of workload S1, D1 and S2 together with sum variables SR4 and DR4 from recovery after the test was carried out.

Results

Women presenting FM showed higher baseline resting SBP and DBP and higher SBP and DBP during the recovery phase (Table 2).

In both study groups, there were correlative links between SBPR and DBPR at base line. But in comparison to healthy women, the study group presenting FM showed less cohesive BPR measures in terms of SBPR measures at baseline and DBPR during work load, being unrelated. Furthermore, women presenting FM contrasted to healthy women by an "all through" correlative relationship between BPR measures during work load. In healthy women, this circumstance concerned only SBPR recordings at two levels of work load. In women presenting FM the correlative relationship between the SBPR and DBPR measures during the recovery phase was pronouncedly higher.

Clinical pain recorded as BP showed four out of seven possible correlative links with BPR mesures concerning the study group with FM as compared to one link only in the group of controls. Lower baseline SBPR and DBPR related to more clinical pain in terms of BP in FM. Lower SBPR and DBPR during recovery related to more clinical pain BP in FM. Thus, in the FM group lower SBPR and DBPR corresponded to higher pain during baseline and recovery. The BPR recordings from the phase of work load were neither related to recorded clinical pain BP from women presenting FM nor from healthy women.

BP related to BPR before and after the test situation in women presenting FM in terms of higher BPR during both phases implying lower everyday pain. Concerning healthy women one value related to BP in terms of higher BPR after the test implying higher every day pain. In contrast to the relationship between higher clinical pain and lower BPR in FM during the recovery phase, in healthy women higher SBPR meant more pain recorded as BP (Tables 3 and 4).

Discussion

In comparison with the healthy women, women presenting FM expressed higher levels of both SBPR and DBPR at baseline and during the recovery phase. This result is conversed to the baseline recordings by Thieme et al. wherein the comparatively lower DBPR in FM also reached statistical significance. Hypothetically, their FM group was 2-3 years younger in comparison with to the present study holds marginal explanatory power.

Women presenting FM show lesser correlative links from the baseline SBPR measure into the DBPR workload phase when compared to healthy women thereby implying an alteration in flexible adaptation. Moreover, the chronic pain condition of FM seems to imply a total coordination between the BPR measures during workload from the test-phase. Overall, in comparison with healthy women, the study group with FM showed an alteration from less cohesion between SBPR and DBPR during baseline to greater cohesion regarding BPR during the test that continues into recovery phase where over-coordination of functions was displayed. The pattern emerging from the comparison with healthy women pertains to the workload-induced situation of achieving ´physiological perseveration´ between SBPR and SBPR along the time line, between DBPR and DBPR along the time line and between SBPR and DBPR from when the workload entered the stage. This pattern that contrasts with the physiological adaptability of healthy women confirms the less ´physiologically-coordinated´ adaptation to the load from sub-maximal test documented by Lange et al. [13] using HRV parameters.

Pain

A higher level of everyday pain BP corresponded with a lower level of SBPR and DBPR before the test in the FM condition. Furthermore, higher levels of everyday pain BP related to lower SBPR and DBPR during recovery from the test phase. In healthy women, the above links between BP and BPR were not evident but nevertheless reversed during the recovery phase where higher SBPR implied more everyday pain. A similarity to the finding by Wentz et al. [10] of a patter among women presenting FM who were heart rate wise the most physiologically similar to the controls but in tandem expressing a greater increase in pain from the submaximal test. A further parallel relates to the healthy mechanism of an inverse relationship between blood pressure and pain sensitivity i.e., valid across the whole blood pressure spectrum [1] that is evidenced in the present result concerning women presenting FM. Nevertheless, the presence of lower pain thresholds in FM appears to upset possible adaptive gains. Thieme et al. [18] suggest a diminished inverse relationship between BPR and pain in FM based on diminished baroreflex sensitivity.

Besides the effect of BPR on everyday pain in FM, Wentz et al. [10] found that the response in terms of a comparatively higher heart rate (HR) to three different levels workload during the test was associated with higher everyday pain BP. Taken together with the above this means that a high pulse during work load and a low BPR during base line and during recovery from work load implies more clinical pain in FM. These measures together may also be shown to predict clinical pain in FM (manuscript in preparation). Attenuated activity of both the sympathetic and the parasympathetic branches of the autonomic nervous system (ANS) concerning FM [19] assessed by greater HR, related to lower adrenaline levels during both night and day. In this regard, Thieme et al. [18] stressed a need for improved ANS functioning from the perspective of an improved DBPR as improved BPR flexibility that may rely on improved vagal influence on heart relaxation. These relationships are linked to the present result in terms of the pattern of BPR measurements (Tables 3 and 4) with an expression of perseveration. Importantly, Thieme et al. [18] described improved psychological functioning as a major agent in the above improved physiology and level of pain symptoms. As a part of the present research program, there is also data on positive and negative affect profiles and on symptoms of PTSD. In this context the age- and education- matched

Measures Blood pressure BLPR	Women presenting FM	Healty women HW	Df beween groups and between groups	F-value	P value
Baseline					
S 0	**122.3 (15.9)**	116.7 (10.3)	1, 93	4.214	0.043*
D 0	**77.6 (12.2)**	72.7 (7.9)	1, 90	5.403	0.022*
Test					
S 1	**132.3 (16.6)**	125.6 (15.3)	1, 48	2.237	0.141
D 1	**78.0 (11.3)**	69.2 (10.3)	1, 10	1.897	0.198
S 2	**136.0 (23.0)**	130 (17.5)	1, 45	.959	0.333
Recovery from test					
SR 4	**121.2 (19.7)**	114.5 (19.2)	1, 192	5.828	0.017*
DR 4	**75.5 (10.9)**	71.5 (13.9)	1, 172	3.980	0.048*

Note: *P <0.05

Table 2: The effect of group in terms of women presenting fibromyalgia (FM) and healthy women (HW) on measures of blood pressure (BPR) before, during and after an ergometer sub maximal test. Systolic blood pressure during baseline resting and sitting at the ergometer (S0), systolic blood pressure during 25 W and 50 W work load in terms of S1 and S2 respectively and diastolic blood pressure during baseline resting and sitting at the ergometer in terms of D0 together with diastolic blood pressure during 25 W work load in terms of D1. A sum variable embraces systolic blood pressure during recovery 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test in terms of SR4. A sum variable embracing diastolic blood pressure during recovery 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test in terms of DR4. Means (with standard deviation presented in).

	BP	Base line	S0	D0	Test	S2	D2	S3	Recovery from test	SR3	DR3
BP 88			374* 42	539** 39		0.407 22	0.721 6	0.368 19		0.49** 83	629** 63
Baseline											
S0 N	0.374* 42			0.664** 43		0.782** 24	0.688 24	0.613** 21		0.363* 43	0.740** 33
D0 N	0.539** 39		0.664 ** 43	1 43		0.609** 24	0.855* 7	0.451* 21		0.454** 40	648** 33
Test											
S1 N	0.407 22		0.782** 24	0.609** 24		1	0.832* 7	0.918** 21		0.752** 23	0.607** 18
D1 N	0.721 6		0.688 7	0.855* 7		0.832* 7	1	0.876* 6		0.919** 7	0.795* 7
S2 N	0.368 19		0.613** 21	0.451* 21		0.918** 21	0.876* 6	1 21		0.698** 21	0.526* 17
Recover from test											
SR4 N	0.494** 83		0.363** 43	0.454** 40		0.752** 23	0.919** 7	0.698** 21		1	0.620** 71
DR4 N	0.629** 63		0.740** 33	0.648** 33		0.607** 18	0.795* 7	0.526* 17		0.620** 71	1

Note: brackets concerning all measures and single items

Table 3: Correlations between systolic blood pressure during baseline resting and sitting at the ergometer in terms of S0 and systolic blood pressure during 25 W and 50 W work load in terms of S1 and S2, diastolic blood pressure during baseline resting and sitting at the ergometer in terms of D0, diastolic blood pressure during 25 W work load in terms of D1, systolic blood pressure during recovery as a composite variable of the 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test values in terms of SR4, together with a composite variable concerning diastolic blood pressure during recovery at 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test in terms of DR4 in women presenting FM. In addition, correlative links between all BPR measures to level and interference from clinical bodily pain (BP) during 4 weeks.

BP	BP	Baseline	S0	D0	Test	S2	D2	S3	Recovery	SR	DR
BP	1 84		-0.180 1	-0.056 40		-0.087 21	-0.048 4	-0.118 21		-0.385** 83	-0.086 83
Baseline											
S0	-0.180 40		1 49	0.689** 49		0.739** 26	0.965** 5	0.642** 26		0.512** 49	0.411** 48
D0	-0.056 40		0.689** 49	1 49		0.593** 26	0.902* 5	0.495* 26		0.416** 49	0.563** 48
Test											
S1	-0.087 21		0.739** 26	0.593** 26		1 26	0.854 5	0.920** 26		0.581** 26	0.491* 25
D1	-0.048 4		-0.965** 5	0.902* 5		0.854 5	1 5	0.790 5		0.208 5	0.214 5
S2	-0.118 21		0.642** 26	0.496* 26		0.920** 26	0.790 5	1 26		0.562** 26	0.498* 25
Recovery											
SR4	-0.385** 83		0.512** 49	0.416** 49		0.581**	0.208 5	0.562** 26		0.1 103	236* 102
DR4	-0.086 83		0.411** 48	0.563** 48		0.491* 25	0.214 5	0.498* 25		236* 102	1 103

Table 4: Correlations between systolic blood pressure during baseline resting and sitting at the ergometer in terms of S0 and systolic blood pressure during 25 W and 50 W work load in terms of S1 and S2, diastolic blood pressure during baseline resting and sitting at the ergometer in terms of D0, diastolic blood pressure during 25 W work load in terms of D1. Systolic blood pressure during recovery as a composite variable of the 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test values in terms of SR4, together with a composite variable concerning diastolic blood pressure during recovery at 3 minutes, 5 minutes, 10 minutes and 15 minutes after the test in terms of DR4 in healthy women. In addition, correlative links between all BPR measures to level and interference from clinical bodily pain (BP) during 4 weeks.

study groups contrast pronouncedly whereas the study group presenting FM also presents a clear affect profile "perseverative" anomaly and in the majority of cases also symptoms similar to PTSD the latter also with significance for BPR measures (manuscript in preparation). The significance of psychophysiological and brain functioning irregularities in FM is indicated by Thieme et al. [18] in terms of normalized BPR and reduced pain in study groups presenting FM.

Conclusion

Blood pressure parameters in FM, as opposed to healthy controls, is associated with experienced changes in pain thresholds.

Limitations

An obvious limitation in the present study is the scarcity of DBPR measurements. This is due to BPR measurements not from the start being intended for analysis and publication. They were instead made as an accommodation for the participants. Nevertheless, in spite of a limited sample size several clear-cut and significant observations are described. Despite, certain limitations, the scenario that emerges from these and other [7,11] appears to imply that pain thresholds which are linked to sympathetic and parasympathetic functions in healthy volunteers, seem to function in a dysregulated manner among FM patients. Notions such as these may reflect higher levels of brain functioning and include the immune system.

Acknowledgement

The local research and development council of Gothenburg and the Fibromyalgia Association funded the present study.

References

1. Duscheks S, Schwartzkopf W, Schandry R (2008) Increased blood pain sensitivity in low blood pressure. J Psychophysiology 22: 20-27.
2. Hagen K, Zwart JA, Holmen J, Svebak S, Bovim G, et al. (2005) Does hypertension protect against chronic musculoskeletal complaints? The Nord-Trøndelag health study. Arch Intern Med 165: 916-922.
3. Bruehl S, Chung OY (2004) Interactions between the cardiovascular and pain regulatory systems: An updated review of mechanisms and possible alterations in chronic pain. Neurosci Biobehav Rev 28: 395-414.
4. Okifuji A, Turk DC (2002) Stress and psychophysiological dysregulation in patients with fibromyalgia syndrome. Appl Psychophysiol Biofeedback 27: 129-141.
5. La Rovere MT, Pinna GD, Raczak G (2008) Baroreflex sensitivity: Measurement and clinical implications. Ann Noninvasive Electrocardiol 13: 191-207.
6. Thieme K, Rose U, Pinkpank T, Spies C, Turk DC, et al. (2006) Phychophysiological responses in patients with fibromyalgia syndrome. J Psychosom Res 6: 671-679.
7. Reyes del Paso GA, Garrido S, Pulgar A, Martín-Vázquez M, Duschek S (2010) Aberrances in autonomic cardiovascular regulation in fibromyalgia syndrome and their relevance for clinical pain reports. Psychosom Med 72: 462-470.
8. Black CD, Tynes BK, Gonglach AR, Waddell DE (2016) Local and generalized endogenous pain modulation in healthy men: Effects of exercise and exercise-induced muscle damage. Pain Med 17: 2422-33.
9. Wentz K, Archer T (2017) Pain and physiological adaptation in women presenting fibromyalgia. J Pain Manag Ther 1: 1.
10. Wentz K, Archer T (2017) Work load and heart rate in fibromyalgia: The hub within “Pain Gaps” and clinical pain. J Chronic Dis Manag 2: 1011.
11. Kosek E, Ekholm J, Hansson P (1996) Modulation of pressure pain thresholds during and following isometric contraction in patients with fibromyalgia and in healthy controls. Pain 64: 415-423.
12. Vierck CJ, Staud R, Price DD, Canno RL, Mauderli AP, et al. (2001) The effect of maximal exercise on temporal summation of second pain (wind-up) in patients with fibromyalgia syndrome. J Pain 2: 334-344.
13. Lange E, Mannerkorpi K, Cider Å, Wentz KAH, Archer TC (2017) Physiological adaptation in women presenting fibromyalgia: comparison with healthy controls. Clin Exp Psychol 3: 147.
14. Ware JE, Gandek B (1998) Overview of the SF-36 health survey and the International Quality of Life Assessment (IQOLA) project. J Clin Epidemiol 51: 903-12.
15. Assumpcao A, Pagano T, Matsutani LA, Ferreira EA, Pereira C A, et al. (2010) Quality of life and discriminating power of two questionnaires in fibromyalgia patients: Fibromyalgia impact questionnaire and medical outcomes study 36-item short-form health survey. Braz J Phys Ther 14: 284-89.
16. Weippert M, Kumar M, Kreuzfeld S, Arndt D, Rieger A, et al. (2010) Comparison of three mobile devices for measuring R-R intervals and heart rate variability: Polar S810i, Suunto t6 and an ambulatory ECG system. Eur J Appl Physiol 109: 779-86.
17. Borg G (1998) Borg's perceived exertion and pain scales. Human Kinetics, United Kingdom.
18. Thieme K, Turk DC, Gracely RH, Flor H (2016) Differential psychophysiological effects of operant and cognitive behavioural treatments in women with fibromyalgia. Europ J Pain 20: 1478-1489.
19. Riva R, Mork PJ, Westgaard RH, Johansen TO, Lundberg U (2012) Catecholamines and heart rate in female fibromyalgia patients. J Psychosom Res 72: 51–57.