Effects of cognitive-behavioral therapy on pain intensity and level of physical activity in Japanese patients with chronic pain - a preliminary quasi-experimental study

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ABSTRACT

Introduction: Cognitive-behavioral therapy (CBT) is one of the psychological approaches and focuses on modifying distorted cognitions that affect persistent pain and pain behaviors. CBT involving an activity program could be applied to the treatment of chronic pain with physical and psychological dysfunctions. The aim of the present preliminary experimental study was to investigate the effectiveness of CBT by comparing treatment responders and non-responders by pain levels and physical activity levels in the patients with chronic pain in our multidisciplinary pain center.

Methods: CBT was given for 6 months period in 12 patients. They were classified into effective group if they had verbal rating scale (VRS) score reduced by 2 points and into non-effective group if there were no changes in VRS, at 1 month after the beginning of the CBT. Pain intensity and physical activity were assessed by VRS and a three-dimensional accelerometer which were expressed as a total together with each activity intensity level- metabolic equivalents: METs 1-3, mild; METs 4-6, moderate; METs 7-9, heavy activity, and sampled at 1, 3 and 6 month intervals after the CBT.

Results: The effective group had lower VRS at 3 and 6 months. They also had higher total physical activity score overall, and mild/moderate activity score was higher at 6 months. The heavy activity score was not different between-groups. VRS was lesser in the effective group at all three levels (1, 3 and 6 months) when compared with before the beginning of the CBT, whereas physical activity levels were similar at all three levels on each group.

Conclusion: The study found that mild to moderate physical activity was associated with reductions in VRS in the effective group suggesting beneficial effects of low-load and high amount of physical activity in chronic pain patients attending a CBT intervention program.

Key words: Cognitive-behavioral therapy (CBT), physical activity, pain intensity, METs.

INTRODUCTION

Physical activity can improve both the physical and psychological conditions of the human body. Several studies have shown that physical activity can decrease pain intensity and pain-related disabilities.1-5 However, chronic pain patients have not only physical but also psychological dysfunctions such as distorted cognitions, emotions, thoughts, and pain-behavior.5 The psychological dysfunction in chronic pain patients can not be improved by physical activity alone, as psychological factors constrain the effect of physical activity.6 Therefore, cognitive-behavioral therapy (CBT) including physical activity have been developed to improve the psychosocial factors in chronic pain patients.

CBT focuses on confirming and modifying distorted cognitions and thoughts that affect persistent pain and pain behaviors, using a psychological approach, i.e. pain education, relaxation,
cognitive behavioral modification, coping strategies and social skills training. CBT consists of not only psychological approaches but also physical activity, i.e. graded/progressive and sub-maximal activity, low-load and low-velocity mobilizing activity or activity training. Numerous reports involving a systematic review and randomized controlled trials have provided sufficient evidence of the effectiveness of CBT for chronic pain compared with no treatment or waiting list control. But in other studies, there has been insufficient evidence of the effectiveness of biopsychosocial and physical rehabilitation versus other active therapies. Furthermore, controversy exists regarding the effectiveness of CBT, because there has been only a few convincing evidence for the efficacy of CBT for chronic pain.

Our center is the first multidisciplinary pain center established in Japan. There are few reports regarding the effectiveness of CBT for chronic pain in our country, because multidisciplinary pain center has not been developed in our country. In the present preliminary experimental study, we investigated the effectiveness of CBT by comparing treatment responders and non-responders by pain levels and physical activity levels in the patients with chronic pain in our multidisciplinary pain center.

METHODS

Study design: This preliminary quasi-experimental study was a non-randomized, single-blind, clinical trial and with six-month follow-up. The ethics committee approval was obtained from Aichi Medical University. Written informed consent was obtained from each patient.

Patients: Twelve out-patients (2 male and 10 female, mean (SD) of age 54.7 (18.3) years) suffering from a variety of chronic non-cancer pain conditions, such as neuropathic pain (1 male and 2 female), osteoarthritis (1 male and 1 female), whiplash associated disorder (WAD) (4 female), low back pain (2 female), fibromyalgia (1 female), were recruited to the CBT by consecutive sampling for treatment of chronic pain in Multidisciplinary Pain Center in our university.

Intervention: In the present preliminary experimental study, the activity program of CBT was operant behavioral activity training and mild activity. Operant behavioral training focuses on withdrawal of positive attention for pain behaviors while increasing reinforcement of well behaviors such as activity. This mild activity was guided by the patient’s functional abilities, low-load activity and low-velocity mobilizing techniques; including walking, stair climbing, radio/TV gymnastics and stretching. The activity program was aimed at helping patients to reach their individual daily life goals, to increase their activity levels, and to modify distorted cognitions and thoughts.

In the initial assessment and following consulting, the patients received education in their pain condition, pain management and risk of activity (e.g. association with overactivity/ disuse and more pain). On the basis of the patients’ accepting, they did individual decision-making, including planning and pacing their activity program and goal setting, together physiotherapist. Pacing is an essential technique for chronic pain management. It is important for chronic pain patients to maintain a fairly even level of activity over the day. They had to maintain to start on easier activities, to take frequent and shot break, to keep their plans and pace, to breakup tasks into small bits, to ask for help with specific tasks, to increase gradually the amount of activity on a realistic build-up rate and to record their plan and progress, for preventing more pain.

Procedure: After individual decision-making was identified, the patients started performing their individually set activities for 30 to 120 minutes a day and for 3 to 5 days a week, with activity levels increasing gradually towards the final treatment goals. Their individual activities were continued to perform for 6 months and physical activity amounts and pain intensity levels were
Out-patients with chronic non-cancer pain (n=12)
Intervention: CBT

### Allocation/Analysis

**Effective group (n=6)**
- At 1 month after the beginning of the CBT
  - There was VRS decrease of at least 2

**Non-effective group (n=6)**
- At 1 month after the beginning of the CBT
  - There was no VRS change or VRS decrease of less than 2

### Follow-Up/Analysis

**Follow-up at 6 months (n=6)**
- After the beginning of the CBT

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**Figure-1: Schematic flow diagram of participants in our study**

(CBT- cognitive behavioral therapy; VRS- verbal rating scale)

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recorded every day all that while. The activity amounts were averaged every month, and then analyzed at 1, 3 and 6 months after the beginning of the recording. Pain intensity was rated using verbal rating scale (VRS), averaged every month, and then sampled for subsequent analysis at 1, 3 and 6 months after the beginning of the recording. At 1 month after the beginning of the CBT, patients were allocated into the effective group when there was VRS decrease of at least 2, and the non-effective group when there was no VRS change or VRS decrease of less than 2.

### Measurements:

**Initial assessment**

Data regarding patients' demographic characteristics (age, gender, marital status, occupation) was obtained during the pre-treatment assessment by a trained interviewer. In addition, patients were assessed regarding pain intensity using VRS and pain-related psychological conditions using a questionnaire: Hospital and Anxiety Depression scale (HAD). For the VRS, pain intensity was evaluated on a numerical scale from 0 to 10 (0 = no pain, 10 = worst pain imaginable). HAD is a well validated scale for measuring the psychological well-being of medical patients and consists of two subscales, the anxiety (HAD-Anx; minimum = 0, maximum = 21) and the depression (HAD-Dep; minimum = 0, maximum = 21) subscale, which have each seven items with rating of severity of symptoms from 0 to 3.15

**Physical activity level**

To quantify the daily physical activities of patients at home, a threedimensional accelerometry-based electronic activity monitor was used (Figure-1).

**Figure-1: Three-dimensional accelerometry-based electronic activity monitor**

The monitor consisted of a built-in tri-axial accelerometer designed to detect refined human motion. The patients wore the monitor during the daytime except during water-based activities and nighttime sleep. Data was able to be...
recorded at 2-minute intervals and to be downloaded to a computer for software analysis. Physical activity was expressed as a total and each level divided by the intensity of the activity: METs 1-3, mild; METs 4-6, moderate; METs 7-9, heavy activity.

Daily diary measurement
Patients recorded a brief diary consisting of following components: pain intensity, medication, the kinds of activity performed (e.g. walking, stair climbing, radio/TV gymnastics, stretching, yoga), the activity amounts and/or time by the activity monitor, achievement of activity goal, pain-related special events. The patients were requested to complete the diary each evening before sleep.

Data analysis:
Pain intensity and physical activity within the group was analyzed at 1, 3 and 6 months after the CBT using by Friedman repeated measures analysis of variance on ranks, followed Student-Newman-Keuls methods. Each data was analyzed using Man-Whitney test between the groups. P < 0.05 was considered statistically significant.

RESULTS
One male and five female patients were included in each group. Table 1 demonstrates the baseline (pre-treatment) characteristics of the patients. There were no significant differences in the VRS, HAD-Anx and HAD-Dep between the groups at the pre-treatment assessment.

Total activity at 1, 3 and 6 months, and mild (METs 1-3) and moderate (METs 4-6) activities at 6 months after the beginning of the CBT were

| Table- 1: Age, duration of pain, verbal rating scale (VRS) pain scores, pain-related anxiety (HAD-Anx) and depression (HAD-Dep) at the pre-treatment assessment |
|----------------------------------------------------------|-----------------|-----------------|------------------|
| Age (year)                                               | 70.0 (53-73)    | 36.5 (30-80)    | 0.020*           |
| Duration of pain (months)                                | 23.5 (12-61)    | 27.0 (12-51)    | 0.883            |
| VRS                                                      | 7.8 (5-10)      | 5.0 (2-10)      | 0.225            |
| HAD-Anx                                                  | 11.0 (10-12)    | 8.5 (7-10)      | 0.078            |
| HAD-Dep                                                  | 8.0 (6-8)       | 12.5 (10-19)    | 0.067            |

Values are presented as median (range 25%-75%).
*: significant at p < .05
Table-2: Pain intensity (VRS) and physical activity amounts obtained by three-dimensional accelerometer

<table>
<thead>
<tr>
<th>Pain/Activity</th>
<th>Month</th>
<th>Effective group</th>
<th>Non-effective group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain VRS</td>
<td>0</td>
<td>7.8 (5.0-10.0)</td>
<td>5.0 (2.0-10.0)</td>
<td>0.230</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1.6 (0.7-6.2)</td>
<td>5.0 (0.6-8.7)</td>
<td>0.262</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.7 (0.1-3.6)</td>
<td>5.2 (1.1-6.6)</td>
<td>0.016*</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0.7 (0.3-4.)</td>
<td>5.1 (1.1-5.9)</td>
<td>0.010*</td>
</tr>
<tr>
<td>Activity (steps)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total activity</td>
<td>1</td>
<td>1396 (1208-2035)</td>
<td>922 (598-1430)</td>
<td>0.048*</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1344 (1216-2106)</td>
<td>799 (391-1460)</td>
<td>0.048*</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1456 (1393-1989)</td>
<td>634 (591-1209)</td>
<td>0.004*</td>
</tr>
<tr>
<td>Mild (METs 1-3) activity</td>
<td>1</td>
<td>969 (583-1311)</td>
<td>584 (457-996)</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>965 (666-1037)</td>
<td>559 (337-1028)</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1001 (782-1457)</td>
<td>490 (455-889)</td>
<td>0.009*</td>
</tr>
<tr>
<td>Moderate (METs 4-6) activity</td>
<td>1</td>
<td>342 (113-1286)</td>
<td>314 (69-414)</td>
<td>0.361</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>326 (237-1317)</td>
<td>244 (53-414)</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>400 (303-1165)</td>
<td>138 (55-312)</td>
<td>0.017*</td>
</tr>
<tr>
<td>Heavy (METs 7-9) activity</td>
<td>1</td>
<td>16 (2-167)</td>
<td>12 (1-25)</td>
<td>0.584</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>36 (1-123)</td>
<td>16 (1-19)</td>
<td>0.584</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>43 (5-57)</td>
<td>10 (1-30)</td>
<td>0.465</td>
</tr>
</tbody>
</table>

Values are expressed as median (range) of total, mild (METs 1-3), moderate (METs 4-6), heavy (METs 7-9) activities and VRS per mouth, and sampled at 1, 3 and 6 months after the CBT. VRS at 0 month is presented as median at the pre-treatment assessment.

†, significantly different from pre-treatment control value (p < 0.05).

*, significant at p < .05 for between-group comparison.

Figure-2: Changes in verbal rating scale (VRS) pain scores.

■, effective group. □, non-effective group. Values are presented as mean. SD represented with error bars. †, significantly different from pre-treatment data (p < 0.05). *, significantly different from the VRS of the non-effective grossup (p < 0.05).
significantly higher in the effective group than the non-effective group (p < 0.05) (Figure 3), whereas there were no significant differences between the groups on heavy (METs 7-9) activity at any time (Table 2). There were also no differences on each activity level at any time after the CBT.

DISCUSSION

Our results demonstrate that VRS at 3 and 6 months after the CBT was lower and total activity at all time and mild/moderate activity at 6 months after the CBT was higher in the effective group than the non-effective group, but there were no significant differences on heavy activity at any time between the two groups. Also, there were no differences on VRS in the non-effective group and on each activity level within each group at any time after the CBT, however, VRS of the effective group were lower at all time after the CBT than pre-treatment control. From the present results, we postulate that even mild and moderate activity could improve chronic pain. Furthermore, these effects of the physical activity remained for the following 6 months in the effective group.

Numerous studies have demonstrated the effectiveness of the CBT in reducing the negative consequences of chronic pain, e.g. reduction of pain intensity distress and pain behavior, and improvement of pain-related disability daily function and return to work. \(^1,10,17\) Furthermore, not only the CBT but also physical activity reduced functional limitations and negative complaints as well as pain intensity in patients with low back pain. \(^2,3,13\) A study reported that physical activity is most effective in the CBT for chronic pain.\(^4\) Also, the effects of
physical activity could remain for the following 6 months (8) to 2 years. Gradually promoting physical activity is likely to reduce pain and disability in chronic pain patients, as observed in the present report. Rehabilitation with activity training is related to both pain reduction and general neuromuscular adaptation conditioning, as activity training relieves pain and increases maximal activity in myalgia. On the other hand, prolonged bed rest due to pain is associated with a higher long term disability level. Most patients with chronic low back pain-associated disability have a lower level of aerobic fitness, owing to a decrease in activity during leisure time and work/household chores. A study provides that the relation between physical activity and chronic low back pain is a U-shaped curve i.e. both inactivity and excessive activities present an increased risk for back pain. Side effects in response to an individualized, progressive, sub-maximal activity program were observed in up to 20% of the subjects. We showed in this preliminary experimental study that the patients who responded positively to the CBT have an increase in mild/moderate activity as well as a reduction in the pain intensity. CBT-guided activity program is recommended to keep the activity load below the pain threshold and to use low-load and low-velocity activity in order to prevent sensorimotor incongruence and not to increase pain when using stabilization and mobilizing activity to re-educate muscle control in the treatment of chronic pain patients. We speculate that the mild program in the CBT could induce not only promotion of physical condition but also improvement of the pain intensity and the pain-related disability in chronic pain patients, and thereby, the mild activity program might be adequate for the CBT of chronic pain.

The distorted cognitions influence physical performance. The dysfunctional descending pain-inhibitory mechanism is influenced by distorted cognitions, emotions, and behavior like catastrophizing. Increased neuronal activity such as pain catastrophizing, has been observed in people with chronic pain and was correlated with disability. Gradually enhancing physical activity is likely to reduce pain catastrophizing and to achieve a positive rehabilitation outcome for patients with chronic pain. That is, the physical activity could influence cognitions, emotions and thoughts. We thus speculate that the physical activity of CBT might have a greater effect on the therapy of chronic pain, thereby being one of the most effective pain management programs.

CONCLUSION

Promoting physical activity due to performing the activity program of mild but not heavy level was associated with the reduction of pain intensity, and these effects of activity remained for the following 6 months in the effective group which responded to cognitive behavioral therapy intervention.

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CONFLICTS OF INTEREST

None identified.
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REFERENCES
Key points:

Past- Cognitive behavioral therapy using behavioral graded activity training was shown to be beneficial in chronic pain population.

Present- Cognitive behavioral therapy was administered in Japanese chronic pain patients attending a multidisciplinary pain clinic and the patients were then sub-grouped into responders and non-responders of which responders had high levels of physical activity measured by accelerometry.

Future- Physical therapists have a global role to play in multidisciplinary chronic pain programs where inclusion of behavioral graded activity training as part of cognitive behavioral therapy. Future large scale studies in this area are warranted.