Virtual reality-based software for the treatment of fibromyalgia: a case study

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Abstract. The aim of this study was to explore the efficacy and acceptance of virtual reality-based software for pain reduction (*VirtualPain*) in a 53-year-old female with fibromyalgia (FM), a chronic pain syndrome. Treatment consisted of four 60-minute sessions. Each session involved 40 minutes of cognitive behavioral therapy (CBT) and 20 minutes of exposure to *VirtualPain* software. *VirtualPain* consists of a recreation of the human body in which the pain or lack of pain experienced by the participant in each body part (e.g., hand or knee) is represented by color, movement and sound. During exposure, the patient modified these characteristics to increase her sensation of control over the pain. In our study, the software was displayed on a stereoscopic laptop with a 17' screen. Pain intensity was assessed on a visual analog scale (VAS, from 0 to 10). Before and after the treatment, the patient completed the Pain Anxiety Symptoms Scale Short Form (PASS-20), the Pain Catastrophizing Scale (PCS) and the Pain Self-Efficacy Scale (CPSS). During each session, the patient reported the amount of extra medication for pain consumed during the week. Follow-up was conducted at 6 and 12 months. The patient showed a substantial reduction in anxiety, catastrophic thoughts and pain perception, and improved self-efficacy after treatment. Most importantly, at 6-month follow-up (after six months without treatment) results were maintained, but at 12-month follow-up (after the patient had been allowed to use *VirtualPain* at home for 6 months) the clinical improvements increased. The addition of *VirtualPain* to a CBT intervention reduced pain intensity and psychological symptoms (anxiety, catastrophism and low self-efficacy) in a patient with FM. Controlled studies with large samples are now needed to assess the specific additional contribution of *VirtualPain* to CBT in the treatment of fibromyalgia.

Keywords: treatment, pain, virtual reality, patient, self-efficacy, anxiety, fibromyalgia

1. Introduction

Fibromyalgia (FM) is a disabling disorder, with a population prevalence of 2.4% [1]. The most common symptoms are generalized pain throughout the body, paresthesia of the limbs, fatigue, sleep disturbances and concentration difficulties [2, 3]. The perception of pain is not only a physical phenomenon; it also involves emotional and psychological variables. Patients' attitudes, beliefs, expectancies, thoughts, learning history and socio-cultural context must all be borne in mind [4, 5]. Patients must assess the level of demand of a situation and their personal resources in order to learn how to cope with this stressful experience [6]. Patients suffering from FM have a maladaptive

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coping style, as well as an external locus of control. They believe that they are powerless to reduce their pain [7], which lowers their quality of life and increases the pain intensity [8]. Cognitive-behavioral therapy (CBT) is the most effective psychological treatment for reducing depressive symptoms and catastrophizing and enhancing perceived self-efficacy [9]. Virtual reality (VR) has demonstrated efficacy in the reduction of acute [10, 11] and chronic pain [12]. However, information on its use in the treatment of FM is still lacking [13].

In *VirtualPain*, the participant manipulates three variables which embody the pain experienced in different parts of his/her own body: color, speed of movement, and sound. The software allows the patient to tailor his/her perception of pain and represent it in a 3D avatar [14]. First, the patient selects the color that best represents his/her perception of pain and the color that best represents the absence of pain. Any color can be chosen. Using this information, the software itself generates a pain continuum from 0 (color of absence of pain) to 10 (color of pain). Second, the participant chooses the sound from a selection representing either the countryside or the beach that best represents the absence of pain. The sensations of pain and rigidity are represented by the sound of cracking wood. Sound values range from 0 (the sound of absence of pain: countryside or beach) to 10 (the sound of pain). Finally, the user selects one of the 27 painful body areas drawn from the updated diagnosis of FM, proposed by Wolfe [3]. Each selected body part has a movement speed which varies according to the self-reported individual's perception from 0 to 10. A score of 0 represents smooth speed, and a score of 10 a severe speed reduction. To sum up, the virtual environment provides a representation of individuals' pain through three continuous features of parts of the avatar's body: color (pain and absence of pain), movement (speed) and sound (cracking wood vs. countryside or beach). Once the features of pain and absence of pain have been established, the patient is asked to rate, on a visual analogue scale (VAS) from 0 (no pain) to 10 (extreme pain), the level of pain experienced in a specific body part. Then, the software gives the appropriate color, sound and movement to the selected body part according to the VAS score.

In the case study, *VirtualPain* was used with three main aims. The first was to assess the acceptability and usability of the software in a patient with FM. The second was to assess the efficacy of the software in combination with CBT to reduce perceived pain intensity and associated symptomatology (catastrophism, anxiety and low self-efficacy). Additionally, extra medication for pain consumption was evaluated. Finally, the third aim was to determine the specific efficacy of the software when it was used without CBT.

2. Method

Patient data

The patient was a 53-year-old woman who lived with her husband and two daughters. She had an active job. The patient identified the first symptoms of FM 19 years ago, but the official diagnosis was made 16 years ago. Her daily medication is Triptizol (0/0/1) and Dolocatil 1g (1/0/0).

Description of the treatment

A weekly one-hour session was conducted for four weeks. During the first 40 minutes of each session, CBT techniques were applied and, during the last 20 minutes, the patient was exposed to *VirtualPain*. CBT consisted of psychoeducation about the

FM's symptomatology and the causes of pain, and coping skills training. Exposure to *VirtualPain* consisted of three steps. First, the patient specified the features of pain and absence of pain (color, sound and movement). Second, the patient selected a body part (the most painful one at that moment) and reported the level of pain experienced on a VAS from 0 to 10; with this information, the software gave a color, sound and movement to the selected body part. Third, the patient was encouraged to feel as if she was the avatar and, eventually, to modify its characteristics (color, sound and speed of movement) using three slides displayed on the screen. Thus, by modifying the virtual representation of the pain, the patient could also modify the perception of its intensity. In each session, the patient was exposed to a minimum of one painful area. When the pain intensity was less than 40% of the pain that was initially reported, the patient could choose another body part to work on.

The virtual body was displayed on a 3D laptop with specific software to create a stereoscopic effect that was duly processed by polarized glasses. Headphones were also used. In order to clarify the specific effect of VR exposure, an AB method was used during follow-up. Thus, during the first 6-month follow-up (phase A), the patient did not receive any intervention (except prescribed medication). However, during the period of time from follow-up at 6 months (baseline) to follow-up at 12 months (phase B), the therapist gave the *VirtualPain* software to the patient, so that she could use it at home. Self-efficacy, catastrophism, pain anxiety and frequency of extra pain medication were assessed at pre-treatment, post-treatment, 6-month follow-up and 12-month follow-up. At 12-month follow-up, the acceptability and usability of the *VirtualPain* software were also assessed.

Measures

The Pain Anxiety Symptoms Scale Short Form (PASS) [15] measures anxiety experienced with pain. Subsets of the questionnaire are cognitive anxiety (α = .86), escape-avoidance (α = .75), fear (α = .82), physiological anxiety (α = .81) and total anxiety (α = .91). The scale has 20 items rated with a Likert scale of 0 to 5.

Chronic Pain Self-Efficacy Scale (CPSS) [16] is a questionnaire to measure expectations of pain. This scale has 22 items, which are divided into 3 factors: self-efficacy for pain management (PSE) (α=.86), self-efficacy for coping with symptoms (CSE) (α=.91) and self-efficacy for physical function (FSE) (α=.91).

The Pain Catastrophizing Scale (PCS) [17] assesses catastrophic thoughts related to pain. Its 13 items are scored on a Likert scale of 5 points (0 = not at all, 5 = all the time). The questionnaire has a total score (α = .87) and three subscales: rumination (α = .87), magnification (α = .66) and helplessness (α = .78).

Pain intensity was assessed by means of a visual analogue scale (VAS) [18] ranging from 0 (no pain) to 10 (extreme pain).

The frequency of extra medication was recorded using a weekly self-report sheet.

The acceptance and usability of software were assessed by means of four VAS-based questions, scored from 0 (do not agree) to 10 (agree absolutely) addressing the level of pleasantness, usability, usefulness and realism of the software.

3. Results

One of the main objectives of this study was to assess the efficacy in FM treatment of an intervention consisting of cognitive-behavioral techniques and exposure to *VirtualPain*, and to explore the specific effect of administrating *VirtualPain* alone. As shown in Table 1, perceived pain intensity diminished during exposure sessions.

Table 1. Exposure to *VirtualPain*

	Session 1			Session 2			Session 3			Session 4		
	Pre	Post	Time	Pre	Post	Time	Pre	Post	Time	Pre	Post	Time
Mean	3.29	2.10	171	1.01	.36	80	6.07	3.09	194	6.17	2.39	215
SD	0.55	1.36	48.93	.06	.28	28.28	.59	.64	52.71	.23	.55	29.61
Min	2.97	.95	101	.93	.16	60	5.09	2.51	144	5.98	1.89	183
Max	4.11	4.04	213	1.05	.55	100	6.56	4.02	280	6.49	3.002	244

Note: SD = standard deviation; Min = minimum value of pain; Max = maximum value of pain; Pre = measure of pain (VAS) before exposure to *VirtualPain*; Post = measure of pain (VAS) after exposure to *VirtualPain*; Time = time of exposure of *VirtualPain.*

Likewise, pain anxiety, low self-efficacy and catastrophic thoughts were substantially reduced at post-treatment (Table 2). Most importantly, at 6-month follow-up (phase A) the results were mostly maintained. Only the scores for the cognitive anxiety subscale of PASS-20 and painlessness subscale of PCS were higher at the first follow-up. However, at the 12-month follow-up (phase B), the patient showed a great improvement in all the outcomes. All the scores on the anxiety and catastrophism subscales substantially diminished, and self-efficacy considerably increased. Furthermore, at 6-month follow-up, the patient no longer used extra medication. It is important to note that during phase B, the patient could self-administer *VirtualPain* at home, in contrast with phase A.

Another aim of this study was to assess the acceptability and usability of *VirtualPain*. At 12-month follow-up, the patient declared that she was very satisfied with the software and reported high levels of pleasantness (9), usability (9), usefulness (10) and realism (10). She also expressed that she felt able to cope with pain.

Table 2. Questionnaires of anxiety, catastrophism, self-efficacy and medication

	PASS-20				PCS			CPSS			Med
	Cogn	EE	Fear	Phy	Rum	Mag	Help	PSE	FSE	CSE	
Pre	16	10	11	12	6	3	10	200	430	510	5
Post	11	11	6	8	0	0	0	400	690	660	3
6-month follow-up	15	11	7	3	2	1	4	400	680	690	2
12-month follow-up	3	2	0	0	0	1	4	500	880	790	0

Note. Pre= measures before treatment; Post = measures after treatment; Cogn = cognitive; EE = escape/avoidance; Psy = psychological anxiety; Rum = rumination; Mag = magnification; Help = helplessness; PSE = self-efficacy for pain management; FSE = self-efficacy for physical function; CSE = self-efficacy for coping with symptoms (CSE); Med = medication

4. Conclusion

This case study provides information about the efficacy of an intervention consisting of four sessions combining CBT techniques and virtual reality exposure using *VirtualPain* software in a 53-year-old female with FM. The patient showed a substantial improvement on completion of the combined treatment. Catastrophic thoughts and pain anxiety, which are strongly associated with pain perception [21], diminished considerably after treatment (CBT + *VirtualPain*).

Likewise, a significant reduction in extra medication was observed. However, the most impressive results came from the model AB used during follow-up. At 6-month follow-up, after 6 months without psychological treatment, the patient maintained the improvement achieved post-treatment. Most interesting, at 12-month follow-up, after self-administering *VirtualPain* software for six months as the only psychological intervention, all the assessed variables improved much more than at 6-month follow-up, and the patient reported that she no longer used rescue medication. These results provide valuable information about the potential benefits of using *VirtualPain* software in FM treatment.

The patient reported that she was satisfied with the software-based intervention and reduced her perceived pain by means of exposure to *VirtualPain*. Furthermore, she described the software as easy to manage and pleasant, which showed good acceptability. Other authors have reported that VR-based software is usually well-accepted for treatment purposes [19].

A major limitation of this study is that it does not include a baseline prior to treatment. However, an AB model was used during follow-up to establish a baseline prior to the self-administration (at home) of *VirtualPain*. In future studies, it would be appropriate to add more phases (ABAB) to clarify the effect of treatment and each of its components. Despite the limitations of this study, the results are positive and should lead to future randomized, controlled studies to assess the efficacy of this new software.

5. References

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