

Video Game Therapy for Fibromyalgia Patients

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Abstract: According to the research on fibromyalgia, it is found that the best way to tackle the pain is through physical exercise. However, it is difficult to indulge in any physical activity due to the stiffness and soreness in the muscles, caused by fibromyalgia. Studies have shown that video games can alleviate the pain through the secretion of certain chemicals. Video games also play a huge role in elevating other senses such as touch and vision, distracting the brain from experiencing any physical discomfort. Hence, we propose a solution that utilizes this quality of video games to indulge fibromyalgia patients in exercises, which eventually, would lead to a higher resistance to pain and increase in flexibility and strength. The system would contain sensors attached to the body of the patient at specific locations which captures the patient's movement. The patient then performs therapeutic exercises in the form of video games which assuages the physical pain attached with exercise, adding to the overall betterment of the patient.

IndexTerms - Fibromyalgia, Chronic Pain, Videogame, Exercise, Motion sensor, Bluetooth

I. INTRODUCTION

Fibromyalgia syndrome (FMS) is a chronic condition which causes musculoskeletal pain accompanied by various physical conditions such as fatigue, morning stiffness, swelling in the joints, irritable bowel, weakness and psychological conditions such as depression, anxiety and insomnia. A popularly associated fibromyalgia condition is fibromyalgia fog or fibro fog. It is the inability to think or reason clearly and makes it difficult to concentrate or remember new things. Although it is a highly common condition and is prevalent in about 3-6% of the world population, as told by the National Fibromyalgia Association, it is vastly misunderstood and misdiagnosed since it mimics other conditions such as thyroid or Vitamin D deficiency.

Although, Fibromyalgia does not have a specific treatment or cure, a multidisciplinary effort can be used to treat it. The primary effort in treating FMS must be in educating the patient about the condition. When the patient is fully aware of the character of the disorder, they are more likely to conform to the treatment and involve in the process. A physician must be an active part of the treatment to keep a track of the progress. Patients must be made to realize that an effective treatment starts with a change in lifestyle. Most people are opposed to this kind of a change due to the discomfort it causes and the effort it takes to make the required adjustments. Therefore, it is very important for the patients to be constantly motivated to continue their treatment. FMS patients may suffer from depression or low morale due to the chronic pain and hence are often advised to undergo Cognitive Behavioral Therapy (CBT) to change their thinking patterns and to learn coping mechanisms to live a positive and happier life. It is advisable for them to get psychological support to make changes in their lifestyle.

Fibromyalgia can be treated in various ways though most of them are just to relieve or cope with the pain temporarily. Painkillers such as Paracetamol or Nucoxia-MR can be used to reduce inflammation and relieve pain for a brief period of time. Doctors may also prescribe antidepressants or stress relievers for better sleep and relaxation since stress plays a major role in FMS. A healthy lifestyle can aid in FMS treatment. Getting adequate amount of sleep and maintaining a regular sleep cycle is necessary. Meditation, listening to soothing music, hot bath before going to sleep and a comfortable bed can help the patient have a relaxed sleep. Other initiatives for a healthy lifestyle include cutting out caffeine, not sitting or standing for a long time and indulging in simple stretches when muscles are starting to feel strained. A bad posture can also exacerbate the pain. Therefore, the patient has to be always conscious of their posture whether standing or while at work. Physicians also advise FMS patients to adopt Lifestyle Physical Activity (LPA), which involves doing a set of self-selected, lower-to-medium intensity exercises every day. By practicing LPA, the patient develops a tolerance for exertion associated with physical activity. This is highly recommended by physicians.

Acupuncture, which is the pricking of needles at specific points in the body, can be used to relieve pain. It stimulates the nerves and promotes a change in blood flow. Acupressure is also used if the patient is afraid of needles. In both of these treatments, there is a release of endorphins, which are neurochemicals that relieve pain. When pressure is applied, the muscles feel relaxed due to the flow of blood and oxygen to that area of the body. Regular massage therapy can help in muscle relaxation and improves range of motion.

An efficient therapy which uses water's buoyancy and its ability to carry temperature to treat pain is Hydrotherapy. It utilizes water in various forms such as in solid or vapor form to treat pain. It improves the blood circulation which is vital in healing and there is very

little stress on the joints due to the buoyancy of the water making it simpler to work out without straining. For swelling and inflammation, ice packs can be used to alleviate the pain. Hydro-Massage can be used to relax the muscles by the usage of swimming in warm water. WATSU, which is the acronym for Water Shiatsu, is a water-based relaxation therapy which combines the practices of Shiatsu, which is a form of Japanese bodywork based on traditional Chinese medicine. WATSU uses the healing power of water on pain and aggregates the principles of the body-mind connection to help alleviate the pain associated with FMS. It includes the patient doing gentle movements and stretches in warm water, guided by a trained therapist. Through this, the muscles can be stretched and the flexibility too can be improved with less exertion, which works great for an FMS patient. The widespread pain due to FMS can thus be handled efficiently through WATSU while promoting relaxation.

While all of the above mentioned techniques can just help deal with the pain, physical exercise can help in the long term. It increases dopamine and endorphin levels in the body which reduces the perception of pain in the brain and creates a sense of happiness. Due to the fluctuating symptoms in FMS patients, it becomes arduous to maintain a strict exercise regimen. So, they can start with low-intensity exercises and increase the duration gradually while undergoing CBT to constantly keep them motivated and positive. Commonly, 3 types of exercises are considered for FMS treatment, which are stretching exercises, conditioning exercises and strengthening exercises. Stretching exercises involves moving your muscles until its range of motion without pain. These exercises cure the stiffness in the muscles and increase flexibility. Yoga and Tai Chi are two great mind-body techniques which involve flowing movements accompanied by deep breathing and meditation, which relieve muscle tension and create a greater control over the body. Conditioning exercises are used to increase your endurance levels. It includes activities such as walking or cycling. These not only strengthen the muscle but also condition and tone them. Swimming is a great conditioning exercise. In water, the weight of the body is about a tenth of the normal weight due to the natural buoyancy of the water, giving the patients a wider range of motion while causing no stress on the joints or muscles. Strengthening exercises build stronger muscles and tendons which support joints. While all of these exercises are great to treat FMS, it must always be done under supervision of professionals to avoid the risk on injuring oneself.

An emerging technology in pain relief techniques for fibromyalgia is Video Game Therapy (VGT). A study by American Pain Society showed that the brain's response to physical pain reduces while playing 3D video games. It is believed that when a person is playing a video game it distracts him and tends to forget about the pain. While in a virtual environment, the area of the brain which perceives pain receives lesser signals. It happens due to the biochemical change that occurs in the patient therefore creating a feeling of relaxation and positivity in the patient. So video games also help in coping with depression caused due to chronic pain.

II. EXISTING TECHNOLOGY

[1] Zina Trost et al., dealt with the guarantees and difficulties of virtual gaming advances for interminable torment. The survey featured the particular importance of VR intuitive gaming advancements for torment particular mediation, including their present use over an assortment of physical conditions. Utilizing the case of evaluated presentation treatment for torment related dread and handicap in unending low back torment, the ways that VR gaming can be outfit to enhance existing endless torment treatments and analyze the potential restrictions of customary VR interfaces with regards to constant torment were talked about. The paper closed with the bearings for future research on VR-intervened applications in perpetual torment.

[2] Ted Jones et al., learned about the effect of Virtual Reality on chronic pain. Thirty (30) members with different perpetual torment conditions were offered a five-minute session utilizing a virtual reality application called Cool! Members were asked some information about their agony utilizing a 0–10 visual analog scale rating before the VR session, amid the session and quickly after the session. Agony was decreased from pre-session to post-session by 33%. Torment was diminished from pre-session amid the VR session by 60%. Three members (10%) announced no change amongst pre and post torment evaluations. Ten members (33%) detailed finish relief from discomfort while doing the virtual reality session. All members (100%) detailed a decline in torment to some degree between pre-session torment and amid session torment. The virtual reality encounter was found here to give a lot of relief from discomfort. VR appeared to have guaranteed as a non-opioid treatment for interminable agony.

[3] Colder Carras M et al., completed an examination on Commercial Video Games as Therapy (VGT). The paper gave foundation data on the utilization of business computer games for the prevention, treatment, and restoration of mental and other wellbeing conditions, and talked about continuous endeavors by online groups to utilize computer games for recuperating and recovery. Notwithstanding off-the-rack computer games having potential applications in preventive and remedial medication, deliberate endeavors to describe and better comprehend this potential has not been attempted and confronted a few difficulties, including an absence of standard wording, quickly evolving innovation, societal states of mind toward computer games, and comprehension and representing complex communications between individual, social, and social wellbeing determinants.



Figure 1: Conceptual framework for VGT

[4] Stephanie M. Jansen-Kosterink et al., completed an examination for Patients Suffering from Chronic Musculoskeletal Back and Neck Pain. The essential point of the pilot study was to investigate the client encounter (ease of use, fulfilment, level of inspiration, and amusement encounter) of the patient with the "PlayMancer" exergame. The auxiliary point was to investigate the movement of the performed motor skills (walking velocity, overhead achieve capacity, and cervical scope of movement) and the clinical changes (to physical condition, handicap, and torment force) in a gathering of patients with constant musculoskeletal torment utilizing an exergame for a month.



Figure 2: The "PlayMancer" suit

[5] Eva Petersson Brooks and Anthony Lewis Brooks, in two connected investigations, investigated the general possibilities, with foci on requirements and facilitators, of engagement in restoration amid movement controlled video gameplay (MCVG). 17 female participants diagnosed with fibromyalgia disorder (FMS) participated in the examinations, wherein three distinctive MCVGs were utilized, which were directed by session pioneers having diverse profiles. This examination exhibited the possibilities of how MCVGs can go about as powerful social insurance mediation for ladies with FMS concerning offering action organized around their advantage, objectives and decisions. These perspectives were observed to enable and additionally reassuring the members to go up against a dynamic part in the movement. Conclusions were that more profound comprehension of engagement inside the FMS people group, specifically identified with recovery utilizing MCVGs, can be helpful to upgrade restoration procedures and better dress recovery suppliers to better encourage engagement and improve the viability of recovery mediations.

[6] J.B.Castano et al., completed a study which included two techniques for enhancing the shoulder flexion in patients by having a session of facilitated treatment and another of VR based treatment. They utilized Kinect sensor, programming which was utilized to catch and analyse down the developments, video projector and an exergame. The patients were put into physical restoration for 30 minutes which included strategies like Kabat and Bobath and afterward they needed to take up VR treatment with exergame for 30 minutes. After the fruition of the sessions a record was made which included execution of the patient in that session alongside the outcomes created by kinect sensor .After couple of sessions it was discovered that the patients could show signs of improvement muscle protection and enhancing their personal satisfaction.



Figure 3: A patient interacting with exergame

III. SHORTCOMINGS OF FIBROMYALGIA TREATMENTS

3.1 Aerobic Exercises

Although aerobic exercises can help in strengthening and conditioning of the muscles, it initially will cause a lot of pain due to the sudden increase in muscle activity. It may worsen the condition and make the pain unbearable for the person. Also, when the pain is that high it is likely that the patient might feel disheartened to continue the exercise. Therefore, it is necessary to not overdo any exercise and one should always gradually increase the time invested in it so the muscles get enough time to endure it and the person must constantly keep himself motivated.

3.2 Cognitive Behavioral Therapy (CBT)

CBT is a great way to create new thinking patterns but it is quite difficult to find a therapist who is well aware of the FMS situation to guide and encourage the patient. And it usually takes a long time to see visible results, throughout which the patient and the therapist have to be very patient with one another. The affordability of the treatment may also play a negative role.

3.3 Medication

Painkillers can only help alleviate pain for a short duration. Prolonged use of painkillers can make the body resistant to it and it might also damage the liver. Therefore, physicians only advise the use of painkillers when the pain is unbearable or when starting a new exercise regimen as a way to aid the treatment. Muscle relaxants are also advised to be used for a short period since this kind of medication usually makes the person very sleepy and stopping a muscle relaxant medication abruptly may have serious repercussions.

3.4 Dry Needling

It is a procedure where dry needles i.e. needles without any medication are inserted into the skin to release taut band of muscle called the trigger points. Although, muscle twitch is considered a positive reaction indicating the release of a trigger point, it might cause severe pain to some. Sometimes patients experience a migration of pain from one area to another. Dry needling may also cause bleeding, nausea and fatigue. The patient might experience sore muscles lasting between an hour and a day and must be treated with hot or cold packs as advised.

3.5 Yoga and Tai Chi

As beneficial as yoga can be to treat chronic pain, it might be difficult to keep going when in pain. It is important to find an instructor who can guide you about which poses are suitable for an individual based on their medical history. Wrongly done yoga can take a toll on the body and might even aggravate the pain. It is difficult to find a teacher trained in Tai Chi, an ancient Chinese martial arts form. It is also hard to convince people to try something new as this. Apart from that, tai chi is great for chronic pain.

3.6 Hydrotherapy

Although it is a great way for fibromyalgia patients to work out without pain, there are certain restrictions when it comes to this. It can worsen certain illnesses. People who have a heart condition, or diabetes, or pregnant are not advised to undergo hydrotherapy. Impure water can cause skin irritation. And patients with hypertension must be cautious when being in hot waters because it might increase their blood pressure levels.

IV. PROPOSED SYSTEM

The idea is to incorporate fun into exercise, so the person is distracted from the pain caused due to physical exertion. The system offers fibromyalgia pain therapy by combining wearable motion sensors and Bluetooth technology in a gaming environment with real-

time performance feedback. It is a great way to get fibromyalgia patients to get exercising and keep them constantly motivated and excited about physical activity.

The system would contain therapeutic exercises for different parts of the body affected by FMS such as lower back, upper back and knees. It would be a set of medically approved safe exercises which would help the patient in stretching out their muscles in an orderly manner and help in increasing their flexibility. The application, immediately after installation shall lead to a video explaining about fibromyalgia and the care that must be taken including the dietary regimen to educate the user more about the condition. The importance of being physically fit shall be emphasized so the user is aware of the situation and is enthusiastic about the therapy.



Figure 4: Illustration of the movement of game character based on the user movement

The user has to install an application either on their phones or tablets. Through the application, the user can choose which part of the body he wants to work on for that day, which could be lower back, upper back or knees. Upon selection, the user shall be guided on where to place the sensor to reap the maximum benefit. The product shall come with 2 sensors and 3 different types of belts with adjustable straps, one for lower back, a pair for the knees and a pair for the shoulders, each designed in such a way that it gives maximum comfort as well as capture the motion accurately.

The sensor can be placed in a slot allocated for it in the belt which would be the most ideal to capture motion. So, if the user wants to work on his lower back, he has to ensure that the sensor is placed right above his tailbone. This way, every intricate detail can be captured. If he wants to work on the shoulders, he can wear the shoulder pads which would cover the motion of upper trapezius. If knees are chosen, the sensor shall capture movement of the knee joint.

The user will then be made to play a series of games in which he would have to clear levels by navigating the character in the game by the movement of his body. Say, if the user bends his trunk to the left, the character in the game would move to the left as well. This is done through the GY-sensor. The GY-80 sensor, made from Micro-Electro-Mechanical-Systems (MEMS) technology is a combination of 5 sensors- Magnetometer, Accelerometer, Gyroscope, Barometer and Thermometer. A 3 axis magnetometer is used to determine the orientation whereas a 3 axis accelerometer for determining the change in position. A 3 axis gyroscope is used for measuring angular rotation and barometer and thermometer to measure atmospheric pressure and temperature. This combination of sensors gives a quick and accurate position and orientation of the user. The device would also consist of a Bluetooth chipset using which the data captured by the sensors is transmitted to the tablets or TV screens.

The user would constantly be guided visually about the right postures and proper movements on the screen. While navigating through the game, the character has to pick up points which can later be traded in to buy new skins for the character. The user will also be rewarded upon completing a certain milestone. The application would generate a weekly report mentioning about the user's performance in terms of accuracy and smoothness while performing the exercises. This way the user can monitor his progress and even improve his movements. The reports generated can also be sent to their physicians so they can keep a track of the patient.

Although the idea is a great way to motivate patients to exercise, the motivation must come from within. Without a constant effort, the results will not be positive. Also, the degree of accuracy of the sensor detection may vary slightly from the original value. There is also a possibility of the patients getting too hooked to the game. It's highly likely that the patient will overdo the exercise and cause more pain to himself, in such a case.

The proposed device promotes a healthy lifestyle by making therapeutic exercises fun. Starting with simple stretches and movements to moderate-impact exercises, the device will take the patient through a journey of wellbeing.

V. CONCLUSION

We proposed an idea to involve therapeutic exercises into the lives of fibromyalgia patients' lives in such a way that it distracts the patient from the pain caused due to exertion. This is done by involving the patient in playing a video game where sensors would be strapped onto the patient's body and their movement would be used to navigate a character in the game. The movements are designed in such a way that it benefits the patient by strengthening and stretching the usually stiff muscles which causes pain. A strict video game therapy regimen accompanied with healthy habits can play a major role in handling and curing fibromyalgia pain.

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