Application of rubber pad electrodes and vacuum suction cups neuromuscular electrical stimulation

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Abstract. The present paper describes a wearable orthopaedic treatment unit. The wearable product requires a service member that is tailored to wear across the user's body. The support person shall have a bracelet and a lumbar belt to ensure fitting over the user's body. In addition, the support member is fitted with rubber pad electrodes and vacuum suction cups. Neuromuscular electrical stimulation is provided by rubber pad electrodes which promote passive contraction and muscle relaxation. The system is particularly suited for the treatment of lower back pain. It also enables the absorption of waste materials such as lactic acid and thereby helps to enhance the functional properties of muscles such as flexibility, contraction, etc.

1. Introduction
Back pain affects persons despite all ages for a variety of reasons. The vast majority of back pain encountered by the general public is found in the lower part of the back, commonly referred to as the lumbar region. Lower back pain affects the mobility, flexibility and strength of the spine, resulting in pain, irritation and stiffness during everyday life tasks such as walking, driving or sleeping [1,2].

In most cases, some form of a support garment is a common expedient for reducing the back pain. One of the well-known garments for this purpose is the wrap-around corset of a non-flexible material. Physical therapy treatments are also widely used as a useful measure of pain relief [3,4]. Typical stretching and other conventional physical therapy treatments may not alleviate pain caused by radiculopathy and acute lower back pain. Till now; as a part of conventional physiotherapy, the first choice of treatment modality used for treating low back pain was “Transcutaneous Electrical Nerve Stimulation” (TENS) which is also called as “Neuromuscular Electrical Stimulation” (NMES).

If LBP (low back pain) was accompanied with radiculopathy, then the modality used is “Interferential Therapy” (IFT). Both TENS/NMES and IFT work on the principle of “pain control” or “pain gate theory”. Further, to correct posture, ergonomic advice is given to the patients. Advances like biofeedback are rarely used as it is not available on a global basis. For LBP cases secondary to PIVD (prolapsed intervertebral disc), spondylolisthesis, spondylitis, etc., exercise protocol like Mckenzie’s Extension Regime is advised [5]. While administering modalities like TENS/NMES or IFT, it is not always taken into consideration that the patient is in anatomically and bio-mechanically
correct posture. The management strategies are available for LBP focus only on the pain-relieving component [6]. Therefore there is a need for a concrete physiotherapy treatment option for low back pain based on medically explained mechanism of action which can partially or completely overcome few or all the drawbacks of the existing devices.

1.1 Research Objectives

i. To provide a wearable device for orthopaedics treatment, especially for treating lower back pain.

ii. To provide a wearable device which will not only focus on the pain relief component but also target posture-correction as well as soft-tissue off-loading simultaneously.

iii. To provide a wearable device, which provides soft-tissue decompression by lifting and off-loading the muscles of the back.

iv. To provide a wearable interface that enables the elimination of waste materials such as lactic acid and thereby helps to enhance the functional properties of muscles such as endurance, contractibility, etc.

2. Literature Review

Recent developments in health-related assessment technology might open up new opportunities beyond the hospital context for the implementation of therapeutic services, offering continuous control and guidance on critical interventions for both healthcare providers including patients[7]. While poor balancing is the major source of dropping, most studies have investigated state-of-the-art equipment to track equilibrium efficiency as well as provide immediate results in an attempts to enhance equilibrium. Pressure and movement detection mechanisms installed on the floor [8].

A number of research studies focused on evaluating the potential technological adoption of medical instruments to track neuro-chirurgical mobility and the mobility of orthopaedic patients. post-operative surgery, therapeutic effectiveness assessment as well as patient movement could be supported by weighted medical equipment which detect movement of the patients after spinal surgeries. The medical system evaluation by doctors is a dynamic procedure related to multiple requirements[9].

Argent et al. [10] introduced post-surgery with a sensor-based monitoring device to monitor motion range (ROM) normally consisting of an gyroscope, barometer, accelerometer, as well as a pressure gauge. Only the acceleration sensor and navigation systems involved were installed on the thigh for the study. After exercising and moving, knee ROM was measured utilizing data from the sensors. The feasibility analysis looked at the association among knee ROM as well as the BMI of patients, using (or not) of anaesthetic regulation and kind of hemostatic intervention in use at different periods both before and up to 6 weeks from the operation[11].

Jeldi et al., [12] assessed the transfer cycle UT (upright time) as well as (STS) sit-to-stand following thigh operation. The patients were examined for post-operative treatment in the clinic via a sensing accelerometer linked to proximal parts of the un-operated thigh. During the first 24 hours, data stream processing revealed a large variance in the STS performance. Findings show that a woman stays considerably longer than male counterparts. Between the 1st as well as the last 24 hours the female patients had undergone low STS and UT [12].

However, no negative impacts from use of any of the equipment in the research conducted have been documented.

3. Materials and Method

Wearable device for orthopedic treatment is provided according to the present research. The wearable device has to be worn by the user. The wearable interface requires a support member that is tailored to wear over the user's torso. The help is fitted with an elastic bracelet and an adjustable lumbar belt to ensure fitting over the user's body. The support member is a jacket like wear arrangement around the user's body. The support member varies in size, shape and aesthetics according to the requirement of the user. In an embodiment, the device is configured in such a way that an inner circumferential area of the support member contacts with the back region of the user for
providing body treatment. With rubber pad electrodes and vacuum suction cups, the support member is configured.

Specifically, the vacuum suction cups are operably mounted in between the rubber pad electrodes. The vacuum suction cups are removably configured from the support member such that the user can wear the support member for correcting the posture. The device provides soft-tissue decompression by lifting and off-loading the muscles of the body through the vacuum suction cups. In the presented orthopedic device, the vacuum suction cups are operated manually.

The wearable interface incorporates a support member that is adapted to be placed across the user's torso. To ensure fitting around the user's body, the support member has an adjustable arm-strap and an adjustable lumbar belt. The arm strap and the lumbar belt enables the user to properly fit the wearable device around the body despite the size and shape of the user. Two such arm straps are provided for holding the support member, each arm straps being wear around both the shoulders of the user. The arm strap has a locking member to be fastened with a corresponding locking element configured on the support member to hold the support member around the body, particularly around the shoulder of the user. Similarly, the lumbar belt is fastened around the waist or lumbar region of the body to hold the support member. It may be obvious to a person skilled in the art to fasten the arm strap and the lumbar belt using hook and loop arrangement and the like.

The support member is a jacket like an arrangement to wear around the body of the user. The support member varies in size, shape and aesthetics according to the requirement of the user. This helps the device to be easy to fit for a variety of individuals with diverse anatomical and physical variations. In the present embodiment, the device is configured in such a way that an inner circumferential area of the support member contacts with the back region of the user for providing body treatment. The support member ensures that the user maintains good posture throughout the treatment. The device also provides soft-tissue decompression by lifting and off-loading the muscles of the body through the vacuum suction cups. In the present embodiment, the vacuum suction cups are operated manually.

Furthermore, a neuro-muscular electrical stimulation (NMES) machine is arranged on the support member for providing neuro-muscular electrical stimulation through the rubber pad electrodes. To promote passive contraction and relaxation of the muscles, neuro-muscular electrical stimulation is delivered via the rubber pad electrodes. The rubber pad electrodes are controlled by a battery-operated controlling unit arranged inside a pocket over the lumbar belt.

The rubber pad electrodes are operated through a cable of electrodes connected between the neuro-muscular electrical stimulation machine and the rubber pad electrodes. The device provides neuro-muscular electrical stimulation along with soft-tissue decompression therapy in anatomically and biomechanically to correct the posture of the user. This would help to minimise pain and promote the elimination of waste materials such as lactic acid, while enhancing the muscle's physiological properties, such as flexibility, contractility, etc.

4. Conclusion

The present research has the advantage of providing a wearable device for orthopedic treatment, especially for treating lower back pain. The device will not only focus on the pain relief component but also target posture-correction as well as soft-tissue off-loading simultaneously. Further, the device provides soft-tissue decompression by lifting and off-loading the muscles of the back. This device facilitates the removal of waste-products such as lactic acid and thus helps improve the physiological properties of muscles such as flexibility, contractility, etc. Also, the device is simple and economical in construction.

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