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Drug Delivery System Embedded in a Belt with Mechanism to Relieve Pain and Infusion of Drug into Skin by Massaging

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Abstract: ***The system designed is actually solving the problem of lumbago (back pain). Pain is felt in the back that usually originates from the muscles, nerves, bones, joints or other structures in the spine. Mainly seen in athletes, old age people, load bearers, office workers etc, this is a common condition and lumbar pain is one of the most common pain experienced. To help relieve such condition the system is designed with a stretch transducer to measure the amount of stretch produced in the back muscle, when the stretch produced in the muscle is more than the threshold value this activate the pump loaded with drug, which is stored in the reservoir. The activated pump releases out the drug through micro pores in the membrane located opposite to the lumbar region. The exit of drug from the pores is in the form of spray onto the skin followed by the pads attached parallel to each other embedded in the belt starts to vibrate and massage the lumbar region and allow infusion of drug inside the skin slowly. The same system can be used as a massager only also, and works on two domains, either automatic or manual, hence making it user friendly and ergonomic in nature.***

Keywords: Lumbago pain, belt, massaging pads, drug infusion, drug delivery system.

1. Introduction

Back pain is the pain felt in the back or the lumbar region. It can be chronic or acute depending on the intensity of the pain. This can cause damage to the muscles, and in severe cases the spine may also get affected. With about 65 million of American suffering from back pain, it is the second most common reason for doctor visits. About 95% cases can be treated without the surgery, hence analgesics and massaging technique works very well. Common back pain causes include nerve and muscular problems, degenerative disc disease and arthritis. Many people find relief from symptoms of back pain with pain medication, physical therapy, rest, changes in lifestyle that aggravate the back muscles, or in the most extreme cases, with surgery. There are many systems in market that help in relief, many medication and pain killers are also available. But the simplest way to relieve the pain and also to keep the back straight is by using belt. People wear belt for the reason that the lumbar region is affected the least while they walk or bend. But in case of excess of stretch produced on the back it causes pain and this can be unbearable many a times. The pain starts from the lumbar region enters the arms and can lead to other muscles of the body. People in every country face the problem of acute back pains and without any easy remedy. The simplest way to relief the pain is to design a belt, with analgesics and massaging system embedded together. Imagine the belt which can pump the drug and with the help of massager can also infuse the drug inside the body.

The patient can get instant relief and also the massaging effect will help the patient to easily overcome the effect. The system is designed in such a way that it can be used both in automatic and manual. In case of acute pain the person can infuse the drug directly into the back region and allow massager to massage the muscle, in case of tiredness the person can sit and use the massager mode only to get relief. The administration of drug is very slow in the skin and this will lead to fewer chances of side effects. The membrane which is in attachment with the skin can be removed and washed for multiple uses and to reduce the bacterial, fungal infection.

2. Research Objective

The following are the specific objectives of this research:-

1. The main objective of the study was to help relieve people suffering from back pain, lumbar pains, and slip disc problems.
2. To design a simple, affordable and easy to use system to keep the back straight.
3. To infuse the drug non-invasively directly to the skin without pain and less side effects.
4. To integrate a massager within the system and to help infuse the drug slowly and producing slow and effective relief.
5. To design a system which is ergonomic, DIY system, time saver and can be used anytime, anywhere.

3. Literature Review

There are many systems available in market which allows drug infusion in to the spinal or lumbar region. The survey of literature mainly consists of drug delivery systems and the massaging belts which are previously invented, available in market and some hypothetical concepts too.

Medicated electric belt: This belt used the battery-pockets wetted with vinegar soaked through the face of the flannel, the copper and zinc plates being preferably perforated. The perspiration of the body may be made to generate a moderate current, especially when the medicine contained in the pockets tends to increase its amount. The medicine „pockets may themselves be damped, or not, as desired, depending on their contents and purpose. It is evident that the belt may be so constructed that the series of voltaic batteries may be

removed for the purpose of wetting in vinegar and returned to a position.

Massage belt: There is provided a massage belt adapted to be wrapped around a body part, the massage belt including at least one first massager with a force imparting portion that extends towards the body part to be massaged, wherein the force imparting portion is movable along a plane in alignment with a portion of the body part to be massaged.

Air traction belt structure: The main motive of this belt is to provide an air traction belt structure, which includes an inner inflatable traction belt having an air valve thereon for communicating with an inflatable space therein and, and an outer solid support belt having a smaller width than the inner inflatable traction belt and movably surrounding outside of the inner inflatable traction belt. Since a first end of the outer solid support belt can pass through a through hole formed on the inner inflatable traction belt and extend to an inner side of the inner inflatable traction belt, a second end of the outer solid support belt can easily pass through a fixing ring provided on the first end of the outer solid support belt and be pulled by a user, for firmly tightening both the Inflated inner inflatable traction belt and the outer solid support belt onto the user's waist at the same time.

Multifunctional medical underpants: This system mainly comprises an underpants body, movable crotch pieces and magic tapes. The multifunctional medical underpants are characterized in that the movable crotch pieces are arranged in the middle of the front side and the back side of the underpants body and are connected through the magic tapes, and the magic tapes are fixed with the underpants body and the movable crotch pieces through sewing. The movable crotch pieces are arranged in the middle of the front side and the back side of the underpants body, so doctors can open the front piece during the gynecologic examination and can open the back piece during the injection on patients.

Medical belt: A medical belt consists of a front belt portion and a back belt portion, respectively made of a semi-rigid and half-resilient material. These belt portions respectively have a number of ventilation and engagement holes formed on almost whole surfaces of them. One of the belt portions has a plurality of hooking pieces and fitting protrusions formed on both ends portions of the belt portion, and the hooking pieces and the fitting protrusions are adapted to engage with the ventilation and engagement holes formed on another belt portion. In operation, an end of the front belt portion and an end of the back belt portion are connected by engaging the hooking pieces and fitting protrusions with the ventilation and engagement holes, then the front belt portion is applied to a belly of a user of the medical belt and the back belt portion is passed to a back of the user and applied to a waist, and finally any ventilation and engagement holes formed an another belt portion are engaged with the hooking pieces and fitting protrusion.

Air-pressure traction and low-tension hot-compression device for spine: An air-pressure traction and low-tension hot-compression device for spines is composed of a fixed outer cover, an air-pressure traction belt, a low-tension hot-compression pad and a connecting and adjusting sleeve. An air-pressure traction function and a low-tension hot-compression function are combined for use, so that soft traction and safe hot compression can be provided for the spines at the same time. Besides, a traditional Chinese medicine placing net is arranged to facilitate medicinal external application physiotherapy by a user.

Magnetic lumbar belt for medical purposes: A magnetic belt for medical purposes, which exposes the lumbar portion of a human body with magnetic flux, has been found. The magnetic belt comprises an elastic belt body, a flexible sheet removal and slide mounted on the belt body, and a plurality of permanent magnets removable mounted in said sheet. The belt body is made of elastic cloth and the coefficients of elasticity differs breadth wise. The sheet is made of flexible plastic, such as ABS (Acryl-Butadiene-Styrene), having a plurality of circular holes for accepting the permanent magnets. Each permanent magnet is mounted in a plastic housing or a capsule having a flange which engages with the edge of the hole of said sheet. The permanent magnet is, for instance, an alloy of samarium and cobalt with a surface magnetic flux of approximate 1,200 Gauss. The present magnetic belt is, when attached on the lumbar portion, effective for reducing stiffness or pain in the muscles of the human body.

Lumbar support belt: In this a thin stretchable top layer is sewn over a thick stretchable bottom layer so that the thin layer is at the top viewable part of the belt and the thick layer is at the bottom part of the belt against the user. A pocket is sewn onto the top of the belt. A gripping mechanism is connected to the bottom part of the belt and is used for holding the belt in place around the user's waist. A hook and loop fastener is used for connecting the ends of the belt together.

Dermal drug delivery system: Methods and apparatus for improving administration of drugs through the use of heat and other physical means. The present invention relates to the use of heat and other physical means in conjunction with specially designed dermal drug delivery systems, conventional commercial dermal drug delivery systems, or drugs delivered into a sub-skin depot site via injection and other methods to alter, mainly increase, the drug release rate from the dermal drug delivery systems or the depot sites to accommodate certain clinical needs.

4. Methodology

The design of the system is such that it consists of a belt, a microcontroller to control the dose and also the sensor part, and in the end the mechanism to vibrate the belt and help infusion of the drug into the body. The process of doing so is such that the belt is embedded with a porous membrane which will act as the main source of drug exit from the system. The porous membrane will be mainly on the Lumbar region and this is the main site of action of analgesics, hence it will be small two stripes of membrane and in the centre of the membrane will be the stretch sensors which will fit to the vertebral column exactly the same level as the vertical vertebrae are. Now when the person is not in need if drug the system is in resting mode and the system can be used in two main domains:

4.1 Automatic System

Before the person wears the belt he or she has to choose which mode to be chosen if automatic mode is set on the system then we will proceed as follows.

Suppose If the patient is old, extremely in pain, and cannot bend the back any further then he/she should activate this mode. Now in this mode the stretch sensors will be activated, as soon as the person bends, he or she will experience pain at a particular level, when encounters pain at a particular level, the person will press the button which says pain perceived. This will be stored in the memory of the micro controller as the threshold of pain. Now when next time the person bends unknowingly he will experience the pain, pain will actuate the system, the voltage from the transducers will go to the pump. PUMP: Upon taking the value from the belt the pump will get activated and ready to be used. The infusion pump takes drug from the reservoir and pumps it through the pipe to the exit site. Reservoir is a chamber with drug in small amount loaded, drugs like diclofenac, lodacaine etc only one single reservoir to load only one drug at a time. The system will calibrate the amount of dose prefed in the micro controller and the loaded dose will enter the pump. The pump now pumps the dose to the back part of the belt where the system for micro porous membrane is made. Drug splits in pipes and spread around the back and seeps out through pores. Once the drug is out from the membrane the system will activate massager upon request or automatic. The massager is a system of pads arranged parallel to each other they starts to vibrate and allow the massaging effect to the person in need. All the devices are powered by a common rechargeable Li ion battery; the battery is embedded at the back of the belt near the reservoir.

4.2 Manual System

If the patient is in pain, he or she can press the button called manual mode and then set the values of dose and when to trigger the system to infuse the drug to the skin. and also the massaging element when it should be activated. In manual mode to make more users friendly and interesting the LCD developed will be touch integrated. With a very attractive interface, patient can choose what activity he or she needs to perform and even the report of the activity will be generated and stored in the controller. The report comprise of how much compression was felt on the back upon bending, how much level of pain was perceived upon bending. The generated report can be stored in the system and if needed the person can show the reports to the doctor in printed format the whole system can be connected to printer through the USB port given and the generated report can be verified by the doctor. Report is based on the activity of the stretch sensor and the inputs given by it. The threshold levels will be prefed and calibrated by the user itself and then the comparison will be made to generate the report.

The activity of each component is governed by the LED's system created. When the drug is loading a blinking red LED will be observed on the front part of the belt, actually telling the patient that the drug is being loaded and will be ready to infuse in a short period of time. Once the drug is loaded red LED stops blinking and a green LED will glow constantly telling that the drug is being sprayed out. Now when the massager will be activated the blue LED will glow constantly till the drug is infused completely inside the skin can be switched off manually by the user.

5. Figures and Block Diagram

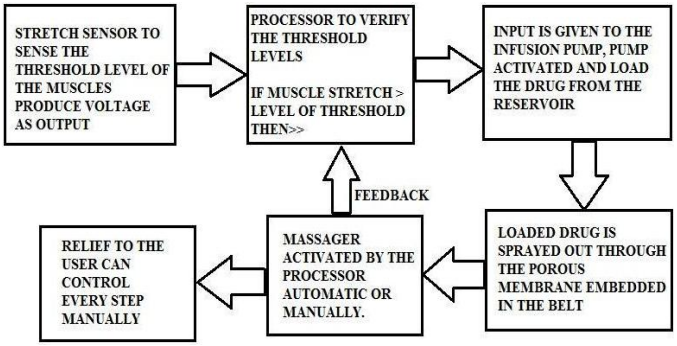

Figure 1: Basic Block Diagram of the complete system.

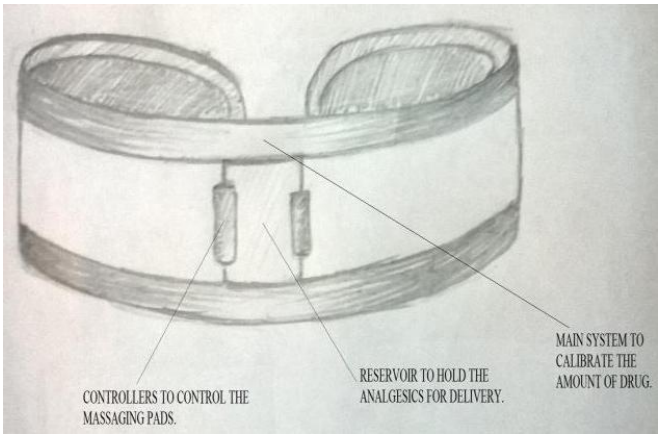

Figure 2: Back view of the belt, design duly made

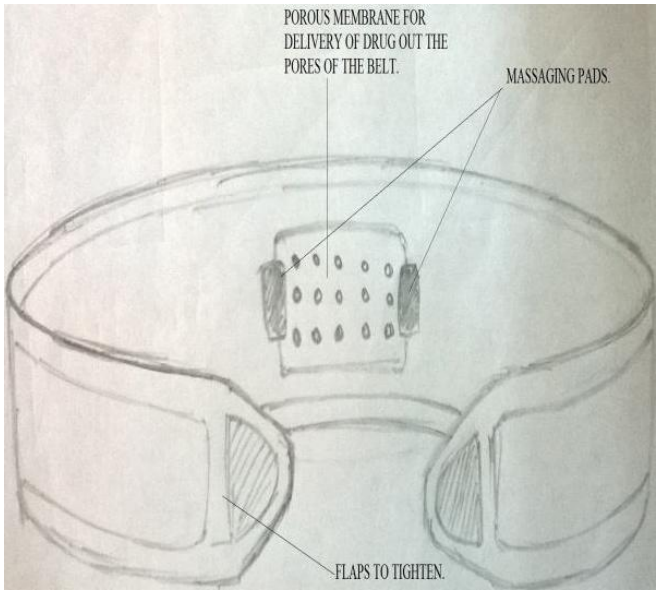

Figure 3: Front view, internal structure of the belt

6. Result

The system will help deliver the drug to the back, help the patient relieve pain, massage the parts of lumbar, and generate report which can be used as a reference to help get

verification and prescriptions from the doctor in case of chronic pains, the report generation part can also be printed through the USB system integrated and controlled by the processor built inside the system.

7. Conclusion & Future Scope

Such system is the future of this world and upon creation they will help the patients suffering from back pain. This system can be transformed into a drug delivery system without using needles directly into the skin, either by iontophoresis or by electrophoresis techniques, such small patch like system with drug loaded in it and can be activated by a small button can be applied to any body part to relieve pain, from head to knee cap pains the athlete and the old age people can get relief from this system. This system has a future scope in sport field, office workers who can wear such belts, patches, caps and go to job and can run with drug going slowly into their body and helping relieve the pain. The drug when it goes slowly also has fewer side effects hence providing multiple benefits.

The aim is to develop many more such system which can be used as the future systems to deliver drug without pain inside the body. Delivery of drug slowly in the body and least side effects of the analgesics and drugs administered inside the body, delivery system which are less painful and more accurate are preferred by the patients. Future of drug delivery system is to make system for every condition of human body which.

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Author Profile

Tarundeep Singh Kalsi is a student of Vellore Institute of technology, Doing engineering in biomedical, He is an innovator, aims to become a successful business man. Had won awards in competitions for innovating new equipments for healthcare have done many projects involving mechanical and electronic part, he is a quick learner, hard worker and like to think, Aim and vision of life is to make equipments, and drug delivery systems which will enhance healthcare and make life easy.

Kuldeep Singh Rajawat is a student of Vellore Institute of Technology, Doing B-Tech in Biomedical Engineering, he want to start working in the field of healthcare, with a belief to work for the people and what they need as the basic daily healthcare requirement, He is diligent worker and likes to think big. In my academic career I have done many electronic projects and I like to work on circuits. Aim of life is to become a successful person in life and work to enhance healthcare of India and World.