CHAIR-LESS CHAIR FOR LUMBAR PAIN REDUCTION

Delicia Elisheba D, Britto Y and Christina V.P.F
Department of Electronics and Communication Engineering, KITS, Coimbatore, Tamil Nadu, India.

ABSTRACT

Standing for hours causes distress to the lower back of the body, to reduce such kind of aches the chair-less chair came into existence. The chair-less chair also called as portable chair is a wearable, ergonomic, mechanical, therapeutic device. The ability to sit anywhere anytime is made possible by this wearable device. The chair-less chair can be worn as an exoskeleton on to our body and can walk normally when not used. It is an equipment of convenience and comfort, because it acquires minimal bearable weight. It is optimized by workers who stand and work for a very long time, especially on conveyor belts and other industrial related works. It helps in reliving back pain, limb ache, and tiredness and produces an increase in the efficiency of the worker. This paper portraits the design of the prototype model which was made from scrap, the mechanism of the portable chair, its applications. Future ideas and challenges are also incorporated in this paper.

Key words: Chair-less chair, exoskeleton, wearable.

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1. INTRODUCTION

Necessity is the mother of inventions. With evolution man was able to sit using his spine. He wanted to make the best use of this. He designed a device to sit. He named it “CHAIR”. He was able to rest his spine whenever he needed rather than sitting on the floor by folding his legs. Ordinary chairs were replaced by cushion chairs to make their sitting experience more comfortable. Now it’s time for man to change to chair-less chair. Man is in a need to work at odd places where he will not be able to carry this conventional chair, so this prototype model of the chair-less chair which could be attached on his/her body can be equipped. He can carry it where ever he goes without much effort, it will help him to sit at anywhere and will also save time and energy. It is with this aim that the chair-less chair was discovered. The chair-less chair was mainly designed for the people who stand for long time and experience fatigue in the lumbar region (a pain in the region from the hip to foot). This is experienced by the people working in industrial environments which are using conveyor belts for inspection and...
assembly of small equipment of etc. and also surgeons who stand and operate their wards for few hours together.

Even domestic laborers like painters, plumbers etc. Using this wearable chair will increase the efficiency of the workers and also indirectly increases the productivity of the organization or company they are working for. It reduces their tiredness and stress by providing a perfect work posture to the workers. Conventional chairs cannot be taken every where as they are static. But this chair less chair is a wearable ergonomic, therapeutic device. Anybody can use it anywhere and anyway according to their needs and uses. Our prototype model of the chair-less chair is made out of using scrap material to make it afford for domestic workers. This chair-less chair was introduced as a product to the society by a company called Nonee. The expense of this chair-less chair is costly. Keeping this in mind we have designed our own chair-less chair to support workers. It can be mainly equipped in manufacturing centers, renowned organization. Providing conventional chair will make the workers to rest for longer time but by providing the chair-less chair the workers will not take much rest as well as work efficiently which will increase the productivity of the company. Innovation has been made to use this chair-less chair in the medical field where the doctors use them during surgery time. It can also be used by physiotherapists in rehabilitating people who are suffering from lumbar pain due to trauma, disease or any deficiencies.

![Figure 1 Prototype model](image_url)

2. BACK PAIN AND LUMBAR PAIN

Back pain usually happens when people stands for a longer period of time and lessen their time of sitting. Prolonged standing creates a pressure on the spinal cord, more the pressure that the spinal cord receives more pressure will be on muscles. This is how the back pain occurs [1]. Your muscles and ligaments will get pressure as you age. Back pain occurs due to the sprains in the muscles, ligaments, spinal stenosis and ruptured discs.

2.1. Common Causes of Back Pain

2.1.1. Sprains

One of the most common causes of back pain is sprain. Works like gardening, lifting heavy objects etc. can cause back pain, back pain occurs when there is a tear in muscles and ligaments which results in spasm which is a symptom of back pain.
2.1.2. **Spinal Stenosis**
Narrowing of spinal spaces is called stenosis which creates a pressure on the spinal cord and on the nerve roots which gives a pain in the leg region.

2.1.3. **Ruptured Discs**
This occurs in the lower back area. This not only causes pain in the back but also in legs. Lumbar pain is a pain that occurs in the lower part of the spinal cord in human body. Human upper body is supported by the lower back. The muscles that are present in the lower back are responsible for the flexibility. Acute lower back pain creates injury in the muscles, joints and ligaments. If you stand more than five hours a day it causes a prolonged and significant lower limb muscle fatigue, which results in long term back pain [2].

2.2. **Symptoms of Lower Back Pain**

2.2.1. **Dull Aching Pain**
This is a pain that retains in the lower back for a very long period. This occurs when you have less mobility, muscle spasm etc.

2.2.2. **Pain in the Butt region, Legs and Feet**
Lower back pain sometimes creates a numb sensation this is also called as sciatica this is caused when there is an irritation in the nerve and it is felt on one side of the body. All the above-mentioned problems can be solved by the chair-less chair.

3. **BLOCK DIAGRAM**

![Diagram of TO SIT and TO STAND states with pressure application and release.]

4. **WHY CHAIR-LESS CHAIR?**
In certain places we can’t use our conventional chair, as it looks awkward or there will not be enough area to place a chair. In such places chair-less chair will be the best tool .For patients who are having severe chronic back pain they can use this chair. It magically appears when you need it. It will be the best solution for the patients who are unable to sit because of the above mentioned problems [3]. It can also be used by the industrial workers who stand for long hours in industries. It’s an exoskeleton model so that the people can wear it. Figure 2
Chair-Less Chair for Lumbar Pain Reduction

shows the exoskeleton modal. It directly increases the efficiency of the workers, for example if a person does a work in 2 hours without chair-less chair can do the same work within 1 hour with the help of chair-less chair. If a person stands for longer period, he/she will get tired quickly so they can’t do their rest of the work. But if they use chair-less chair they can sit whenever they want so that they their energy will be retained and they can do their work completely, which eventually increases the productivity of the company or the industry where they are working. It doesn’t occupy much space so it can be used anywhere. Its application is wide and it depends on the user how he/she want to use it. It is made from scrap materials and so it is very cost efficient, as it can be used by all kinds of people.

5. DESIGN OF PROTOTYPE MODEL

The chair-less chair is a flexible, portable, contraption, ergonomic device which looks more like an exoskeleton worn on the body. The exoskeleton covers the hip and extends to the back of the leg to the feet, belts are provided around the user’s shoulder to hold the exoskeleton firmly [4]. This model can be adjusted to different body sizes and for safety shoes are also provided. Figure 1 shows the prototype model. The user can walk around as well as sit anywhere with this device. Some strenuous postures like squatting, crouching, bending etc. should be avoided. This device is an ergonomic device because it is related to or designed for efficiency and comfort in the working environment. To produce medical rehabilitation and locomotion of the human body exoskeletons are used. A supportive leg exoskeleton can be worn to benefit workers who involve a lot of standing, load carrying etc. will reduce the fatigue in the lower back and the legs.

![Figure 2 Exoskeleton](image)

The exoskeleton is of two types one is active, the other is passive exoskeleton. Active exoskeleton must be powered by external sources it can be like a motor, battery etc... Passive exoskeleton does not need to be provided by any external sources, it only involves pneumatic and hydraulic mechanism along with mechanical linkages and spring controller devices etc….Active exoskeleton needs to be designated with the amount of external source to be provided with respect to the quantity, quality and the time. To avoid such parameters we are using passive exoskeleton. Passive elements are used to dissipate energy or store energy which leads to reducing of residual energy that the human would have to expend for the locomotion .This exoskeleton acquires minimum weight and it is mobile and portable. Cases of MSD (musculoskeletal disorders) which is developed among people indulging in prolonged standing conditions can be cured by this chair-less chair.
5.1. How does this Device Work?
The person should first wear the exoskeleton properly. The shoes are worn first. Then the hip region straps are tied around the user tightly, and then the shoulder and chest supporting straps are adjusted according to the body size so that the user feels more comfortable to wear it. Once the exoskeleton is fitted into the user’s body properly, the user should give mechanical pressure on the rod placed near the butt region. The pressure is given to the rod when the whole-body weight of the user is exerted on it. When the rod is pressurized it will pull down the thigh support stainless steel rod by compressing the hydraulic piston [5]. Due to this compression the calf support rod, will also bend and the edges of the calf support rod will be balanced on the ground. Now the whole exoskeleton will help the user to sit comfortable without much effort. If the person wants to stand he has to lift his butt from the hip rest rod so that the hydraulic piston expands the calf and the thigh support to the normal position. A person wearing this can also walk up to few meters. Total height of the prototype model is 151 cm. Total numbers of nuts and bolts used are 14.

6. CONSTRUCTION OF CHAIR-LESS CHAIR
We are separating this chair less chair device into 5 parts they are

6.1. The Lower Hip Region Support
The lower hip region support is a rectangular rod placed parallel to the butt region. Holes are drilled to attach the straps from the backside to the shoulder of the user to hold the device intact to the user as shown in figure 3. To the other end, two sets of stainless steel rods are welded for each thigh region as a support. The length of the rod used is 33 cm.

6.2. The Thigh Region Support
There are 2 thigh regions support stainless steel rods which are slightly bend for getting the desired design of our chair-less chair. Each rod is connected to the calf region support through the joint made parallel to the knee joint of the user as shown in Figure 3. The two thigh support rods are also attached or welded with one end of the hydraulic piston. The lengths of the two stainless steel rods are 39 cm.

![Figure 3 Thigh region support](image1)
![Figure 4 Hydraulic piston](image2)
6.3. The Calf Region Support
The other end of the joint is the calf support rod (47 cm). They are also 2 in number and their length is more when compared to the thigh supports rods as shown in Figure 5. This is to balance the chair-less chair on to the ground. The other end of the hydraulic piston is welded on to the calf rod support.

![Figure 5 Calf region support](image)

6.4. The Hydraulic Piston
Hydraulic is a descriptive term for a device to be operated or moved by a fluid mostly oil. One side of the piston is welded on to thigh support the other to the calf support. The position of hydraulic piston is shown in Figure 4. Only when the piston is compressed the user will be able to sit if expanded the user will be able to stand. The piston is the main part of our construction because this makes the device to work. It is 50 cm in expanded state.

6.5. The Shoes and the Straps
The end of the calf support region rod is connected to a pair of shoes with the help of straps. These straps are attached to the shoes as well as to the rod with the help of the nuts and bolts as shown in Figure 6 and Figure 7. This helps in keeping the rod placed to the ground under the control of the user. The straps are provided around the shoulder hip and chest region to make the two devices stay intact to the user. Strap length from hip to shoulder is 90 cm.

![Figure 6 Shoes](image) ![Figure 7 Straps](image)
7. APPLICATION OF CHAR-LESS CHAIR

7.1. Industries
Chair-less chair is mainly designed for the workers in manufacturing companies, especially for those who don’t move often and for the people who work in awkward position like bending, crouching, and standing for a very long time. They can wear it according to his/her convenience for different tasks [6]. Whenever they feel stressful or uncomfortable they can sit and relax or they can stand and continue the same work in the same place. In the manufacturing companies, workers are forced to stand and work for long period of time. Thus it results in back pain and vertebral problem for them. In general, people who are standing for long time will be affected by varicose disease. As the workers are now free from the stress by wearing chair-less chair they can work more efficiently compared to the previous state, this will automatically increase the productivity of the company.

7.2. Medical Field
People, whom are advised by the doctor not to stand for long time due to medical conditions of their body they can use this model according to their health conditions. Even the doctors can use it while doing major surgeries which will take a longer time of process to complete. This will reduce their tiredness and stress and will help them to concentrate on their subject [7]. Physiotherapists can equip this model to rehabilitate their subjects from lumbar and back pain.

7.3. Anyone Anywhere
It can also be useful to all people who stand for a long time with or without back pain. As it is wearable and cost efficient it is affordable by all. Anyone can use it if he/she wants to sit without the help of a chair. It can be useful to professors, teachers, and people working in catering services, in construction sites, supervisors, plumbers and painters who stand for long time. Thus it depends on the user how he/she equips this device.

8. CHALLENGES
There are a few challenges faced in this chair-less chair. The person who is using this chair should give a physical pressure. In this model there are too much of straps used for balancing because it was taken from scrap, simpler and light weighted straps can be used when not taking affordability into consideration. It is not as comfortable as a conventional chair it helps you to sit and stand as well as concentrate on the work the user is doing. Since there is no back support, positions like bending, crouching or positions beyond 90 degrees of angle will cause the user to fall without balance. To use this chair-less chair one should learn to balance it properly.

9. CONCLUSIONS
This prototype model was designed in concern for the society, we are trying to make this society a better place to live in. “WORK IS NOT MAN’S PUNISHMENT IT IS HIS REWARD AND HIS STRENGTH AND HIS PLEASURE” to make the work of the laborers simpler and easier this model has been proposed. We are now working on to overcome the challenges as mentioned above in this model and to develop a better model than this prototype.
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