DESIGN OF MECHANICALLY CONTROLLED HAND GLOVES TO REDUCE SPASTICITY OF PARALYZED PERSON

(KARONNATHI HAND GLOVES)

Burhan Pasha C S[1], Chandan S[2]
HMS Institute of Technology, Tumkur, Karnataka, India
Email:[1]burhancsen@gmail.com,

Abstract: Paralysis is loss of muscle function for one or more muscles. Paralysis is most often caused by damage in the nervous system, especially the spinal cord. Other major causes are stroke, trauma with poliomyelitis, cerebr al palsy, peripheral neuropathy, Parkinson's disease, spina bifida, hyper tension, diabetes mellitus etc. Primary goals of stroke management are done which includes reduced brain injury and promotion of patient recovery. Once the patient is medically stable, our focus shifts to reducing the patient's disability and handicap through rehabilitation. During rehabilitation, it is often observed that the muscles affected develop many potential features of altered performance including decreased motor control, weakness, clonus, exaggerated deep tendon reflexes, decreased endurance and spasticity. For this we have designed glove to avoid wrist drop condition and to achieve proper functionality of hand.

Key Words: paralysis, diabetes, hand gloves

INTRODUCTION

Spasticity: One of the common sequels to stroke is spasticity. The role of spasticity is over-emphasized in stroke rehabilitation, as it is a widespread problem in paralysis. It has been estimated that approximately 65% of individuals develop spasticity following stroke and studies have revealed that approximately 47% of stroke victims may still have spasticity at twelve months post stroke. It is more prevalent in younger patients. Spasticity is defined as "a motor disorder characterized by a velocity dependent increase in tonic stretch reflexes that result from abnormal intra-spinal processing of primary afferent input". The common clinical features seen in spasticity are muscle imbalance (co-contraction, co-ordination, lack of selective control), muscle weakness, contracture and progressive joint deformity. In order to treat spasticity, measurement of spasticity is essential to assess the response to treatment. Spasticity at any particular instance is dependent on several factors including presence of noxious stimuli, the physical and mental status of the patient, and the position of the body. Different methods are available to measure spasticity. Few of the commonly used methods are Ashworth scale, modified Ashworth scale, Tardieu method etc. Here, we have designed a suitable device to measure spasticity targeting the following goals/ **Objectives**: **Improved mobility improved positioning, Decreased spasm frequency, decreased pain and increased ease to perform day-to-day activities. Spasticity treatment should be based on the assessment of each patient/ beneficiaries**. For spastic muscles with mild to moderate impairment, exercise should be the main stay of management, under the guidelines of health professionals. **Background:** Muscles with severe spasticity are likely to be

more limited in their ability to exercise and may require help to do this. They may require additional interventions to manage the greater neurological impairment and also the greater secondary complications. Interventions may include icing, serial casting, sustained stretching, inhibitory pressure and medical interventions. **Statement of problem: succinct definition of the problem:** Treatment should be done with firm and constant manual contact positioned over non-spastic areas to avoid stimulating the spastic muscle. Alternatively, rehabilitation robotics can be used to provide high volumes of passive or assisted movement, depending on the individual's requirements. Spasticity commonly affects the upper limb, which is often painful and interferes with the movement and limits use of the limb for active functional tasks. It can cause involuntary movements that impact on gait, balance, walking speed etc. In severe cases, it can also impair passive functions such as washing, eating, dressing, driving i.e. all day to day activities.

RESEARCH

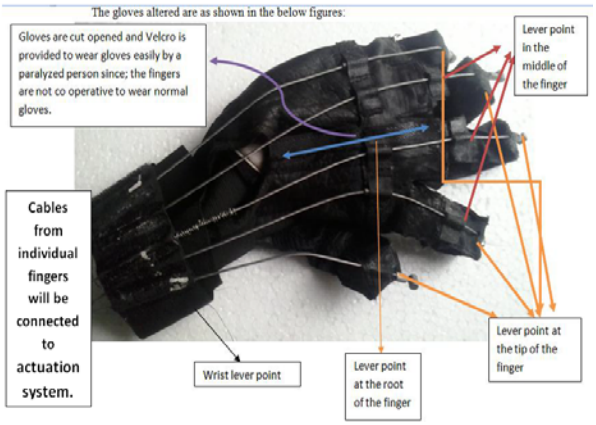
The problem of spasticity differs from person to person and this problem of spasticity can be solved specifically for different individuals. Therefore our team member Chandan come forward to solve his own problem of (wrist drop condition figure .1) spasticity because of paralysis occurred past 3yrs. Due to this, he is facing so many problems such as unable to ride vehicle, to do drawing according to scale in university and other exams and many more. In order to tackle and solve his problem, we think of developing a gloves which actuates the hand giving the movements to reduce the contracture, spasticity by proper flow of blood and functionalize the hand i.e. if we keep on using any organ it will continue to functionalize or it defuntionalize, if we not use organ that is according to Lamrakian's use and disuse theory. To give the movements to hand, we have decided to design and develop a gloves with actuation system to reduce spasticity, therefore we analyzed so, methods for tackling the problem and in order to give the solution in affordable i.e. low cost and effective manner we have used **locally available raw materials, such as: cycle's break cable and wire, Velcro, riding gloves, plastic caps, foam, PVC pipe, flat small iron pieces, servo motor, threaded shaft and nut.**

Stage1: ***Identification of the lever point of fingers in order to actuate as shown in figure***

The process of development of gloves involves the following stages:

Stage2: Alteration of gloves: In order to wear the gloves easily by paralyzed person i.e. the hand is not cooperative in nature to wear normal gloves, the alteration process is carried out and that is as illustrated

The gloves in below figure



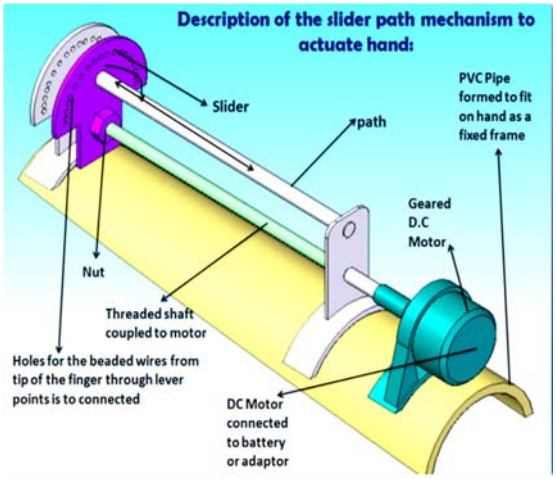
having the problem of shrinkage at the tip of the finger therefore we have provided end cap (plastic and foam inside) at tip and glove is now functionalizing properly and figure is as shown: With these alterations, we are able to make that glove to wear easily and all the lever points (the frame work which we have did earlier) are mounted on the gloves itself using fevi quick gum. This is the unique design of gloves which we have developed. Though there are alternate

solutions to reduce spasticity like static cock up

splint and other splint the dynamic nature can be achieved by this karonnathi gloves which reduces spasticity.

Stage3: The actuation system involves a slider path mechanism which is coupled to motor through a threaded shaft mechanism similar to bench vice the detailed description of the mechanism is explained in later section of this report, this also a unique innovation that we have carried out.

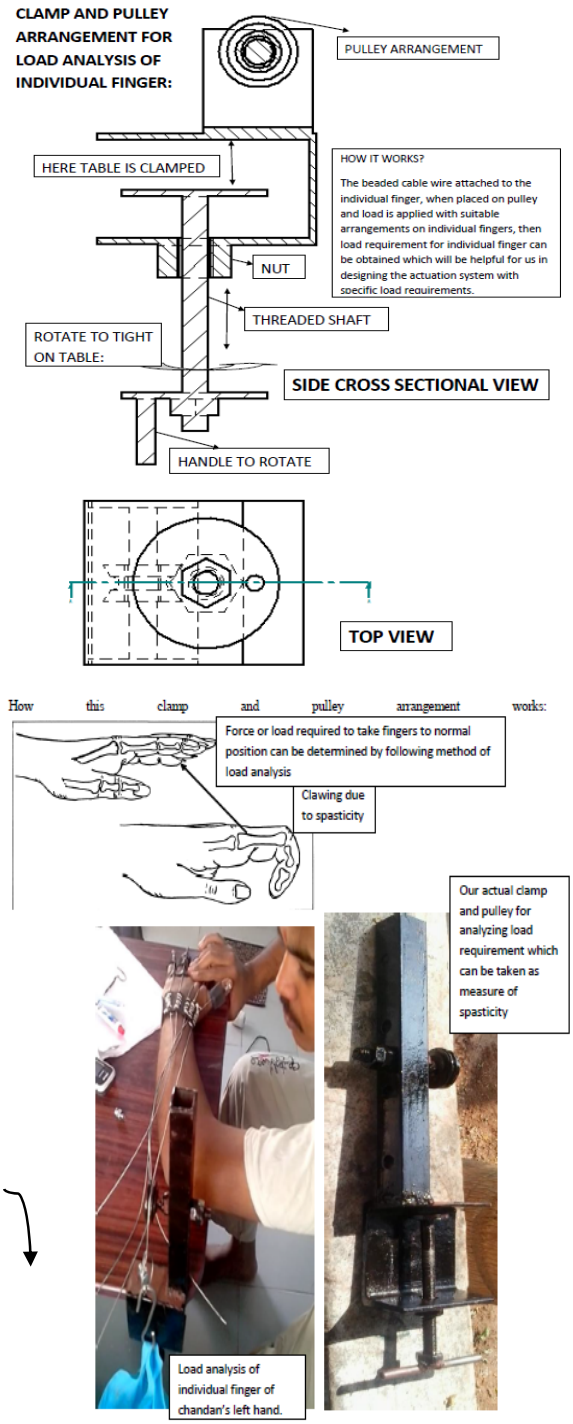
Gloves: The gloves specification is as explained last section that is we have to take the length of the finger of the patient and we have design end cap and mount the lever point on the gloves.



The above actuation system is to be mounted on the hand from wrist to elbow using Velcro. And there will be provision of the foam leather lining at the inner surface. As illustrated in the above figure the cable wires from the gloves through lever points are constrained to slider

Technical aspect of proposed solution:

The force or load required for individual finger is estimated by the clamp which, we have designed and functionality is as show in the figure



After analysing the load in order to make the hand to extended position a dragging mechanism is required therefore we have designed a slider and path mechanism by adopting the locally available raw material i.e. as explained in the earlier modeling of actuation system with slight

modification, it is fabricated which is under development.

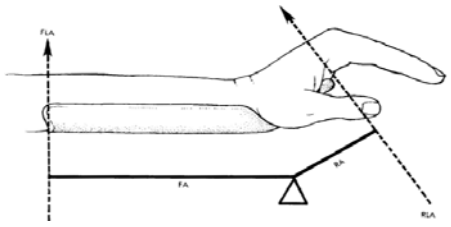
The slider is provided with a nut which is on threaded shaft, coupled to the geared DC motor controlled by 3-way switch. The 3 way switch is provided in order to give power to motor in both clockwise and counter clockwise to move the slider from rear end to front end respectively. This motor is powered by DC power supply and can be obtained by adaptor i.e. which converts AC to DC.

Description of flow of operations demonstrating key features and functionality:

Step1: To wear the altered gloves, the cable wires from tip of the gloves are connected to the actuation system.

Step2: To power the motor in both clockwise and counter clockwise in order make the movements form clawed position to extended position and extended position to clawed position respectively. These movements to be done for 30-40 minutes results in making the hand to become normal. (By our external guide)

Step 3: For a certain period of time the hand can be kept in certain position statically, as shown in the image, this can easily be achieved by our gloves because we are using slider mechanism integrated with screw which will bear load and keep the hand in certain angled position and make the to become normal by positioning.



Performance estimate of the solution: As explained in demonstration, our gloves help the patient to reduce the spasticity or tightness of hand gradually i.e. to reduce clawing of hand, upon using this unique device and with proper medical treatment for 3months (roughly) by our external guide, can reduce spasticity about **40-45%.**

Experimentation done to establish the workability of the above:

1. **Modeling and simulation of the mechanism,** infer the proper workability of actuation system.
2. **The altered glove is experimented on the patient directly.**
3. The proper load requirement is analyzed by the clamp and pulley design and roughly we got to know that the magnitude of **4.5 kg** (roughly) is enough to drag the fingers from clawed position to extended position thread integrated slider path mechanism which is coupled inline to DC geared motor.

Application:

Our idea of developing and designing the mechanically operated hand gloves is implemented on our team member is successful and this can be incorporated to the paralyzed person having the problem in hand i.e. deformation or clawing to rehabilitate to Improved mobility, improved positioning, Decreased spasm frequency, decreased pain and increased ease to perform day-to-day activities.

Additional application: The mechanism or technique which we have adopted for hand can also be incorporated to '**jaw**' and '**leg**' by suitable design that is identifying, mounting lever points and actuation, overcomes the deformity and to functionalize**.**

Benefits to the users:

The unique design of hand gloves which we have designed will ensure technical feasibility, affordability, usability, adaptability and robustness. The patients with **claw hand** and **loss of precision grip** can use the technology of our gloves to regain the functionality that is rehabilitation can be achieved.

References:

[1] Upper limb anatomy by BD Chaurasya
[2] Hand Splinting Catalogue
[3] Basic Principles of Splinting the Hand by Rebecca M Duncan