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Management of Hemiplegia for Adult Survivors: A Review on Therapeutic Procedures

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ABSTRACT

Hemiplegia is the paralysis, severe weakness or rigid movement associated on either right or left side of the body. Hemiplegia may be congenital, or might be acquired conditions resulting from an illness, an injury, or a stroke. It is characterized by limited use of hand, balance issues, speech issues and visual field problems. The effects of hemiplegia include changes in muscle tone, spasticity, weakness, change in posture, loss of sensation, loss of awareness and subluxation. Hemiplegic patients exhibit motor, sensory, balance, speech and perceptuo-cognitive deficits. Injury or insults to the brain cells that control movements in one half of the body cause hemiplegia. The symptoms largely depend upon the part of the brain affected. There are three types of Hemiplegia that have been recognized – right, left and alternating. This review will cover aspects of their causes, diagnosis and different treatment approaches.

Keywords: paralysis, congenital, stroke, spasticity, subluxation

I. INTRODUCTION

Paralysis of the limbs that a Human body experiences following an injury, a disease, or the degenerative process of aging is the most debilitating injuries. Disabled people are entirely dependent on other people or assistive devices for even the simplest tasks,

which are normally taken for granted. Providing independence for a human brings reintegration into society allowing him/her to be productive, which will ultimately lead to improved quality of life. [13]

Hemiplegia is the complete paralysis of the limbs and trunk on either right or left side of the Human body. It can occur due to Head injury, Diabetes, Brain tumor, Infections, Migraine syndrome, Inflammation of the blood vessels, Diseases affecting the nerves, Conditions presenting from birth and Hereditary diseases. A common cause of Hemiplegia is Cerebro Vascular Accident (Stroke). [6] Hemiplegia occurs in 88% of individuals who have suffered a Stroke. The prevalence of Stroke is 1 in 10 thus making it as the third most common cause of death in developed countries. The incidence of hemiplegia is much higher in premature babies than term babies. The incidence of hemiplegia is higher during pregnancy and experts believe that this is related to either a traumatic delivery by the use of forceps or some event that could have caused brain injury.

Return of functional activity of the limbs after Hemiplegia depends on neurological recovery in the paralyzed limbs and it also depends on efforts and motivation of the patient. [4] Recovery after stroke is related to neural plasticity of the Brain which involves developing new interconnections between neurons and acquiring new functionalities. [7] Therefore, it is important that therapies used for the Hemiplegic patients should facilitate neural plasticity to compensate for the functional loss on the paralyzed side.

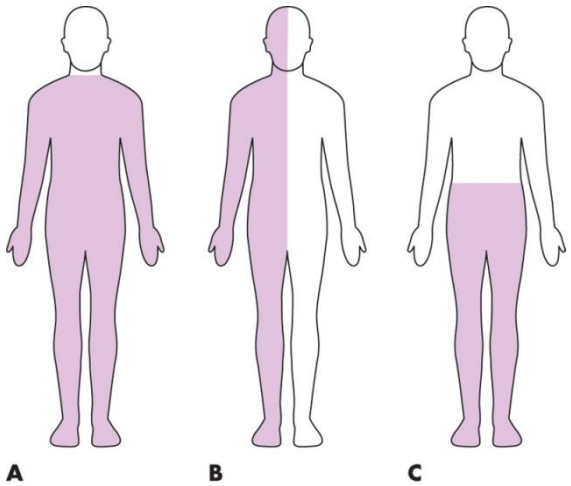

Figure 1: Types of Paralysis Diplegia (B) Hemiplegia (C) Quadriplegia
Courtesy: http://www.library.thinkquest.org

Rehabilitation techniques should include repetitive, intensive, and task-specific movement training to promote neural plasticity and motor recovery in the paralyzed limbs. [7] The aim of rehabilitation is to reduce the disabilities and enable the patient to return to community.

TYPES OF HEMIPLEGIA:

a. **RIGHT HEMIPLEGIA:**

Right-sided hemiplegia results from injury to the left side of the brain, which controls language and speaking. Since the left side of the brain is affected, a person with right-sided hemiplegia can have problems expressions using facial muscles and speaking. They also face difficulties in comprehending language and this condition is called aphasia.

b. **LEFT HEMIPLEGIA**

Left-sided Hemiplegia results from injury on the right side of the brain which has control over the process of learning, nonverbal communication and behavior of the humans. Stroke survivors with damage to the right side of the brain have trouble with their memory and attention span, and they often talk more. It also inhibits a stroke survivor's sensation and spatial skills.

c. **ALTERNATING HEMIPLEGIA:**

Conditions like Alternating Hemiplegia have recurring episodes of paralysis. The symptoms include yawning, fatigue, appearing very exhausted. Alternating hemiplegia has an ipsilateral and contralateral presentation in different parts of the body. It is characterized by recurrent episodes of paralysis on only one side of the body. There are multiple forms of alternating hemiplegia, Weber's syndrome, Middle Alternating Hemiplegia, and Inferior Alternating Hemiplegia. This type of syndrome can result from a unilateral lesion in the brainstem affecting both upper motor neurons and lower motor neurons. The muscles that would receive signals from these damaged upper motor neurons result in spastic paralysis.

II. DIAGNOSIS AND TREATMENT

Hemiplegia is identified by clinical examination by a health professional, such as a physiotherapist or a doctor. In the Physical examination, Muscle weakness of the paralyzed limb is evaluated during the physical and neurological examination. Identifying the pattern of muscle weakness or paralysis can help the physician identify where the damage of neurons has occurred in the nervous system. Muscle weakness can be seen in the limbs or trunk of one side of the body. Individuals with hemiplegia may have difficulty walking or grasping objects. Hemiplegia patients usually show a characteristic gait. They have loss of ability to coordinate movement and they face problems with body posture during walking and balance. Clinical Examination also reveals a loss of sensation in the affected limbs.

Some additional Information about the Patients can be acquired through the following tests:

- Complete blood count.
- Blood biochemistry test.
- Cranial CT which is a highly detailed, non-invasive, imaging procedure that combines x-rays with computer technology and allows the study of the brain from many angles.

- Cranial MRI which is a non-invasive, highly sensitive procedure that uses electromagnetic properties of tissues providing detailed studies of their structures.
- An EEG (electroencephalogram) which can measure the nerve activity within the brain.

TREATMENT

Hemiplegia Treatment should be based on assessment by the relevant health professionals, such as physiotherapists, doctors and occupational therapists. Patients having paralyzed limbs with severe motor impairment and loss of function need these therapists to assist them with specific exercises.

a. **CONSTRAINT-INDUCED THERAPY :**

Constraint-induced movement therapy (CI or CIMT) is a form of rehabilitation therapy that improves the paralyzed limb function. CI is effective in improving limb function and its use in real-world environments after Cerebro Vascular Infarction (CVI). The therapy involves constraining movements of the unaffected arm with a sling for 90 percent for 2 weeks, while intensively training the use of the more-affected arm so as to recover the functionality of the muscles. [13] Modified constraint-induced therapy (mCIT) is an intensive motor practice combined with behavior therapy, in which regular practice can improve nerve function in the central nervous system. The therapy is applied with different intensity and duration over time depending on an individual's motor functioning and effort.

b. **PHYSICAL THERAPY :**

Physical therapy (PT) can help improve muscle strength & coordination, mobility and other physical functions using different sensorimotor techniques. Assistive devices, such as braces, splints, slings can be used to help treat shoulder subluxation to minimize disability and pain. Enhanced physical therapy is the key element for faster recovery. It has introduced behavioral methods to provide motor learning in the patients affected with Hemiplegia. [13]

c. **ELECTRICAL STIMULATION :**

Electrical stimulation has been used in the treatment of hemiplegia to enhance sensory awareness and to strengthen a weakened body part. It improves the range of motion in the paralyzed limbs. This procedure consists of placing small electrical pads or electrodes on the weakened muscles of the affected body part. An electrical stimulus that helps the muscles contract as the patient works to make it move. Electrical stimulation of sensory-motor systems contributes to strengthening of atrophied muscles, changes in the muscle length, type and function, interactions between agonist and antagonist muscles, increasing the range of movement thereby reducing muscle spasticity. [13] Cortical stimulation is a special type of electrical stimulation in which the electrodes are placed on the dura, the tough membrane covering the brain. This method is used for stimulation of the cortex area of the brain while the patient is doing exercises.

d. **PHARMACOLOGICAL:**

Pharmacological Drugs can be used to treat issues related to the Upper Motor Neuron Syndrome that results in paralysis. Drugs like Librium and Valium can use as a relaxant for reducing the muscle tightness. Drugs are also given to individuals who have recurrent seizures, which is separate but related problem after a traumatic brain injury.

e. **SURGERY**

Surgery may be used if the individual develops a secondary issue of contracture, from a lack of muscle activity. The surgeon may cut the ligaments and relieve joint contractures in the limbs. In case of severe attack, Individuals who are unable to swallow may have a tube inserted into the stomach. It allows food to be given directly into the stomach.

f. **MOTOR IMAGERY:**

Motor imagery is the process of imagining the movement of the affected part of the body. This imagination is made as a repetitive mental practice to stimulate the motor areas of the brain. The paralyzed muscles of the body get activated as if the patient is actually doing an activity. The neurons in the brain involved in visualization and physical movement overlaps and forms a connection between them. This technique is highly effective activity for the Hemiplegic patients when it is paired with other therapies.

g. **REHABILITATION:**

The goal of Rehabilitation is to facilitate restoration of patient's prior role in the Activities of Daily Living (ADL) and task performance. This is mainly done with the assistance of physiotherapists and gait rehabilitation devices.[11] In all cases, the major aim is to regain maximum function of the muscles. Both physical and occupational therapy significantly improves the patient's quality of life and make them to survive alone in the society without depending on others.

h. **ROBOT THERAPY:**

Physiotherapy is labor intensive, manual assisted training and therefore training duration is usually limited by personnel shortage and/or exhaustion of therapist. Manually assisted movement training lacks the repeatability and it is less effective. The patient's performance is monitored only by observation. Utilizing robotics to model machines for rehabilitation of the Hemiplegics improves the training sessions, reduces personnel cost by assigning one therapist to train two or more patients. Rehabilitation robots assist in strengthening and restoring functionality of the muscles and they also help in improving coordination of the musculoskeletal system. [9] Robotic assist devices have the potential to deliver high intensity, repetitive therapy for the patients affected with Hemiplegia. [1] Robotic training offers precise controllable assistance or resistance during movements and quantifiable measures of subject performance.[7] Robotic devices can potentially improve the quality of rehabilitative treatment after stroke. [8]

A robot can have control on quantifying the intensity of practice and it also measures the changes in kinematics and forces during the movement. [11] MIT-Manus is a robot designed to provide interactive motor activity for clinical neurological applications. It was used to test the influence of the externally driven impaired limb on the motor recovery of hemiplegics. [13] Robot therapy involves the use of an exoskeleton to help the patient retrain motor coordination by performing well-focused and repetitive practice. The exoskeleton is an assistive device with joints and links corresponding to those of the human body. Robot therapy aims at developing the technologies that can be easily used by patients, therapists, and clinicians. [9]

Junghyeon Choi et al developed a Rehabilitation device with sensors and microcontroller-controlled electro-mechanical actuators. The ASD system can develop patient's muscle by the dynamic balance of training, if they are stimulated from outside or they move themselves. [5]

A powered exoskeleton is a powered mobile machine consisting of an exoskeleton worn by a person and a power supply that supplies activation-energy for limb movement. The powered exoskeleton Re-Walk was developed to have an alternative mobility solution to the wheelchair. It also replaces the rehabilitation treatment for individuals with severe walking impairments. [9]

Thomas G Sugar et al designed an Exoskeleton for Upper extremity rehabilitation was designed and it is named RUPERT (Robot Assisted Upper Extremity Repetitive Therapy). Air muscles are used and are controlled by adjusting the air flow through valves. Position sensors are used to measure the joint rotation and inertial sensors are used to measure the tilting movement. [14]

Figure 2: RUPERT Exoskeleton Design
Courtesy: http://orion.bme.columbia.edu

Surachai Panich designed an exoskeleton for lower limb rehabilitation. The Rehabilitation of the lower limb is complicated and hence its important. It is done to restore the patient's physical, sensory and mental capabilities due to injury, disease or illness. The exoskeleton suit can reduce the time taken for the therapy process for the

patient to be trained by one therapist. [10] The WREX (Wilmington Robotic Exoskeleton Description) structure consists of a two-link exoskeleton that shadows the upper arm and forearm as shown in the figure. [12]

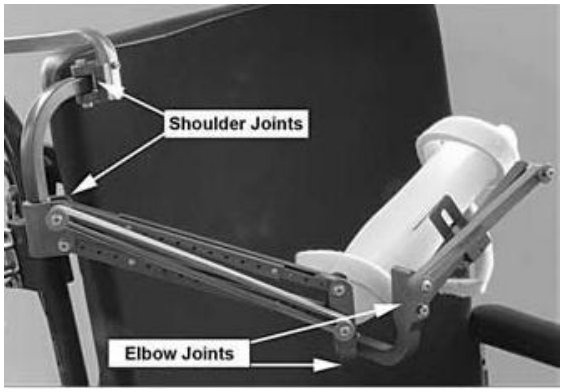

Figure 3: WREX Upper Limb Exoskeleton Design
Courtesy: http://www.rehab.research.va.gov

Colombo et al. at the University Hospital Balgrist (Switzerland) have implemented a robotic Orthosis that can be used to move the legs of spinal cord injury patients during rehabilitation training on a treadmill. [15]

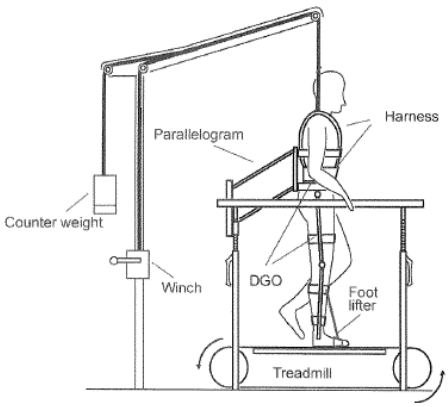

Figure 4: Driven Gait Orthosis (DGO) Lower Limb Exoskeleton Design
Courtesy: http://www.rehab.research.va.gov

The exoskeleton robot, serving as an assistive device, is worn by the human (orthotic) and functions as a human-amplifier. The joints and linkages correspond to those of the human body, and its actuators are placed on portion of the external load with the operator.

The idea was to set the Human Machine Interface (HMI) at the neuromuscular level of the using the body's own neural signals as command signals of the exoskeleton. [16] Robotic rehabilitation has several advantages over conventional

manual rehabilitation. Robotic therapy decreases burden on clinical staff, can assess quantitatively the level of motor recovery and delivers well controlled and repetitive training sessions at reasonable cost. [17]

Figure 5: EXO-UL3 Exoskeleton Design
Courtesy: http://bionics.soe.ucsc.edu

III. ACCESSMENT TOOLS

There are a variety of standardized assessment scales available to physiotherapists and other health care professionals for use in the ongoing evaluation of the status of a patient's hemiplegia. The use of standard assessment scales helps physiotherapists and other health care professionals during the course of their treatment plan to:

- Assign and prioritize the treatment interventions based on the specific motor and sensory deficits.
- Create appropriate goals for treatment based on the results of the scales, their professional expertise and the desires of the patient.
- Evaluate and monitor any changes based on either improving or declining scores.

Some of the most commonly used scales in the assessment of recovery after hemiplegia are as follows:

a. THE FUGL-MEYER ASSESSMENT OF PHYSICAL PERFORMANCE (FMA)

The FMA is often used as a measure of functional or physical impairment following a cerebrovascular accident (CVA). It measures sensory and motor impairment of the upper and lower limbs, balance control in several positions, range of motion, and pain. This test is valid and reliable measure for measuring post-stroke impairments. A lower score in each component of the test indicates higher impairment and a less functional level in that particular area. The maximum score for each of the component is 66 for the upper limb, 34 for the lower limb and 14 for balance**.** Administration of the FMA should be done after reviewing a training manual.

b. THE CHEDOKE-MCMASTER STROKE ASSESSMENT (CMSA)

This test is a reliable measure of two separate components evaluating both motor impairment and disability. The disability inventory can have a maximum score of 100

with 70 from the gross motor index and 30 from the walking index. Each task has a maximum score of seven except for the 2 minute walk test which is out of two. The impairment component of the test is used for the evaluation of the upper and lower limbs, their postural control and pain reduction. The impairment inventory focuses on the seven stages of recovery from stroke from flaccid paralysis to normal motor functioning.

c. THE STROKE REHABILITATION ASSESSMENT OF MOVEMENT (STREAM)

The STREAM consists of 30 test items involving upper-limb, lower-limb and basic mobility. It is the most common clinical measure of voluntary movements and general mobility following a stroke. The voluntary movement is measured using a 3-point ordinal scale and the mobility part of the assessment uses a 4-point ordinal scale. The maximum score one can receive on the STREAM is a 70 (20 for each limb score and 30 for mobility score). The greater the score, the better movement of the limbs and mobility is available for the individual being scored.

IV. CONCLUSION

Treatment of Hemiplegia includes the diagnosis, management and proper care of patients suffering from paralysis to support their Activities of Daily living (ADL). Various treatment approaches have been used in the management of this disorder in recent times. The Success rates of these procedures are, however, relatively low due to the lack of repeatability and intensity.

Rehabilitation devices play a major role in the non surgical management of Hemiplegia. Of all the treatment methodologies involved, the robot therapy was found to be the most effective technique for management of Hemiplegia.

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