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THE LIFTING DEVICE WITH WINCH AND TRAPEZE FOR NEUROLOGY PATIENTS

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ABSTRACT: This paper has presented a lifting device with winch and trapeze for neurology patients. The work is based on design, construction and tests of functional model, which is done for more easy transfer, precocious from position of dorsal in sitting of neurology patients, post-traumatic and post-operator in order to avoid some complications as: pulmonary infections and to accelerate the rehabilitation process. The device is vital for neurology patients with tetraplegic sick.

1. INTRODUCTION

Neurological, orthopedic, post-traumatic, rheumatic affections are representing the most frequent human affections, which cause motor deficits. The precocious transfer from dorsal lying down to sitting positions is essential in the case of neurological, post-traumatic as well as post-operated patients in order to avoid some complications as sores, breathing infections and to accelerate the process of rehabilitation [1]. Mobilization in bed is very important with the patients suffering of spinal cord injury (tetraplegic, paraplegic) or after stroke: somersaulting, turning from dorsal lying down into ventral and lateral one from dorsal lying down in sitting in bed or on the bedside and sitting in a semi-inclined position.

At the beginning, it's recommended to raise the front folding part of the bed and then to use a board progressively inclined towards vertical positions with the tetraplegic or paraplegic patients. One of the first steps in re-educating the paraplegic to sit down is that to prepare and learn how to pass from lying position to that of sitting one at the beginning stretching out the arms (extended sitting) and then sitting with the arms hanging (shorted sitting). In early stages of rehabilitation adaptable equipment [2,3] over the head or grasping handles over the bed can be used (fig.1).

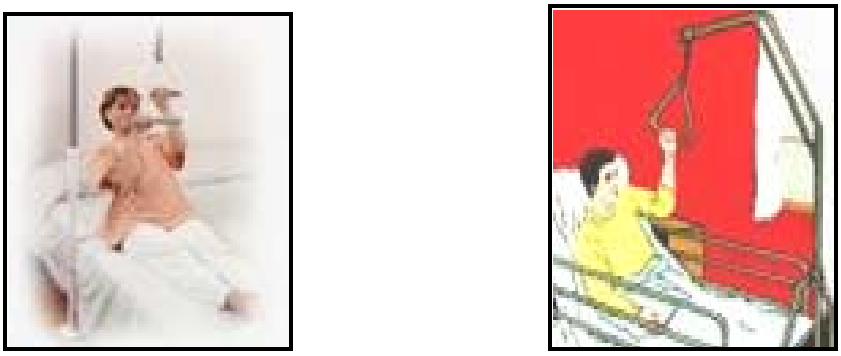

Fig.1. The handle devices of lifting.

Hanging up the paralyzed limps in different positions using different types of pulley allows reducing the gravitation effects, to practice active exercises by the patients with important deficits The most used lifting device are with motor action [6], which is more useful (fig.2).

Fig.2. The lifting device with pulleyes.

In the cases when abdominal and sacro-lumbar musculature shows a deficit it is recommended to use a supporting corset. The patient will use crutches for walking irrespective if the inferior limbs are orthesized or not. Although a lot of paraplegics will be dependent on wheel chair it is recommended to practice ambulance even if in the future it won' be the way the patient moves. The patients suffering of high cervical lesions require a rolling armchair with electrical command (fig.3).

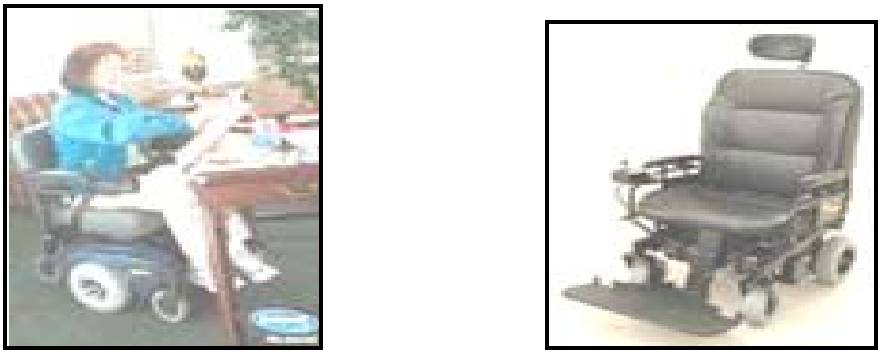

Fig.3. The rolling armchairs.

In the cases of the patients who suffered fractures of the cervical column and which were operated one can use different tip-up or rotate beds to turn the patient even if the skeleton-like-extension is applied on the skull. Stryker bed is made of a frame and two stretches to get the patient in lying down and the other to assure his sitting in lying down, which consists in positioning the patient between two ones after which a spinning movement around a horizontal axe on 180^0 will get him in the desired position (fig.4).

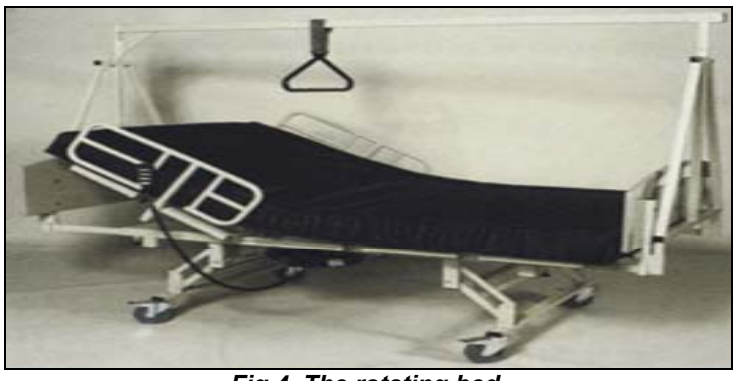

Fig.4. The rotating bed.

A circular Stryker bed supplied with an electric engine is used recently. More practical is Guttmann type bed, a dihedral bed which can be rolled to right-left allowing the patient's changing to the desired position with minimum manipulation. The positions in dorsal lying down, right and left flank can be achieved with Guttmann bed avoiding the appearance of the sores. Gendron Maxi Rest bed represents a modern option to the transfer the neurological post-traumatic and post-operated patients from dorsal lying down in semi-inclined sitting and after that in sitting.

2. LIFTING DEVICE

The apparatus of lifting device for neurological patients is a great social human interest theme, which solves the problem of partial movement of the paralyzed human body as the precocious transfer from the especial dorsal position to essential sitting with neurological post-traumatic and post-operated patients. This device is recommended to be used when the hands and the arms have no power to perform the operation of transfer from the dorsal lying down position to that of sitting. The device can be used for rehabilitation the inclination movements of the body as well as the extension of the arms beyond the normal limits (fig. 5). It's interesting to take in vie the possibility to roll the body parts by turning movements followed or not by movements of the feet. The rolling is achieved by the deviation of the shoulders in comparison with the hips.

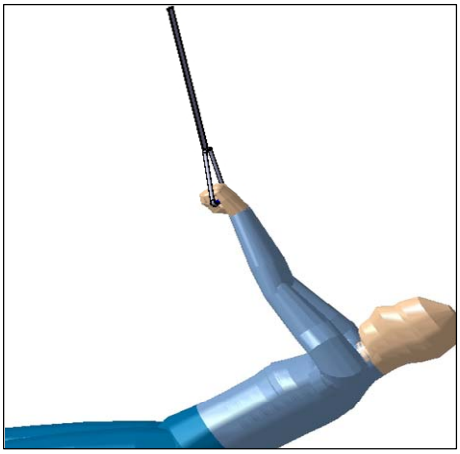

Fig.5. The partial lifting.

In order to use body lifting device with remote control and trapeze the patients should have the possibility of body moving vertically up and down and horizontally from one part to another using as pivot the back-head. The patients should also have the possibility to use the hand for applying a pressure. This device needs the participation of eyes and hands with a physical control and intellectual concentration.

The important movements are: turn the head, visualize the remote control and the trapeze, stretch out a hand, catch the trapeze and press, stretch out the other hand, catch the remote control, press the buttons, start the drum, stop it, detach and leave it. For the lifting movement it's important to consider the time necessary for lifting the body and the lifting velocity which should be taken as to avoid the phenomenon of standing hypo-pressure and the dislocation of the humeral body with paralyzed bronchial plexus. The time for body lifting should be between 10-20 seconds and the lifting speed not more than 0.05 m/s.

The lifting device realized by authors (fig.6 and fig. 7) should have a weight sensor and the run should be limited when the trapeze is dropped, the wrapping up of the lifting and moving down strap on the tambour is stopped. The lifting device according to the theme consists of one fixed frame – *1,* which are attached tot the extremities of the bed on which a shaped bar is fixed – *2,* which can be moved on the widths of the bed and fixed in the desired position by a clamping screw – *4.* On the bar – *2*, which is a rolling way, a winch – *3* is fixed, which can be moved and positioned in the desired place. The winch – *3* consists of an electrical motor of direct current – *5*, coupled to a speed-reducing worm gear – *6*, a coupling – *7*, a reducing gear – *8* with cylindrical teeth united to a drum – *9*, on which a wide belt is wrapped – *10*, to which is attached a catching trapeze– *11,* that ensures a good grip with palm, having a high friction ratio of material. There are two limitation drives- *13* on a screw – *12*, united to the drum axle – *9,* which act upon some micro-switches - 14 in order to limit the run. A weight sensor allows – *15,* ensures the device uncoupling and stopping the belt moving when the trapeze is dropped from hand.

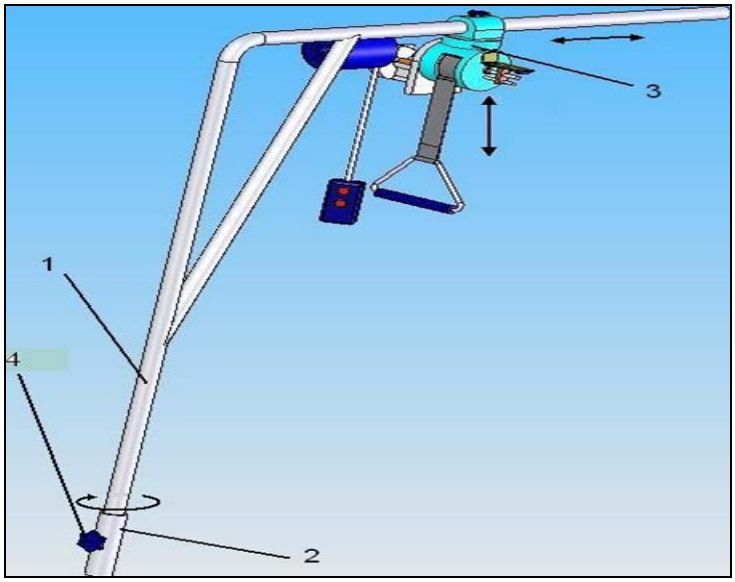

Fig.6. The block scheme of lifting device.

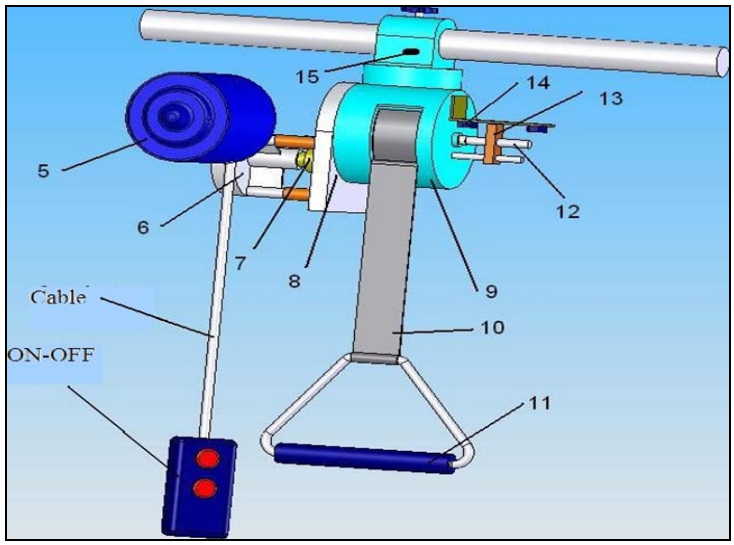

Fig.7. The winch with trapeze.

The kinematics scheme of the lifting winch is presented in fig. 8.

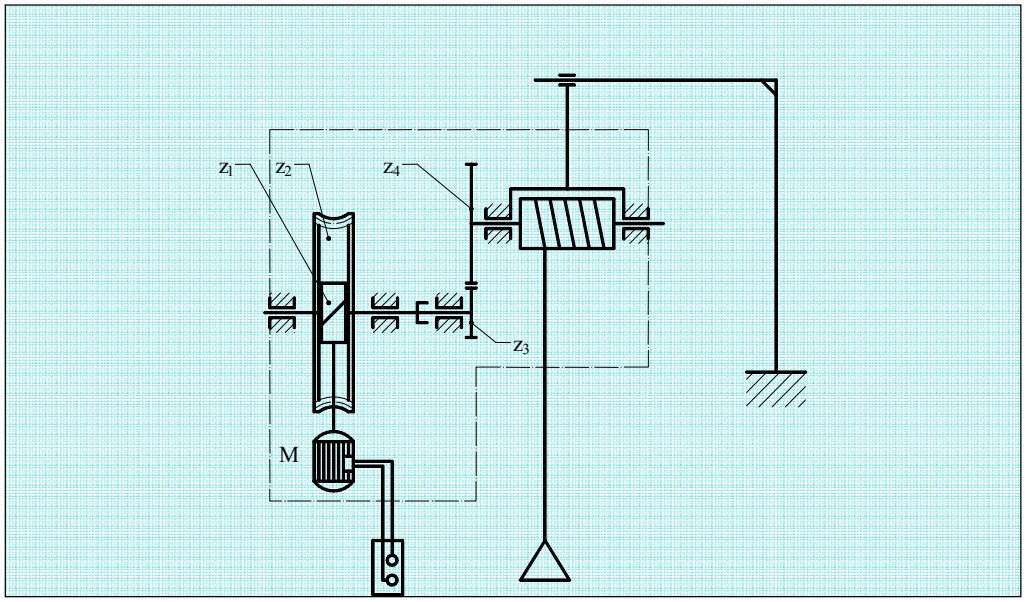

Fig.8.Kinematic scheme of winch.

The ratio transmission gear-*i* is:

$$i = i_{12} \cdot i_{34} \cdot i_5 \tag{1}$$

$$i_{12} = \frac{2\pi \cdot R_c \cdot 1/i}{p} \tag{2}$$

$$i_{34} = \frac{z_3}{z_4} \tag{3}$$

The electrical block diagrame of winch is showed in fig.9.

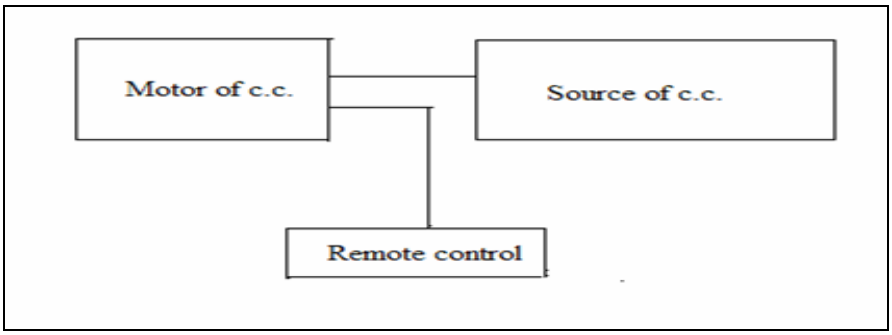

Fig.9. The electrical block diagrame of winch.

The characteristic parameters of the winch are:

- nominal charge load = 900 – 1800 N;
- maximum weight = 180 – 200 kg;
- upper limit of raising = 500 mm;
- useful working run = 300 mm;
- action and electrical command.

This medical device has been realized by a mixed research team formed from professor's engineers and doctors. The experiments and testing the prototype include the following activities:

- assembling the apparatus at the legs of the bed or on the right-left flank;
- instructing and informing the patient about the characteristics and the way the device works;
- measuring the pulse, heart rhythm, blood pressure (before lifting);
- monitoring the symptoms of the patient;
- assembling the orthopedic corset of lombo-standing or waist for avoiding hypotension arterial of orthostatic and for raising inferior trunk stability;
- catching the trapeze of the device by the patient;
- lifting the patient in the sitting and semi-inclined position-extended sitting or shorted sitting with a speed of 0.05 m/s;
- measuring the heart parameter and monitoring the symptoms in sitting positions;
- the patient's coming back at the lying position.

The results of exprimental tests were very well which recommmend this device for using in hospiatal for neurologic patients with mortor disabilities.

3. CONCLUSIONS

The device has presented by authors represented an experimental model of lifting device for patients with vertebro-medullary traumas, tetraplegias or paraplegias unmovable in bed, which is helping at transfer from dorsal decubitus into ventral and lateral one, and from dorsal in sitting down of bed or edge bed in semi-inclined sitting position. The relevance of this device is realized by association of reduction gear devices of simple transmission ratio with electro-motor of low power and c.c., winch, belt and trapeze, which their combination ensures an easy lifting of 180-200 kg weight, at height of 0.5 m has assured a lifting speed more less that 0.05m/s.

Such as well-known device from international level, this device used in kinetotherapy has a simple construction with reduce size and good price versus, being easy to fix at hospital bed.

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