Letter to Editor

Designing and Manufacturing of Upper Limb Lifting Orthosis (Kayer)

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The upper limb plays a crucial role in daily life activities, self-care, work, leisure, and social activities. It enables a person to perform essential tasks, such as eating, drinking, writing and searching the environment, leading to increased cognition and intelligence in children [1]. Various disorders in children (for instance, Erb palsy, cerebral palsy, hemiplegia, muscular dystrophy, neuropathy) and adults (such as stroke and central, and peripheral nerve damage) can affect the functioning of the upper limb. While mobility aids exist for individuals with lower limb disabilities, there is a lack of suitable technical solutions for those with upper limb disorders because of structural and joint complications. Minimum muscle strength, at level 3 or higher, is necessary for limb movement, and this strength can be affected by neurological and musculoskeletal disorders, resulting in a limited range of motion or no movement [2].

In rehabilitation, the primary goal is to restore movement function, as improving upper limb movement leads to greater independence in daily life activities and reduces the need for constant care. The use of assistive devices can facilitate limb movement in individuals who cannot move their upper limbs, and not using such aids leads to various issues including the inability to perform normal activities, lack of improvement in upper limb function, increased pain, restricted shoulder range of motion, unwanted movement, and vulnerability to re-injury [3]. Upper limb orthoses are external devices used to restore or improve the functional and structural features of the musculoskeletal and nervous systems. They can stabilize fracture sites or unstable joints, immobilize joints to promote healing, correct joint contraction and dislocation, prevent scar tissue formation, maintain joint alignment, facilitate joint movement, and reduce muscle tone in spastic muscles [4].

Unlike static orthoses, dynamic/applied orthoses allow movement due to their specific characteristics. They are primarily used to assist weak muscles and some have a dual mechanism to prevent soft tissue injuries. While electric forces (battery-powered) are used in some lower limb orthoses in Iran, functional upper limb orthoses are not available. There is only one known example made by Professor Vorobyev et al. in Russia, which utilizes residual muscle force to move the upper limb [5-7]. Therefore, this study designs and manufactures an upper limb

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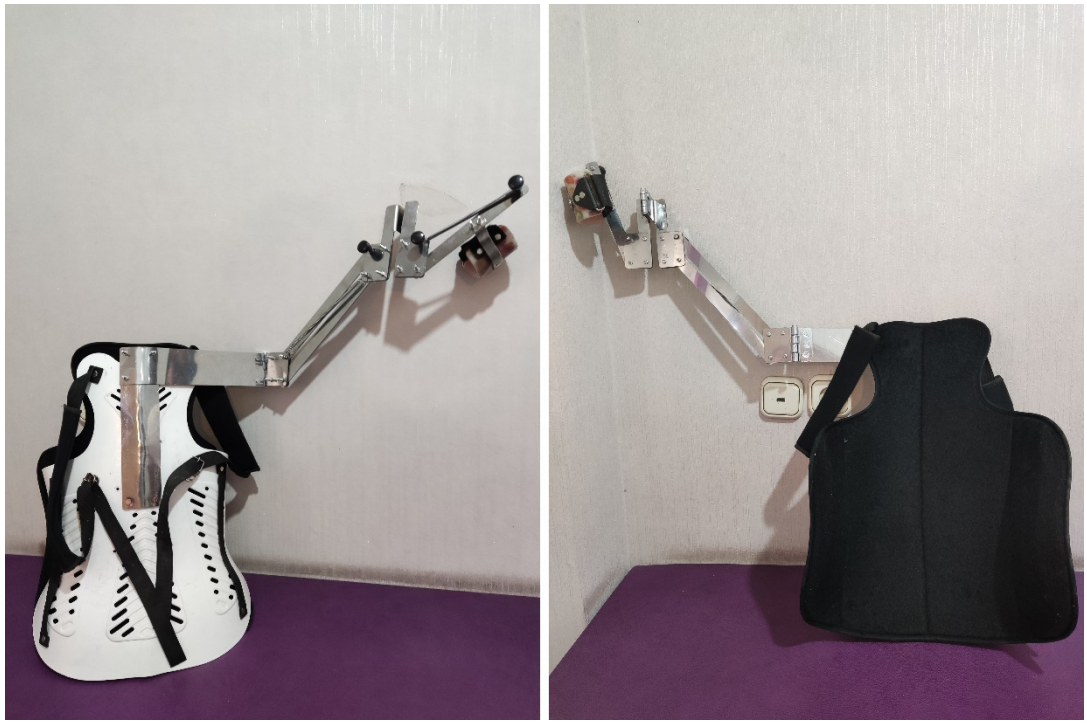

Figure 1. Kayer: Upper limb lifting orthosis

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orthosis capable of lifting and moving the limb with no electrical driving force, solely relying on the remaining muscle strength in other muscles or the trunk muscles. This orthosis facilitates flexion and abduction movements of the shoulder joint, allowing the wrist to be in the extension position and the elbow to be in the flexion position during shoulder flexion.

The upper limb lifting orthosis, named "Kayer" (Figure 1), is constructed using thermoplastics with low temperatures along with other readily available materials, such as plaster, metal, tape, and glue. Its utilization can reduce rehabilitation costs and the need for frequent visits to rehabilitation clinics for individuals and their caregivers. Additionally, Kayer does not require complex maintenance or repairs, as any necessary maintenance is minimal. The advantages and innovative aspects of this orthosis include the absence of electric power (battery) in upper limb movement, its lightweight design facilitating movement, increased range of movement in different directions, and its high acceptability among children.

The process of designing and manufacturing Kayer involved the following stages:

Reviewing sources and finding similar designs, followed by an initial design using computer software and the creation of preliminary models using available materials; testing the initial models on individuals, addressing functionality and material-related issues that emerged; conducting tests on children and adults with disabilities using the initial model, resolving any observed problems related to functionality and materials.

Through the development and utilization of Kayer, individuals with upper limb disorders might regain independence in daily activities, enhancing their quality of life and reducing the burden of care.

Kayer employs the following quality control methods:

Assessing patient satisfaction with orthosis; Evaluating the range of motion achieved during treatment sessions; analyzing the daily performance of patients both with and without orthosis.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of the Mazandaran University of Medical Sciences (Code: IR.MAZUMS.REC.1402.094).

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