Innovative Approaches to Hand Rehabilitation: A Comparative Study of Traditional and Customized Peg Boards with Wrist Support

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ABSTRACT:

INTRODUCTION- Individuals with wrist and hand dysfunction often face challenges in performing daily tasks that require fine motor skills. Traditional rehabilitation tools, such as peg boards, have been widely used, but the need for personalized and supportive interventions persists. In response to this, a novel workstation incorporating an adjustable peg board with wrist support has been designed. This workstation aims to provide a more tailored and supportive environment for rehabilitation, addressing the specific needs of individuals with wrist and hand dysfunction.

AIMS -The primary objective of this study is to assess the impact of the newly designed workstation on user satisfaction in comparison to the traditional peg board. The aims include:

To design an adjustable peg board workstation with wrist support.
To compare user satisfaction levels between the newly designed workstation and the traditional peg board.

METHOD- The workstation was designed & prototype was developed. 12 stroke subjects were recruited based on selection criteria. All subjects were trained to use workstation for 3 days and then ask to rate Quebec user satisfaction with assistive device 2.0. Same subjects were asked to use traditional peg board for 3 days then ask to rate Quebec user satisfaction with assistive device 2.0.

RESULTS- Mean score for 8 components involving design was analyzed for both workstation & traditional peg board & then between group comparison was done for all 8 components using Mann Whitney U test. For all components except adjustment & simplicity to use users were more stratified with workstation then traditional peg board.

CONCLUSION- Workstations offer superior support for gripping activities in stroke rehabilitation compared to traditional peg boards. With features like adjustable heights and wrist support, they cater to patients' unique needs, enhancing independence and rehabilitation outcomes.

1. Introduction

A stroke is described by the World Health Organization (WHO) as "a clinical illness defined by rapidly evolving clinical symptoms and/or indicators of localized and sporadically widespread loss of brain function, with symptoms lasting longer than 24 hours or leading to death, with no evident cause other than that of vascular origin." [1,2]

Stroke is the main etiology of disability and the next leading etiology of death in developed countries[3] it makes an important concern not only for the physiotherapists but for the entire rehabilitation team.

Crude incidence of stroke ranged from 108 to 172/100,000 people per year, crude prevalence from 26 to 757/100,000 people per year [4]

Contralateral hemiparesis is one of the most frequent effects. The bodily side opposite the damaged brain hemisphere experiences weakness. Limbs, particularly the hands, are the most affected areas of the body. During the acute phase, the muscles of the limbs are flaccid (lose

their tone). The muscle activity changes throughout the course of a few days or weeks. Some temporarily altered nerve fibers recover their functions, and the paralysis stabilizes only in the affected body parts. At the same time, the muscles move from flaccidity to spasticity. Twitchell demonstrated that motor recovery starts immediately after the stroke and follows a foreseeable pattern. These stages have been empirically described by brunnstrom. A post-stroke patient can progress from flaccidity to full recovery moving through different levels of spasticity. However, not the totality of patients reaches the full-recovery stage.[5,6]

Only 10-15% of the stroke survivors regain complete functional use in the Activities of Daily Life (ADL) within six months after stroke.[7]The remaining proportion of the stroke survivors often need support from both formal and informal carers to get around ADL restrictions. 30% of hemiplegic stroke patients still lack the ability to move their arms and hands six months after the stroke began. This situation is consistent with considerable damage to the corticospinal tract which unable the patient to perform basic hand movements such as cylindrical and pinch grasps movements.[8]Prolonged non-use of the hand in daily life resulting from the decreased hand function might limit the independence even more.[9] To regain dexterity, post-stroke patients must undertake as soon as their conditions have been stabilized a rehabilitative therapy. To promote use of the hand, intensive use of the affected hand by means of repetitive, task-specific therapy based on the essential principles of motor relearning is suggested.[10-12]

It can be a long process that usually requires the patient to periodically and frequently perform exercises in the rehabilitative clinic. It has a high social and economic impact on the patient and their family. Long-term, it may result in the therapy being stopped. Moving the rehabilitation to the patient's home, when possible, could allow greater flexibility and increase the patient's sense of Autonomy.[13] Traditional peg boards are used in grasp and release activities. This device helps for providing repetitive exercise. Traditional peg board have lack of wrist support & customization so it makes difficult for the patient to perform isolated movements.

2. Objectives

The primary objective of this study is to assess the impact of the newly designed workstation with wrist support on user satisfaction in comparison to the traditional peg board. The aims include:

- ✓ To design an adjustable peg board workstation with wrist support.
- ✓ To analyse the effectiveness of the workstation in enhancing user satisfaction.
- ✓ To compare user satisfaction levels between the newly designed workstation and the traditional peg board.

3. Method

Design of workstation was finalized after expert onions from neuro physicians, physiotherapists, Patients, Family. Prototype was developed based on the design. Twelve subjects were selected according to selection criteria by convenient sampling to compare user satisfaction with newly developed workstation & traditional peg board. Institutionally approved Inform Consent was taken from the all subjects.

Subjects were selected based on bellow mentioned criteria

Inclusion Criteria: [15]

1.Patients with > 3 months post-stroke duration.[15]

2.Age - 40 to 65 years. [15]

3.Mini mental status examination score- >24 [15]

4.Skin intact on hemi paretic arm [15]

5.Medically stable [15]

Exclusion Criteria: [14]

1.Modified Asworth Scale (MAS) ≥ 3 [14]

2.Other acute injuries to arms or hands [14]

3.Intramuscular Botox injections in any upper extremity muscle in the last 3 months [14]

4.Patients with cardiac pacemaker [14]

5.Stroke subjects who are not cooperative [14]

6.Stroke subjects who have auditory &/or visual deficits [14]

7.Stroke subjects who do not have proper medical history [14]

8.Patients having another neurological deficit with strok[e14]

All subjects were trained to use workstation for 3 days and then ask to rate Quebec user satisfaction with assistive device 2.0. Same subjects were asked to use traditional peg board for 3 days then ask to rate 1 to 8 components of Quebec user satisfaction with assistive device 2.0.

4. Results

Statistical Package for Social Sciences (SPSS) version 21.0 for windows was used for statistical analysis. Mean score for 8 components involving design was analyzed for both workstation & traditional peg board & then comparison between workstation & traditional peg board for 8 components QUEST 2.0 score was done using Mann Whitney U test.

Table 1 shows significance of comparison between workstation & traditional peg board for 8 components of QUEST 2.0 score.

Sr No	Components of QUEST 2.0	Remarks
1	DIMENSIONS	0.00 (Significant)
2	WEIGHT	0.00 (Significant)
3	ADJUSTMENTS	4.5 (Not significant)
4	SAFE	0.00 (Significant)
5	DURABILITY	0.00 (Significant)
6	SIMPLICITY TO USE	3.0 (Not significant)
7	COMFORT	0.00 (Significant)
8	EFFECTIVENESS	0.00 (Significant)
9-12	SERVICE	NA

In between workstation & traditional peg board for all components (Dimensions, weight, Safe, Durability, Comfort & Effectiveness) except adjustment & simplicity to use users were more stratified with workstation then traditional peg board.

5. Discussion

The results of this study provide valuable insights into the effectiveness and user preferences regarding workstations versus traditional peg boards for assisting stroke patients with gripping activities. Utilizing the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0) scale, which assesses various dimensions including dimensions, weight, safety, durability, comfort, and effectiveness, it was evident that participants favoured the workstation over the traditional peg board across most criteria, with exceptions noted in adjustment and simplicity of use. [16]

One of the significant findings of this study is the superior performance of workstations in facilitating gripping activities for stroke patients, particularly those grappling with spasticity and weakness. Stroke patients often encounter challenges in executing grasp and release activities due to muscle stiffness and weakness, which hinder isolated movements. The workstation, equipped with adjustable heights and wrist support, addresses these specific needs by providing a stable platform for patients to engage in isolated movements effectively.

The inclusion of wrist support in the workstation design is particularly noteworthy as stroke patients commonly experience difficulties in wrist control, impacting their ability to perform daily activities. By providing additional support to the wrist, the workstation mitigates these challenges, allowing patients to engage in gripping activities with greater ease and precision. This aligns with occupational therapy principles emphasizing the importance of adaptive equipment in promoting functional independence and rehabilitation.

Furthermore, the adjustable height feature of the workstation adds versatility, accommodating patients of varying heights and preferences. This adaptability ensures optimal ergonomics and comfort, crucial factors in enhancing user satisfaction and compliance with assistive devices. Customization options empower users to tailor the workstation to their individual needs, fostering a sense of autonomy and engagement with the rehabilitation process.

The preference for workstations over traditional peg boards highlights the importance of incorporating innovative design elements and ergonomic features in assistive devices for stroke rehabilitation. While traditional peg boards may offer simplicity in design and adjustment, they often lack the specialized support and customization necessary for addressing the complex needs of stroke patients. Workstations provide a comprehensive solution that not only facilitates gripping activities but also promotes functional recovery and independence.

Limitations of this study include the relatively small sample size and potential participant response bias. Future research with larger sample sizes and longitudinal designs would validate the effectiveness and long-term impact of workstations in stroke rehabilitation.

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