THE EFFICACY OF ROBOTIC-ASSISTED REHABILITATION FOR PATIENTS WITH SPINAL CORD INJURIES

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ABSTRACT

BACKGROUND: Spinal Cord Injuries (SCIs) can cause severe disability, impacting patients' quality of life and functional independence. Robotic-assisted rehabilitation has been gaining attention as a promising strategy to promote motor recovery in SCI patients, although the extent of its efficacy requires further exploration.

OBJECTIVE: This study aimed to investigate the efficacy of robotic-assisted rehabilitation in improving functional mobility, upper limb function, and quality of life in patients with SCIs.

METHODS: In this randomized controlled trial, 80 patients with SCIs were assigned to either a robotic-assisted rehabilitation group or a traditional therapy group. Interventions were conducted for six weeks, and outcome measures tools used were SCQOL (spinal cord injury quality of life Questionnaire), GRASSP (Graded Redefined Assessment of Strength, Sensibility and Prehension) and SCIM (Spinal Cord Independence Measure).

RESULTS: Both groups showed improvements from baseline to post-intervention, but the robotic-assisted group showed significantly greater improvements in all outcome measures.

CONCLUSION: Robotic-assisted rehabilitation appears to be a promising intervention for improving functional outcomes and quality of life in patients with SCIs.

KEYWORDS: Spinal Cord Injuries, Robotic-Assisted Rehabilitation, Quality Of Life, Functional Mobility, Upper Limb Function, Randomized Controlled Trial.

INTRODUCTION

Spinal cord injuries (SCIs) represent a significant cause of disability globally, profoundly affecting an individual's quality of life and imposing substantial societal economic burden. Rehabilitation for individuals with SCIs is a complex, multifaceted process aimed at maximizing functional independence, enhancing quality of life, and facilitating community reintegration(1, 2). In recent years, robotic-assisted rehabilitation has emerged as a promising approach to augment traditional therapeutic strategies for these individuals.(3, 4)

Robotic-assisted rehabilitation devices offer several advantages, including the ability to provide high-intensity, repetitive, task-specific, and interactive therapeutic interventions, which are fundamental for neural plasticity and functional recovery after SCI(5, 6). Robotic devices can deliver consistent therapy, reduce the physical burden on therapists, provide quantitative feedback, and facilitate intensive and task-specific training.(7, 8)

The effectiveness of robotic-assisted rehabilitation for spinal cord injury patients has been investigated in a number of researches.(9-11) People who underwent conventional physical therapy in addition to robotic-assisted gait training displayed greater walking distance and pace than those who received only conventional therapy(12, 13). A study conducted in the same year indicated that individuals with cervical spinal cord

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injuries can improve their arm function through the use of robotic-assisted upper limb training.(14-16)

Nevertheless, clinical effectiveness and acceptance of robotic devices for SCI rehabilitation depend on various factors, including the patient's injury level and severity, the type and design of the robotic device, and the integration of the robotic device into a comprehensive rehabilitation program.(17-19) Therefore, additional high-quality research is warranted to understand better the best utilization of this technology in SCI rehabilitation.(20-22)

MATERIALS & METHODS

STUDY DESIGN

This study employed a randomized controlled trial design to assess the efficacy of robotic-assisted rehabilitation in patients with spinal cord injuries (SCIs).

PARTICIPANTS

A total of 80 patients diagnosed with SCIs (40 cervical, 40 thoracic) from a regional rehabilitation center were recruited for this study. The patients were aged between 18 and 65 years and had an SCI duration of at least six months.(23, 24)

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria were: diagnosis of SCI (ASIA Impairment Scale A-C), stable medical condition, ability to understand and follow instructions, and ability to tolerate a one-hour therapy session. Exclusion criteria included: significant lower extremity contractures inhibiting robotic device use, pressure sores, fractures or other conditions contraindicating physical therapy, or severe cognitive or communicative impairments.(25, 26)

DATA COLLECTION PROCEDURE

Every one of the forty people who took part in the study was placed in either the conventional physical therapy group or the robotics-assisted rehabilitation group based on a random assignment. One hour of each of the interventions was carried out every day, five days a week, for a total of six weeks. In the robotically assisted group, patients worked on strengthening their upper and lower limbs while wearing an exoskeleton. In the conventional therapy group, patients underwent traditional physiotherapy. The Spinal Cord Independence Measure (SCIM) and the Graded Redefined Assessment of Strength, Sensibility, and Prehension (GRASSP) were used, respectively, to measure functional mobility and upper limb function. In order to assess quality of life as one of the secondary outcomes, the Spinal Cord Quality of Life Questionnaire (SCQOL) was filled out by the participants. The first evaluations as well as the final evaluations were carried out by the evaluators without them being aware of the group designations.

DATA ANALYSIS

For the purpose of data analysis, SPSS 25 was applied. for analysing the differences that existed within groups, paired t-tests were utilised, whilst independent t-tests were utilised for analysing the differences that existed between groups. It was assessed, with the use of Cohen's d, how significant the influence was. When the p-value for a hypothesis is lower than 0.05, statistical significance can be inferred from the data.

ETHICAL CONSIDERATION

The study was given the green light by the regional ethics committee since it was in line with the principles outlined in the Helsinki Declaration. Before taking part in the study, each participant was required to fill out and sign a consent form. During the entirety of the investigation, every precaution was taken to shield the identity of the participants and maintain their confidentiality.

RESULTS

DEMOGRAPHICS

The study sample consisted of 80 patients, equally divided into two groups: Robotic-assisted rehabilitation group (n=40) and traditional therapy group (n=40). The average age of patients was 43.7±12.4 years. In terms of SCI level, 50% (n=40) had a cervical level injury, while 50% (n=40) had a thoracic level injury.

PRE-AND POST-TREATMENT OUTCOME VARIABLES

Both groups showed improvement from baseline to post-intervention. However, the robotic-assisted rehabilitation group showed significantly greater improvements in functional mobility (SCIM scores) and upper limb function (GRASSP scores) than the traditional therapy group (p<0.05). There were also significant improvements in quality of life (SCQOL scores) in the robotic-assisted group compared to the traditional therapy group (p<0.05).

Tables

Table 1: Demographic Characteristics

	Robotic-Assisted Rehabilitation	Traditional Therapy
Total Patients	40	40
Gender (Male/Female)	26/14	24/16
Average Age (years)	44.2±11.7	43.1±13.2

SCI Level (Cervical/Thoracic)	20/20	20/20

Table 2: Outcome Measures

	Robotic-Assisted Rehabilitation (Pre/Post)	Traditional Therapy (Pre/Post)	P-value
SCIM	34.5±7.2/49.3±8.9	35.1±7.1/42.8±7.8	<0.05
GRASSP	30.2±6.1/38.1±7.4	30.7±6.2/34.5±6.7	<0.05
SCQOL	45.1±9.6/56.2±10.7	45.7±9.2/50.8±10.1	<0.05

The data suggest that robotic-assisted rehabilitation can contribute to significant improvements in functional mobility, upper limb function, and quality of life in patients with spinal cord injuries.

DISCUSSION

The purpose of this research was to ascertain whether or not robotic-assisted therapy is effective in improving the functional outcomes of patients who have had spinal cord injuries. According to the data, patients in the robotic-assisted therapy group improved more in terms of quality of life, functional mobility, and upper limb function than those in the standard therapy group.(27)

Our findings corroborate previous research suggesting that robotic-assisted rehabilitation is more advantageous for SCI patients(28). Author found that robotic-assisted rehabilitation improved motor function in SCI patients relative to conventional therapy. The purpose of this research was to ascertain whether or not robotic-assisted therapy is effective in improving the functional outcomes of patients who have had spinal cord injuries.(29)

Importantly, the improvements in functional outcomes were accompanied by significant enhancements in quality of life, indicating that the benefits of robotic-assisted rehabilitation extend beyond physical function and impact broader psychosocial aspects of recovery.(30)

CONCLUSION

The findings suggest that robotic-assisted rehabilitation is a promising intervention for patients with SCIs. However, more research with larger sample sizes and long-term follow-ups is needed to fully understand the potential and the most effective utilization of this technology.

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