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Clinical Research

Effectiveness of Locomat Therapy in Neurological Rehabilitation

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ABSTRACT

Objective: To retrospectively analyze the demographic characteristics of patients receiving robotic rehabilitation treatment and examine various parameters such as walking distance, speed, and time before and after treatment.

Material and Method: Between 2019 and 2021, 136 patients who received robotic rehabilitation therapy were analyzed. 136 patients were divided into 3 groups-hemiplegia, cerebral palsy, and spinal cord injury groups. Walking distance, speed and time recorded in the Lokomat device on the first and last day of treatment were recorded.

Results: Of the 136 patients, 62 were male (45.5%) and 74 (54.5%) were female. The number of patients treated with hemiplegia, cerebral palsy and spinal cord injury was 46 (33.8%), 30 (22%) and 60 (44.1%), respectively. In all the three diagnostic groups, a significant increase was observed in the walking time, distance, and speed recorded in the Lokomat device on the first and last day of treatment ($p < 0.001$). No significant difference was observed between the groups in terms of walking parameters ($p > 0.05$).

Conclusion: We believe that this treatment approach is effective in the neurological rehabilitation group.

Keywords: *Neurological Rehabilitation, Lokomat, Paraplegia, Hemiplegia, Cerebral Palsy.*

ÖZ

Nörolojik Rehabilitasyonda Lokomat Tedavisinin Etkinliği

Amaç: Robotik rehabilitasyon tedavisi alan hastaların demografik özelliklerini geriye dönük olarak incelemek ve tedavi öncesi ve sonrası yürüme mesafesi, hız, süre gibi çeşitli parametreleri incelemek.

Gereç ve Yöntem: 2019-2021 yılları arasında robotik rehabilitasyon tedavisi alan 136 hasta analiz edildi. Yüzotuzaltı hasta hemipleji, serebral palsi ve omurilik yaralanması grupları olmak üzere 3 gruba ayrıldı. Tedavinin ilk ve son gününde Lokomat cihazında kaydedilen yürüme mesafesi, hız ve süre kaydedildi.

Bulgular: Çalışmada yer alan 136 hastanın 62'si (%45.5) erkek, 74'ü (%54.5) kadındı. Hemipleji, serebral palsi ve omurilik yaralanması ile tedavi edilen hasta sayısı sırasıyla 46 (%33.8), 30 (%22) ve 60 (%44.1) bulundu. Her üç tanı grubunda da tedavinin ilk ve son gününde Lokomat cihazında kaydedilen yürüme süresi, mesafesi ve hızında anlamlı artış gözlendi ($p < 0,001$). Yürüme parametreleri açısından ise gruplar arasında anlamlı fark gözlenmedi ($p > 0.05$).

Sonuç: Bu tedavi yaklaşımının, nörolojik rehabilitasyon grubunda etkili olduğuna inanıyoruz.

Anahtar Sözcükler: *Nörolojik Rehabilitasyon, Lokomat, Parapleji, Hemipleji, Serebral Palsi.*

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The health profile worldwide is changing rapidly. As life expectancy increases, the rate of noncommunicable diseases, especially those affecting the musculoskeletal system, increases substantially, requiring health systems that better support individuals in maintaining their functional health status and quality of life. The need for rehabilitation services is increasing in parallel with the increasing burden of these diseases, especially the burden of disability.

The World Health Organization defines rehabilitation in general as all the measures that aim at reducing the effects of disability in individuals and the disability itself and ensure the social integration of individuals (1). Through "Rehabilitasyon 2030: Call for Action" (February 6-7, 2017; Geneva; Switzerland), the World Health Organization stated that rehabilitation services in health systems are a fundamental component of care and that all health systems must be quickly adapted to support the declining quality of life that is inversely proportional to the rapidly increasing life expectancy (1, 2). In line with this requirement, assistive technologies aimed at promoting or maintaining the well-being of individuals by improving their functional independence (3).

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Neuroplasticity is the underlying mechanism that leads to the improvement of functional outcome after neurological injury (4). Therefore, an important purpose of neurological rehabilitation is the effective use of neuroplasticity for functional recovery. Other principles of neurological rehabilitation include target setting, high-intensity application, multidisciplinary team care, and mission-specific training. These requirements make neurological rehabilitation a highly laborious, time-consuming, and intensive process (3).

Robot technology has advanced remarkably in recent years with the development of faster and more powerful computers and new computational approaches as well as electromechanical components with greater complexity (5). This advance in technology has made it possible to employ robots in rehabilitation intervention. A robot is defined as a reprogrammable, multifunctional manipulator designed to move materials, parts, or special devices using variable programmed movements to perform a task (6). The most important advantage of using robot technology in rehabilitation intervention is high dose and high-intensity training (7). This makes robotic therapy a promising new technology for the rehabilitation of patients with motor disorders. Research on rehabilitation robotics is increasing rapidly, and the number of therapeutic rehabilitation robots has increased substantially in the last two decades (8). Lokomat therapy is administered to patients who need a versatile neurological rehabilitation (9-11). However, enough data is not available to suggest that Lokomat therapy is superior to the conventional physical therapy program.

In this study, we aimed to retrospectively analyze and examine the demographic characteristics of patients with hemiplegia, cerebral palsy and spinal cord injury who received robotic rehabilitation treatment in the physical therapy and rehabilitation clinic of our hospital between the years 2019-2021, various clinical parameters before and after the treatment, and the effectiveness of the treatment.

MATERIAL AND METHOD

The study is planned in the form of retrospective file scanning. After obtaining permission from the hospital management for file screening, the approval of the Ethics Committee was obtained (approval number: 2021/12/28) and necessary information was collected from the hospital data. The study was conducted in accordance to the “Helsinki Declaration.” For three years (January 01, 2019-December 31, 2021), the files of patients undergoing robotic rehabilitation treatment (Lokomat®Pro Hocoma AG, Switzerland, www.hocoma.com) (Figure 1), in our hospital were retrospectively scanned, data was collected, and 156 patients were retrospectively examined.

Figure 1. *Lokomat robot used in neurological rehabilitation.*

Patients who did not complete 20 sessions of treatment for any reason were excluded from the study, resulting in a total study population of 136 patients. The age, gender, and diagnosis of the patients were recorded.

Based on their diagnosis, the patients were divided into the following three groups: hemiplegia, cerebral palsy, and spinal cord injury groups. Walking distance, speed, and time that the patients were able to achieve on the first and last day of Lokomat treatment were recorded on the device, and the data were compared between the groups.

Statistical Evaluation

Statistical analyzes were made with SPSS 21.0 package program. Data are expressed as mean, standard deviation, and percentage (%). In the descriptive statistics of the data, mean, standard deviation, median minimum, maximum, frequency and ratio values were used. The distribution of variables was measured with the Kolmogorov-Smirnov test. The mann-whitney u test was used in the analysis of quantitative independent data. Chi-square test was used in the analysis of qualitative independent data, and fischer test was used when the chi-square test conditions were not met.

RESULTS

Of the 136 patients, 62 were male (45.5%) and 74 (54.5%) were female. The number of patients treated with hemiplegia was 46 (33.8%), cerebral palsy was 30 (22%), and spinal cord injury was 60 (44.1%).

In the group treated for hemiplegia, the average walking time that could be tolerated by the patients on the first day of treatment was 27.35 ± 6.6 min, whereas on the last day of treatment it was 38.17 ± 8.5 min. In the group treated for cerebral palsy, the average walking time on the first day of treatment was 28.8 ± 6.95 min, whereas on the last day of treatment it was 43.2 ±6.07 min. In the group treated for spinal cord injury, the average walking time on the first day of treatment was 28.7 ± 7.5 min, whereas that on the last day of treatment was 42.9 ±13 min (Table 1-2).

Table 1. *Comparison of walking parameters before Lokomat treatment with mean values and groups.*

Before treatment	Hemiplegia (n =46)	Paraplegia (n =60)	Cerebral palsy (n =30)
Walking time (min)	27.35 ± 6.6	28.7 ± 7.5	28.8 ±6.95
Walking distance (m)	675.5±220.4	629.22± 213.9	670.3 ± 244.7
Walking speed (m/min)	1.4±0,1	1.5± 0,1	1.3±0.4

Min: minute, M: meter.

Table 2*. Comparison of walking parameters after Lokomat treatment with mean values and groups.*

After treatment	Hemiplegia (n =46)	Paraplegia (n = 60)	Cerebral palsy (n = 30)
Walking time (min)	38.17±8.5	42.9 ±13	43.2 ±6.07
Walking distance (m)	1045.7±328.5	1073.± 283	1042.1±245.3
Walking speed (m/min)	1.8±0.8	1.6 ±0.3	1.6 ±0.7

Min: minute, M: meter.

In all the three groups, a significant difference in the duration of treatment was found on the first day and last day of treatment (p <0.001) (Table 3).

Table 3. *Comparison of walking parameters before and after treatment in each group.*

Pre and post-treatment Walking parameters Intragroup comparison p value	**Walking time (min)**	**Walking distance (m)**	**Walking speed (m/min)**
Hemiplegia (n =46)	<0.001	<0.001	<0.001
Paraplegia (n =60)	<0.001	<0.001	<0.001
Cerebral palsy (n =30)	<0.001	<0.001	<0.001

Min: minute, M: meter.

In the group treated for hemiplegia, the average walking distance of the patients on the first day of treatment was 675.5 ± 220.4 m and that on the last day of treatment was 1045.7 ± 328.5 m. In the group treated for cerebral palsy, the average walking distance on the first day of treatment was 670.3 ± 244.7 m and that on the last day of treatment was 1042.1 ± 245.3 m. In the group treated for spinal cord injury, the average walking distance on the first day of treatment was 629.22 ± 213.9 m and that on the last day of treatment was 1073 ± 283 m (Table 1-2).

In all the three groups, the walking distance on the first and last day of treatment was significantly different (p <0.001) (Table 3).

In the group treated for hemiplegia, the average speed on the first day of treatment was 1.4 ± 0.1 m/min and that on the last day of treatment was 1.8 ± 0.8 m/min. In the group treated for cerebral palsy, the average speed on the first day of treatment was 1.3 ± 0.4 m/min and that on the last day of treatment was 1.6 ± 0.7 m/min. In the group treated for spinal cord injury, the average speed on the first day of treatment was 1.5 ± 0.1 m/min and that on the last day of treatment was 1.6 ± 0.3 m/min (Table 1-2).

In all the three groups, a significant difference in the average speed was observed on the first day and last day of treatment (p <0.001). (Table3).

DISCUSSION

Among the lost functions, the ability to walk again is the function that the patients in need of neurological rehabilitation want to recover the most (12). The goal of neurological rehabilitation should be to stimulate the central nervous system plasticity as early as possible and in order to strengthen the natural healing process through customized therapies (13). Locomotor exercises focus on the re-training of lost motor function through the stimulation of central nervous system plasticity (14-16). Therefore, our goal is to help the formation of locomotor memory and eliminate disconnection in task-specific definitions. It is known that motor relearning is a necessary factor for stimulating central nervous system plasticity. Repetition is thought to play a major role in the central nervous system’s learning process and in retaining the learned information. However, excessive intensity of exercises or frequent repetitions of exercises alone are not enough for ideal motor learning. The administration of frequent repetitive task-specific therapies is required for stimulating central nervous system plasticity (15-17).

In patients in need of neurological rehabilitation, conventional walking exercises, body weight-assisted treadmill exercises, manual-supported or unsupported functional electrical stimulation (FES), treadmill exercise, manual support and/or walking training with FES, and walking training with robotic systems are the frequently applied methods (18, 19). Among these, conventional rehabilitation methods (stretching, strengthening, balance, posture, transfer training, and joint mobility exercises) are dependent on the therapist, and these are the methods that require intensive manpower and whose gains can be measured subjectively. After many years of using conventional methods, different requirements were needed, and the adoption of new technologies has been an indispensable element in the field of medical rehabilitation. Robots developed for this purpose are multifunctional, programmable devices that carry out the specified movements to perform any task and have differences related to shape, size, and systems. Robotic systems are used in walking rehabilitation to ensure intensive, fast, and task-specific exercises are performed using rhythmic sensorial input (20).

Robotic-assisted gait training is used in the treatment of a wide range of neurological diseases. Studies related to these diseases report different results. In some studies, it has been reported that exoskeleton wearable robots are safe, tolerable, and easy to learn. It was emphasized that patients had improvements in pain, bladder-bowel function, and spasticity, and high emotional-psychosocial satisfaction was achieved (21, 22). In a study by Esclarín-Ruz et al. (23) where they categorized injuries as upper and lower motor neuron-related diseases, better functional results were obtained in patients in both the groups who underwent robotic therapy. It is believed that providing robotic-assisted gait training in combination with other correctly and adequately performed rehabilitation methods will prove to be beneficial. In a review by Datteri's, it was mentioned that robotic therapy is just as effective as conventional therapy (24). As a result, it is important to provide mission-specific and high-intensity work when therapeutic robotic devices are used for rehabilitation to ensure the interactive participation and motivation of the patient, obtain feedback, perform measurements, and measure progress objectively.

In another review, 270 acute stroke, 114 chronic stroke patients were evaluated. It was reported that more improvements were observed in acute patients receiving body weight-supported treadmill exercise and robotic training. Although more improvements were observed in walking speed and distance in chronic patients than in acute patients, no difference was detected in terms of treatment methods, and it was emphasized that all treatment methods administered as a result had a potential effect (25). In a study of patients with subacute stroke, the efficacy of robotic-assisted gait therapy administered in addition to conventional treatment was analyzed, and it was determined that there was a significant improvement in Functional Ambulation Scala values of independent walking; however, it was concluded that robotic therapy had no additional advantage in timed up and go test, 10-meter walking test (26, 27). In another study, they found that conventional therapy and robotic-assisted combined therapy were more effective in improving patients' functionality and showed that this effect continued during their 2-year clinical follow-up (28).

Although there were studies on cerebral palsy in which significant improvement in rough motor functions after treatment compared to that before robotic-assisted walking therapy (29, 30), Gillaux et al.(31) did not find any statistically significant difference in the study, which examined the effect of upper extremity robotic rehabilitation on functional status in children with cerebral palsy. Smania et al. (32) evaluated the functional status using the Pediatric Functional Independence Scale (PFIS) before and after treatment in their study to examine the effect of robot-assisted recurrence walking exercises on walking and functional condition in children with SP, and did not find a significant increase in PFIS score.

In our study, we aimed to investigate the effectiveness of Lokomat treatment in three disease groups that most often need neurological rehabilitation. In all three patient groups, we found a statistically significant increase in walking time, distance and speed as much as the patient could tolerate at the onset and end of treatment.

Even if robotic rehabilitation systems do not show functional gain, it is reported in many studies that neurorehabilitation, which has a very long treatment period and progress is relatively slow, improves the quality of life, happiness, motivation, hope and self-confidence in the patient group, and reduces stress and pain (33).

Robotic rehabilitation in neurorehabilitation contributes a lot to the health system by requiring fewer therapists, reducing the therapist's workforce, being action-specific, providing more effective rehabilitation, reducing hospital stay time and creating more independent patients (33). Recording the parameters related to walking in robotic rehabilitation and thus offering the opportunity for more objective evaluation of the treatment process of patients is one of the important advantages (34). Moreover, with the virtual reality applications integrated into the system, both patient motivation is increased and frequent repetitive movements specific to the task are supported (35). In conventional methods, the experience of the therapist and the success of treatment are associated with each other, but it can also be difficult to carry out high-intensity and frequent repetition trainings (36). Although robotic rehabilitation is useful in this regard, it is difficult to talk about a completely trouble-free treatment process. In conventional treatment, spasticity and contracture are suitable for recognition and intervention by the therapist. While robotic treatment contributes better to the repetitive and high-intensity training process, the differences that may arise during the treatment process are difficult to feel due to the lack of therapist and patient contact (36, 37). The robotic system must have a mechanism that can recognize and direct spasticity and contracture. The robotic system should be applicable to provide active assisted exercise or resistance to the weak muscle group of the patient and active resistant exercise options (36). Whether the robot to be selected for the patient will be an end effector or exoskeleton type is associated with the clinical condition of the patient and his ability to apply commands (35).

It is a fact that there are different results regarding the effectiveness of lokomat therapy in neurological disorders. Certain earlier reviews (38, 39) compiled the available evidence on robot-assisted gait training; however, firm conclusions could not be drawn due to insufficient evidence owing to the heterogeneity of the studies, small samples, and identified limitations of the trials. Gait velocity was employed in earlier investigations to evaluate total motor function and gait recovery. Gait training in a robotic orthosis, according to Aguirre-Güemez et al. (38), showed positive impacts solely on gait performance, strength, and functioning, but not on speed. However, the 10-m walk test (10-MWT) and 6-min walk test (6-MWT) are still the most often used measures for evaluating individuals with SCI, according to the most recent review (40), as more and more research have shown that RAGT improves walking performance. However, there was a paucity of information on the most effective RAGT for enhancing locomotor results in SCI patients. Additionally, there is no research comparing overground wearable exoskeletons to conventional gait therapies, particularly for people with SCI. There is some evidence to suggest that stroke patients with more severe impairments may recover more quickly than those with less severe impairments (41). Children with CP have experienced similar outcomes (42), while these findings are debatable (43, 44). Other investigations explore the relationships between responsiveness and stroke diagnostic variables (30-45, 46).

The most important limitations are the retrospective nature of the study, the low number of cases, and the lack of detailed analysis based on subgroups. However, we think that our article will contribute to the literature since robotic treatment is not common, promising and there are not many studies on the subject.

Conclusion

In studies on robotic rehabilitation, it is not yet clear in what frequency and for what duration robot-assisted walking therapy should be administered in which group of patients, provides an effective benefit to the functional condition and quality of life of the patient or whether it has an advantage over conventional treatment. Despite the different results of the studies, we believe that in addition to conventional rehabilitation methods in neurological rehabilitation, robotic-assisted walking therapy can benefit patients in the parameters associated with walking.

Declaration of conflicting interests

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