The Use of Hydrotherapy for the Management of Spasticity

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Introduction. *Spasticity is a major problem for the rehabilitation team. Physiotherapy is a vital component of therapy. Oral medication and other modalities such as heat, cold, ultrasound, electrical stimulation, and surgery (neurosurgical or orthopedic) can also be used. The aim of this study was to compare the effects of hydrotherapy on spasticity and Functional Independence Measure (FIM) scores of patients with spinal cord injury (SCI).* Materials and Methods. *This is a control case matched study. Twenty SCI patients were divided into 2 groups and matched for age, gender, injury time, Ashworth scores, oral baclofen intake, American Spinal Injury Association, and FIM scores. The control group received passive range of motion exercise twice a day and oral baclofen for 10 weeks. The study group also received passive range of motion and oral baclofen, as well as 20 min of water exercises (at 71 °F, full immersion) 3 times per week. The authors evaluated spasm severity, FIM scores, oral baclofen intake, and Ashworth scales, between groups at the beginning and at the end of the treatment period.* Results. *Both groups demonstrated a significant increase in FIM scores. However, the hydrotherapy group demonstrated a larger increase (*$P < 0.0001$*) than the control group. There was a statistically significant decrease in oral baclofen intake in the hydrotherapy group (*$P < 0.01$*). There was no statistical change in the control group. Spasticity was evaluated by the Ashworth scale. There was a statistical improvement in each group (*$P < 0.01$, $P < 0.02$*). However, when compared to the control group, the use of hydrotherapy produced a significant decrease in spasm severity (*$P < 0.02$*).* Conclusion. *Side effects are often seen when using oral drug treatment for spasticity. Adding hydrotherapy to the rehabilitation program can be helpful in decreasing the amount of medication required. Future studies must evaluate benefits of hydrotherapy for rehabilitation.*

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The prognosis after spinal cord injury (SCI) is a reflection of the level and completeness of injury and strength of the leg muscles. Spasticity is a major health problem for patients with SCI, which limits patients' mobility and affects their independence in activities of daily living and work. Spasticity may also cause pain, loss of range of motion, contractures, and sleep disorders, and impair ambulation in SCI patients. Spasticity creates great difficulty for both the patient and the rehabilitation team.[1]

A comprehensive treatment of spasticity should take into account the segmental pathophysiological changes in the spinal cord as well as changes in muscle properties. As spasticity presents with polymorphic clinical pictures resulting in various types and degrees of discomfort and dysfunction, the aim of symptomatic treatment also varies.[2-4]

Physiotherapy is a vital component in the management of spasticity. Oral medication (baclofen, diazepam, clonidine, tizanidine, gabapentin, dantrolene sodium, cyproheptadine, opiates, amino acids such as glycine, a potassium channel blocking agent 4 aminopyridine, carisoprodol, orphenadrine citrate, etc.), intramuscular or intrathecal Botulinum toxin A, and/or other modalities such as heat, cold, cold air therapy, ultrasound, electrical stimulation, EMG biofeedback, surgery (neurosurgery, posterior rhizotomy, intrathecal neurolytics, dorsal column stimulation, stereotactic thalamotomy, or orthopedic surgery) can also be used. Although no studies exist, SCI persons use herbs such as kava (*Piper methysticum*) and valerian. Current therapies for spasticity are far from ideal, and many new therapeutic interventions are being explored. The effectiveness of available drugs is

still uncertain, and they may cause adverse effects.[2,4-11]

Hydrotherapy is one of the oldest therapeutic methods for managing physical dysfunctions. It is used for the effects on body tissues of heating, cooling, debridement, pain relief, muscle relaxation, treatment of joint stiffness, psychological relaxation, and warm-up to assist with exercises. Water has complex thermal, mechanic, and inherent mechanical forces of buoyancy, pressure, cohesion, and viscosity that play a role in the effects produced on the body from hydrotherapy. The supportive, assistive, and resistive qualities of the water make it possible for patients to begin range of motion, strength, and endurance exercise.[12,13]

Giesecke classified many of the therapeutic goals of aquatic exercise: reduced spasticity, better strengthening, increased or maintained range of motion, reduced pain, improved respiratory status, improved peripheral circulation, improved cardiovascular and metabolic status, increased aerobic endurance, improved function, and psychological benefits.[14]

The aim of our study was to evaluate the effects of hydrotherapy on spasticity and functional independence in spinal cord–injured patients.

METHODS

Participants were recruited as a convenience sample from the inpatient population of the SCI department of the Istanbul Physical Medicine and Rehabilitation Centre who had not reached their rehabilitation target owing to spasticity. Twenty new established spinal cord–injured individuals with various degrees of spasticity, 15 male and 5 female, consented to participate in this study. Their conventional rehabilitation and study programs were continued during the time of study in the same rehabilitation center. All patients gave informed consent for participation. Patients were divided into 2 groups and matched for age, gender, injury time, Ashworth scores,[15] oral baclofen intake, level of injury, and American Spinal Injury Association[16] (ASIA) and Functional Independence Measure[16] (FIM) scores. Medication and rehabilitation programs were monitored by the patients' physicians, and an investigator collected data forms from them. Spasm severity,[1] FIM scores, oral baclofen intake, and Ashworth scales were recorded weekly and evaluated at the beginning and at the end of the treatment period between groups. Average age of patients was 33 years. Injury time was between 7 and 9 months. There was no statistical significance between FIM scores. Daily oral baclofen intake was 100 mg (Table 1).

Both groups received psychotherapy twice a week with their program. The control group received passive range of motion exercises twice a day and oral baclofen for 10 weeks. The study group also received the control group's management as well as 20 min of underwater exercises at 71 °F 3 times per week. Sessions took place in a heated exercise pool (approximately 4.5×6 m, 1.2 by 1.7 m deep with tap water). Pool air temperature was 81 °F, and humidity was 50%. Patients were placed into the pool either with or without a flotation device to assist them. Floats (such as rings for the trunk and extremities), paddle boards, slippers, parallel bars, and weighted stools or chairs were used during hydrotherapy sessions.

Statistical analyses were performed using the SPSS statistical program. Results were considered significant at $P < 0.05$. To compare the baseline characteristics of the 2 groups, chi-square analysis or *t* tests were performed as appropriate, for descriptive purposes. Ashworth scales and spasm severity before and after treatment were compared using the Wilcoxon signed rank test; FIM scores and baclofen intake were compared with paired *t* tests in each treatment group and with independent *t* tests between groups.

RESULTS

Ashworth scores. There was a statistical improvement in Ashworth scores for both study and control groups ($P < 0.01$ and $P < 0.02$, respectively). Before therapy, the mean Ashworth score for the control group was 3.9 and for the study group was 4.1. This was not a statistically significant difference ($P > 0.05$). After therapy, the mean Ashworth score for the control group was 2.1; the study group was 1.7. When they were compared, again, this was not a statistically significant difference ($P > 0.05$).

Spasm severity. Before therapy, the mean spasm severity for the control group was 2.3; the mean for the study group was 2.4. There was no statistically significant difference between the groups ($P > 0.05$). When comparing the 2 groups at the end of the 10-week study period, the hydrotherapy group showed a significant decrease in spasm severity

Table 1. Demographic and Injury Characteristics of Groups

	Control (n = 10)	Hydrotherapy (n = 10)	P Values
Age (year)	33.10 ± 10.71	32.13 ± 8.34	$P > 0.05$
Sex:			
Female:Male	3:7	2:8	$P > 0.05$
Injury time (month)	7.70 ± 6.06	8.6 ± 5.5	$P > 0.05$
FIM	54.70 ± 18.8	52 ± 14.13	$P > 0.05$
Ashworth score	2.50 ± 1.18	3 ± 0.92	$P > 0.05$
Oral baclofen (mg)	100 ± 0	96 ± 12	$P > 0.05$
Levels: C5-6	3	3	$P > 0.05$
T8-9		7	7
ASIA: A	3	3	$P > 0.05$
B-C	3	3	
D	4	4	
Etiology (accident)	50%	50%	$P > 0.05$

FIM = functional independence measurement; ASIA = American Spinal Injury Association.

($P < 0.02$). The control group's spasm severity was 1.4, and the hydrotherapy group's was 0.7 (respectively, $P < 0.05$, $P < 0.001$).

Oral baclofen intake. Both groups were taking baclofen before therapy. The amounts taken were not statistically different between the groups (96 mg for controls, 100 mg for hydrotherapy group, $P > 0.05$). This was decreased to 45 mg for the hydrotherapy group, which was a statistically significant decrease in oral baclofen intake ($P < 0.01$). There was no change in the control group (96 mg, $P > 0.05$). At the end of the treatment period, when therapies were compared, the hydrotherapy group achieved a statistically significant enhancement compared to the controls ($P < 0.002$) (Figure 1).

FIM scores. The FIM consists of 18 items (13 motors and 5 cognitive) clustered into six areas: self care, sphincter control of bladder and bowel, mobility, locomotion, communication, and social recognition. At the beginning of treatment, the mean FIM score for the control group was 54.7 and was 52 for the study group ($P > 0.05$). Both groups demonstrated a significant increase in FIM scores: 69.1 for the control group and 94 for the hydrotherapy group ($P < 0.01$ and $P < 0.0001$, respectively). However, the hydrotherapy group demonstrated a larger increase ($P < 0.001$) compared to the control group (Figure 2). Both groups showed increases in motor and cognitive categories, but the hydrotherapy group had larger significant increases than the control group in subtotal scores.

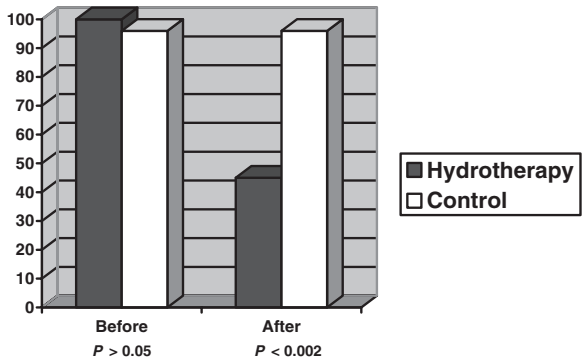

Figure 1. Total baclofen dose before and after therapy.

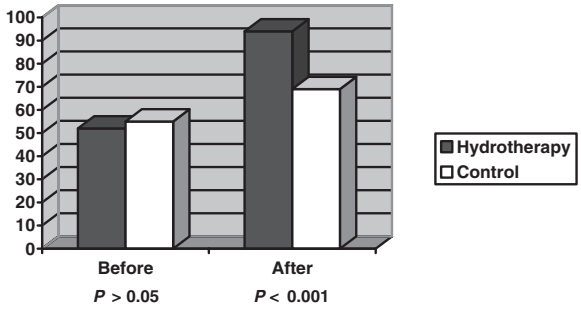

Figure 2. Functional Independence Measurement M values, before and after therapies.

At the beginning of the treatment, cognitive subscores for was 22 for the control group and 21 for the hydrotherapy group ($P > 0.05$), and at the end of study, results were 27 for the control group and 34 for the hydrotherapy group ($P < 0.01$). Ini-

tially, motor subscores were 32 for the control group and 31 for the hydrotherapy group ($P > 0.05$), and at the end of study, they were 42 and 60 ($P < 0.01$), respectively.

Mild fatigue was observed in 2 patients in the control group, probably due to oral baclofen intake.

DISCUSSION

In spinal cord injury, spasticity intensity results from a combination of various pathophysiological changes.[2,3] For this reason, management must be complex.

Oral medication can be used, and baclofen was one of the 1st specific antispastic agents. In clinical trials, it appeared that the most frequent adverse effects were fatigue, muscle weakness, hypotonia, and sedation, whereas nausea, vomiting, dizziness, euphoria, depression, and confusion were less frequent side effects.[2,4]

In our study, 2 patients in the control group had mild fatigue probably due to oral baclofen intake. They did not drop out. Many exercise studies for SCI reported dropouts.[17] Our participants were inpatients, so control and contact with groups was easier.

When the groups were compared, baclofen intake of the hydrotherapy group was less than the control group. This is consistent with the literature. Giesecke advocated that the reduction of spasticity in patients with medullar lesions was one of the aims of hydrotherapy.[14] Adding hydrotherapy can be helpful in decreasing the amount of medication required secondary to the reduction of spasticity.

The small number of participants in our study may have influenced the statistical analysis, which is a problem in testing persons with SCI, as in other studies.[18]

SCI rehabilitation is not easy, especially in water. The hydrotherapy team must be aware of the complications of immersion. Based on standard protocol for all SCI patients who are immersed in water, vital signs such as heart rate, blood pressure, and axillary temperature must be measured both before and after hydrotherapy. Although our aim was not to show an adaptive response, we want to emphasize that there was no adaptive response to hydrotherapy. Gass's study is in agreement with ours. They reported that repeated warm water immersion for 60 min per day, for a total of 5 days, did not produce a significant adaptive response.[19] But one of their studies showed that when compared to exercise, immersion was associated with a lower heart rate. Our study did not show increased heart rates or heat gain.[20]

Individuals with SCI depend on a reduced muscle mass for locomotion. This may lead, in combination with a sedentary lifestyle, to a poor physical capacity.[18] Several authors have emphasized the importance of physical exercise and sports in persons with SCI for maintaining or improving an adequate physical fitness level. In our study, both groups had physiotherapy. The bottom line of many studies is that physiotherapy in general is effective in improving motor function and activities of daily living.[7,17,18] Long-term stretch of the hypertonic muscles has been shown to reduce both spasticity and co-contraction and to increase the range of motion in the hip joint; as a consequence, the energy cost of locomotion was found to decrease in patients with stationary paraparesis.[21] The results in our groups were statistically significant and were consistent with the literature.

FIM is a comprehensive measure of activity frequently used in research and practice with various patient groups.[16] In our study, FIM scores significantly improved in patients with SCI in both groups. Duran et al. reported that their exercise program had a positive impact in most of the measures of physical function like FIM scores.[22] Some previous reports claim that FIM scores plateau approximately 6 months after the injury following a suitable rehabilitation program, but some studies also showed improvements in FIM scores in persons who had their injury for several years.[23,24] The use of hydrotherapy in the treatment of SCI helps reduce spasticity and favors the improvement of the patients' functional movements. As well as helping decrease spasticity, body relaxation in hydrotherapy may also be instrumental in allowing the patient to feel more independent in the water after an adaptation period. Once relaxed, it is likely that the patient will be able to perform motor skills in a more functional way and will be able to move more freely. As a result, the patient will feel better adapted and probably happier in physical, emotional, and even spiritual terms (in that a certain degree of freedom and independence is what these patients expect the most).

Exercise in an aquatic environment could be expected to improve the gait characteristics in patients with SCI.[13,14,19,20,25] In the following para-

graphs, the data collected in this study will be compared with the literature, and the effect of hydrotherapy will be subsequently discussed.

In our study, the hydrotherapy group achieved statistically significant results compared to the controls; the unique difference between them is that the study group received hydrotherapy.

Zamparo and Pagllaro, in their studies on spastic paresis, reported that SCI patients who are characterized by slow self-selected speeds of progression benefit more from hydrokinesi therapy.[25] Miglietta found that clonus frequency dropped or disappeared for 4 h after spastic extremities were immersed in water at 65 °F for 15 min.[6] The water temperature is important because water that is too hot or cold may worsen the spasticity.[14]

One mechanism of hydrotherapy on spasticity may be related to depressing the sensitivity of the muscle spindle and a decrease in skin sensitivity, thereby reducing gamma fiber activity. The administration of cool water leads in many cases to a sufficient relaxation in spastic muscle groups. It may be mediated by a decrease in skin sensitivity and its influence on alpha/gamma motoneuron activity.

The physical properties and comfort of warm water allow those with SCI to move freely in ways that would be painful and difficult on land. SCI persons can work with less fear of falling. Therefore, many physical and functional goals can be facilitated.[14]

CONCLUSION

The data show that therapy in an exercise pool, in this population and setting, was effective in reducing spasticity severity and oral baclofen doses, and resulted in increased FIM scores compared to controls receiving otherwise identical interventions. Because of the small number of patients in this study, future studies are needed to replicate and further evaluate these findings. The benefits of hydrotherapy in SCI rehabilitation must be studied more.

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