Original

Safety of Aquatic Exercise for Patients with Cerebral Palsy and Severe Motor Disabilities

Tadashi Matsuda[1] and Yoshiteru Akezaki[2]

[1]Department of Rehabilitation, Suita Municipal Disability Support Center I-Hope Suita

[2]Department of Rehabilitation, National Hospital Organization Shikoku Cancer Center

(Received: October 26, 2017)

Abstract

PURPOSE: The purposes of this study are to investigate the safety of the water treatment method for adults with cerebral palsy (CP) and severe motor disabilities and examine the psychological changes in the subjects' families after implementation of the water treatment method.

PARTICIPANTS: We targeted three participants with CP, who visited our facility to participate in daytime activities. All participants were GMFCS level V.

METHODS: The aquatic exercise program was conducted for 23 weeks, 1–2 times a month, for 15 minutes per session for each participant. Since all participants had difficulty performing voluntary exercises, the aquatic exercises were passive.

As all three patients had a tracheostomy, waterproof treatment was given to the tracheostomy. A waterproof tape is pasted around the tracheostomy, and the water did not rise above the chest of the patient.

Pulse, muscle spasticity, and adverse events were tracked as part of the safety assessment. Pulse was measured immediately before and immediately after implementation of each aquatic exercise, and averages values of each were calculated. A questionnaire was completed by each patient's caregiver at the beginning and end of the study.

RESULTS: Each patient participated in the aquatic exercise program a mean 8.0 times (range, 6–11).

In muscle spasticity, Patient 1 and 2 showed decreased or no change after the intervention. Patient 3 showed increased myotonic tone of the right elbow flexor muscle and the left palmar flexor muscle after the intervention.

In this study, the questionnaire results demonstrated a tendency toward increased health management awareness, satisfaction with the aquatic exercise, and effect of aquatic exercise.

CONCLUSION: There were no adverse events, such as fever or pneumonia, during the intervention period. Since there was little fluctuation in mean pulse before or after the exercise, this intervention method can be said to have created a mild exercise burden.

Although the possibility of increased muscle tone due to viscous resistance of water was considered, we believe that the chances of it causing deterioration were low.

Aquatic exercise for CP patients with GMFCS V level can be safely implemented through appropriate risk management. In addition, there was a possibility of having a positive influence for their families.

(JJOMT, 66: 270—275, 2018)

—Key words—

aquatic exercise, cerebral palsy with severe motor disabilities, psychological benefit

Introduction

Cerebral palsy (CP), the most common childhood-onset physical disability, affects daily activities and participation[1]. Children and adolescents with CP are more likely to have decreased physical activity levels than

their peers; thus, they are at risk of developing other negative health conditions such as obesity[2] and cardiovascular disorders[3].

Children with a Gross Motor Function Classification System[4] (GMFCS) level IV or V have a 50% risk of developing moderate or severe scoliosis by 18 years of age, whereas children with a GMFCS level I or II have almost no risk[5].

Much evidence has demonstrated that the physical therapy management of CP requires a proactive approach to promoting activity[6]. However, since young people with CP participate in physical activities and sports, there are various environmental factors such as economic aspects, leader shortages, and access problems that impede opportunities[7]; thus, it is necessary to create an environment that will increase the participation of these patients in physical activity.

Water is a gentler environment than land and may allow children with CP, especially those with GMFCS levels IV and V, to exercise more freely[8]. However, the feasibility of an aquatic exercise program for children with GMFCS levels IV and V is less than one for children with less severe CP[8]. Since there is a possibility of risk, an investigation of the safety considerations is necessary for the implementation of the program.

The purposes of this study are to investigate the safety of the water treatment method for adults with CP and severe motor disabilities and examine the psychological changes in the subjects' families after implementation of the water treatment method.

Participants

We targeted three participants with CP who visited our facility to participate in daytime activities (Table 1). Since the participants were difficult to communicate, the measurements and evaluations were performed with family consent, doctor recommendation, and permission of the facility manager. Participants and their caregivers provided informed consent.

Methods

The aquatic exercise program was conducted for 23 weeks, 1–2 times a month, for 15 minutes per session for each participant.

The aquatic exercises were performed in an indoor swimming pool (I-Hope Suita) that was 15 m long, 6 m wide, and 110 cm deep. The water temperature was 32℃, and the room temperature was 30℃. Since all participants were GMFCS level V and had difficulty performing voluntary exercises, the aquatic exercises were passive. The training staff supported each patient's dorsal trunk, and the subject was asked to move backward. This exercise utilizes the viscous drag of the water to slowly exercise the entire body in the frontal and sagittal planes. The support staff supported each subject's trunk from behind and moved backwards. To utilize the viscous resistance of water, the passive exercise was performed by slow shaking of the patient's entire body on the frontal and sagittal planes. The nature of the underwater movement and its implementation were reported to the family.

All three patients had a tracheostomy. For the exercises, Waterproof treatment was given to the tracheostomy. A waterproof tape is pasted around the protective filter (Laryngofoam, Kapitex Healthcare., Ltd) affixed to the tracheostomy (Fig. 1), and the water did not rise above the chest of the patient. While entering the water, a bandana was rolled around the neck to cover the tracheostomy. The bandana was changed every time it got wet.

The support staff completed the facility's safety management training prior to providing swimming support. During the aquatic exercises, nurses were present by the poolside in case of emergency. In the water, one

Table 1 Characteristics of participants

Patient	Sex	Age	Body mass index	Cerebral Palsy Subtype
1	male	30	17.3	Spastic-bilateral
2	male	23	12.6	Spastic-bilateral
3	female	25	19.2	Spastic-bilateral

staff member was on standby, while the other directly supported the subject. If pain or fatigue occurred during the intervention, the patient was promptly transported to a medical institution.

Pulse, muscle spasticity, and adverse events were tracked as part of the safety assessment. Pulse was measured immediately before and immediately after implementation of each aquatic exercise, and averages values of each were calculated.

Muscle tone was noted before and after the intervention, and adverse events during the intervention period were recorded. Muscle tone was evaluated using the Modified Ashworth Scale[9] to evaluate the left and right elbow flexor, palm flexor, knee flexor, and plantar flexor muscles.

A questionnaire including a Zarit Burden Interview was completed by each patient's caregiver at the beginning and end of the study[10]. Caregiver satisfaction with the aquatic exercise was recorded using a visual analog scale; the higher the value assigned by the subject, the greater the degree of satisfaction. We also recorded sleep time, nursing time, and the number of times the subject required nighttime nursing care; scores for life motivation and health management awareness were also assessed, as were caregiver satisfaction with the aquatic exercise and facility service. Our goal was to achieve improved scores for all measures.

Results

Each patient participated in the aquatic exercise program a mean 8.0 times (range, 6–11). Pulses were expressed as mean ± standard deviation (times/min) for each case.

Patient 1 showed 63.0 ± 5.0 before intervention and 62.6 ± 4.8 after intervention, patient 2 showed 76.8 ± 14.0 before intervention, 76.8 ± 7.2 after intervention, and patient 3 showed 68.6 ± 3.0 before intervention and 58.0 ± 3.4 after intervention.

The muscle spasticity results are presented in Table 2. Patient 1 and 2 showed decreased or no change after the intervention. Patient 3 showed increased myotonic tone of the right elbow flexor muscle and the left palmar flexor muscle after the intervention.

The questionnaire results are presented in Table 3. The survey showed improvement in nine of the 10 items.

Discussion

The purposes of this study were to investigate the safety of the water treatment method for children with CP and severe motor disabilities and examine the psychological changes in the subjects' families before and after its implementation.

Aquatic exercise is an attractive form of exercise for children with CP since weight-bearing requirements, trunk control, joint load, and the effects of gravity are reduced in water[8]. As a result, aquatic physical activities are more protective of joint integrity than land-based activities[8]. Studies have reported that performing motor

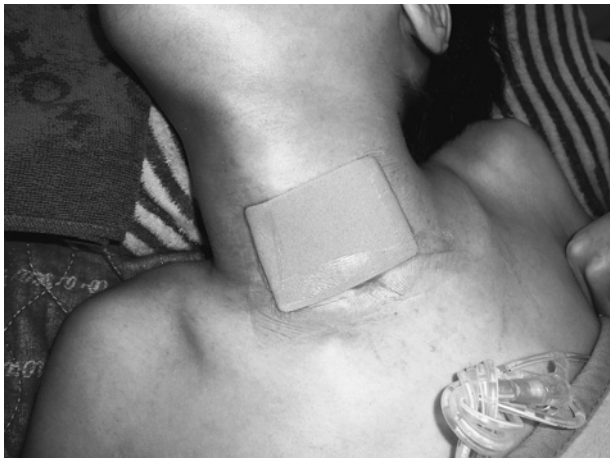

Fig. 1 Waterproof treatment to the tracheostomy

Table 2 The results of muscle spasticity

	Case 1		Case 2		Case 3	
	Beginning	Final	Beginning	Final	Beginning	Final
Elbow flexor muscle (right)	3	1	4	4	2	3
Elbow flexor muscle (left)	3	2	4	1	2	2
Palmar flexor muscle (right)	3	1	4	4	3	2
Palmar flexor muscle (left)	3	2	4	4	1	3
Knee flexor muscle (right)	3	2	2	1	2	2
Knee flexor muscle (left)	4	1	2	2	2	2
Ankle plantar muscle (right)	4	4	5	2	5	4
Ankle plantar muscle (left)	5	1	2	1	5	4

Table 3 The results of the caregiver questionnaire survey

Item	Beginning	Final
Zarit Burden Interview (point)	37.7 ± 16.8	35.7 ± 18.7 [a]
Sleep time (hour)	5.4 ± 0.8	5.5 ± 0.9 [a]
Nursing time (hour)	10.7 ± 5.5	9.7 ± 6.4 [a]
The number of times the subject required night nursing care (time)	1.8 ± 1.9	1.2 ± 1.6 [a]
Life motivation (point)	6.3 ± 4.0	7 ± 3.6 [a]
Health management awareness (point)	7.7 ± 2.5	9 ± 1 [a]
Satisfaction with the aquatic exercise (point)	7.7 ± 2.5	10 [a]
Satisfaction of safety consideration (point)	9 ± 1	9.3 ± 1.2 [a]
Effect on aquatic exercise (point)	5.8 ± 3.3	8.3 ± 2.9 [a]
Satisfaction with facility service (point)	9.7 ± 0.6	9.7 ± 0.6

a: improved items

skills in the water can potentially increase a child's confidence and reduce resistance to trying difficult tasks as compared with land training[12]. Furthermore, activities in the water can be more fun and novel for children, potentially enhancing their motivation and interest[13]. Performing aquatic physical activities may be significantly beneficial for patients with higher GMFCS levels, i.e., those with significant mobility limitations for whom land-based physical activities may be difficult to perform[11].

In a report on exercise participation in children with CP, swimming is the second and third most frequent activity for patients with GMFCS levels I, II, and III but the highest for patients with GMFCS IV and V levels[14]. From these facts, aquatic exercise was presumed to be useful if it could be safely performed even by patients with high GMFCS levels.

According to one study, underwater therapy was an effective treatment for children with spastic CP with severe mobility impairments including those with GMFCS level IV[15]. Since no side effects were observed in this study, underwater therapy was considered a safe and effective treatment.

In the patients with GMFCS level V included in this study, there was no significant fluctuation in pulse before and after aquatic exercise. No adverse events such as fever or pneumonia were noted during the intervention period. The safety of water therapy was ensured by the individual consideration of safety-related aspects for each patient. Since there was little fluctuation in mean pulse before or after the exercise, this intervention method can be said to have created a mild exercise burden. It is possible that this is related to the lack of adverse events.

Gains in strength and gait velocity without concomitant increases in muscle tone were seen in stroke survivors after strengthening and aerobic exercise were performed, and these gains were not associated with measurable changes in lower-limb muscle strength or spasticity[16][17]. There was no increase in spasticity for adults with CP who completed maximum-effort strength training[18][19].

In this study, although muscle tone was increased in the right elbow flexor muscle and the left palmar flexor muscle after the intervention, it decreased in other muscles or did not change. Our patients were treated using passive exercises because voluntary exercises were difficult for them to perform. Although the

possibility of increased muscle tone due to viscous resistance of water was considered, we believe that the chances of it causing deterioration were low.

Nursing care for children with CP is associated with anxiety, depression[17], stress[18], caregiver self-efficacy, and lack of quality of life for their parents as compared with that of parents of healthy children. It is also known that the functional limitations become more apparent as the child grows older, increasing the magnitude of caregiver burden over time[20].

In this study, the questionnaire results demonstrated a tendency toward increased health management awareness, satisfaction with the aquatic exercise, and effect of aquatic exercise. It was also speculated that the performance of the exercises in the water had a positive psychological effect on the families. Aquatic exercise for CP patients with GMFCS V level can be safely implemented through appropriate risk management. In addition, there was a possibility of having a positive influence not only for patients but also for their families.

This study does have limitations. Since only three subjects were included, it will be necessary to increase the number of patients in a future study. Also, we were limited to examining safety only since we did not examine changes in physical function or activities of daily living. Thus, it will be necessary to verify the effects of the intervention in future studies.

References

1) Rosenbaum P, Paneth N, Leviton A, et al: A report: the definition and classification of cerebral palsy April 2006, Developmental Medicine and Child Neurology. Supplement 109: 8—14, 2007.
2) Rogozinski BM, Davids JR, Davis RE, et al: Prevalence of obesity in ambulatory children with cerebral palsy. Journal of Bone and Joint Surgery — Series A 89: 2421—2426, 2007.
3) Morris PJ: Physical activity recommendations for children and adolescents with chronic disease. Current Sports Medicine Reports 7: 353—358, 2008.
4) Persson-Bunke M, Hagglund G, Lauge-Pedersen H: Scoliosis in a total population of children with cerebral palsy. Spine (Phila Pa 1976) 37: E708—E713, 2012.
5) Damiano DL: Activity, Activity, Activity: Rethinking Our Physical Therapy Approach to Cerebral Palsy. Physical Therapy, November, Volume 86, Number 11, 2006
6) Verschuren O, Wiart L, Hermans D, et al: Identification of facilitators and barriers to physical activity in children and adolescents with cerebral palsy. J Pediatr 161: 488—494, 2012.
7) Gorter JW, Currie SJ: Aquatic exercise programs for children and adolescents with cerebral palsy: what do we know and where do we go. Int J Pediatr 24: ID712165, 1—7, 2011.
8) Kelly M, Darrah J: Aquatic exercise for children with cerebral palsy. Developmental Medicine and Child Neurology 47: 838—842, 2005.
9) Fragala-Pinkham MA, Dumas HM, Barlow CA, et al: An aquatic physical therapy program at a pediatric rehabilitation hospital: a case series. Pediatric Physical Therapy 21: 68—78, 2009.
10) Retarekar R, Fragala-Pinkham MA, Townsend EL: Effects of aquatic aerobic exercise for a child with cerebral palsy: single-subject design. Pediatric Physical Therapy 21: 336—344, 2009.
11) Brunton LK, Bartlett DJ: Description of exercise participation of adolescents with cerebral palsy across a 4-year period. Pediatric Physical Therapy 22: 180—187, 2010.
12) Lai CJ, Liu WY, Yang TF, et al: Pediatric Aquatic Therapy on Motor Function and Enjoyment in Children Diagnosed With Cerebral Palsy of Various Motor Severities. Journal of Child Neurology 30: 200—208, 2015.
13) Sharp SA, Brouwer BJ: Isokinetic strength training of the hemiparetic knee: effects on function and apasticity. Arch Phys Med Rehabil 78: 1231—1236, 1997.
14) Brunton LK, Bartlett DJ: Description of exercise participation of adolescents with cerebral palsy across a 4-year period. Pediatric Physical Therapy 22: 180—187, 2010.
15) Andersson C, Grooten W, Hellsten M, et al: Adults with cerebral palsy: walking ability after progressive strength training. Dev Med Child Neurol 45: 220—228, 2003.
16) Fowler EG, Ho TW, Nwiqwe AI, et al: The effect of quadriceps femoris muscle strengthening exercises on spasticity in children with cerebral palsy. Phys Ther 81: 1215—1223, 2001.
17) Özlem A, Akin I, Sait A, et al: Anxiety and depression levels in mothers of children with cerebral palsy. Turkish J Phys Med Rehabil 53: 22—24, 2007.
18) Skok A, Harvey D, Reddihough D, et al: Perceived stress, perceived social support, and wellbeing among mothers of school-aged children with cerebral palsy. J Interllectual Dev Disabil 31: 53—57, 2006.
19) Dambi J, Jelsma J, Mlanbo T, et al: A critical evaluation of the effectiveness of interventions for improving the well-being of caregivers of children with cerebral palsy: a systematic review protocol. 5: 112, 2016.

20) Dambi J, Chivambo G, Chiwaridzo M, et al: Health-related quality of life of caregivers of children with cerebral palsy and minor health problems in Zimbabwe: a descriptive, comparative cross-sectional study. Int J Sci Res Publ 5: 679―703, 2015.

Reprint request:
Tadashi Matsuda
Department of Rehabilitation, Suita Municipal Disability Support Center I-Hope Suita, 12-27, Senri-Banpaku-Kouen, Suita, Osaka, 565-0826, Japan.

別刷請求先 〒565-0826 大阪府吹田市千里万博公園 12―27
吹田市立障害者支援交流センターあいほうぷ吹田リハビリテーション部
松田 忠司

重度運動障害のある脳性麻痺者における水中運動の安全性

松田 忠司[1)]，明崎 貞輝[2)]
[1)]吹田市立障害者支援交流センターあいほうぷ吹田リハビリテーション部
[2)]独立行政法人国立病院機構四国がんセンターリハビリテーション科

―キーワード―
水中運動，重度運動障害の脳性麻痺，心理的利得

目的：本研究の目的は，重度運動障害のある脳性麻痺者への水治療法実施の安全性の検証，および水治療法実施前後における対象者の家族の心理的変化を検討することである．

対象：対象は脳性麻痺者 3 例である．3 名は吹田市立障害者支援交流センターあいほうぷ吹田に日中活動への参加目的で通所している．参加者のすべては GMFCSV レベルである．

方法：対象者は，23 週間，月に 1～2 回，1 回 15 分間の水治療法を実施した．参加者のすべては自発的な運動が困難であるため，水中での受動運動を水中療法とした．

対象者 3 名はすべて気管切開をしているため，防水措置として，気管切開部周囲は防水テープを張り，水中療法中は対象者の胸から上は水面から出ていることを原則とした．

安全性の評価としては，脈拍，筋緊張，有害事象を測定した．脈拍は，入水前後，筋緊張は介入前と終了時，有害事象は介入期間中にそれぞれ測定した．

家族には，介入開始日と介入終了日にアンケート調査を行った．

結果：水治療法の平均参加回数は 8 回（6～11）であった．

筋緊張の結果は，症例 1 と症例 2 は肘屈筋，手掌屈筋，膝屈筋，足底屈筋の左右いずれにおいても開始時と比較して終了時に低下，あるいは変化を認めない結果を示した．症例 3 が，手掌屈筋の左側において，筋緊張の亢進を認めた．

アンケートの結果は，健康管理意識，水中運動への満足度，水中運動への効果は増加傾向を認めた．

結論：介入期間中に熱発，肺炎などの有害事象も認めなかった．脈拍に大きな変動がなかったことから，今回の介入方法は，運動負荷量が軽度であったことも有害事象を生じさせなかった要因と推測された．

筋緊張に関しては，水による粘性抵抗などあるが，筋緊張の悪化を生じさせる可能性は低いことが示唆された．

重度運動障害のある脳性麻痺者の水中療法は，適切なリスク管理により安全な実施が可能となる．また，家族へ好影響を及ぼす可能性も考えられた．

利益相反：利益相反基準に該当無し

（日職災医誌，66：270―275，2018）