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Effect of Training Using Repeated Rolling Movement on Muscle Tone and Range of Motion in Boccia Players with Severe Cerebral Palsy

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Abstract

Objectives: To evaluate the effect of interval rolling (IR) on physical parameters, including the range of motion (ROM), muscle tension, and throwing ability of boccia athletes with severe cerebral palsy (CP).

Participants: This study included 10 boccia athletes with CP (GMFCS III–V). Main outcome measures: IR, wherein rolling movements are repeated using an interval training format, was performed on each participant to determine the effect of IR on the athlete's ROM, muscle tone, and throwing ability.

Results: Athlete ROM improved significantly in many directions. muscle on, a significant improvement in muscle tone was observed in the hip extensor muscle groups bilaterally. A comparison between pre- and post-intervention throwing distances using the average value showed a significant improvement in throwing ability.

Conclusions: The throwing distance of all athletes improved. IR presents an effective training method for boccia athletes with severe CP and may improve physical function and throwing distance.

Keywords: Boccia; Cerebral Palsy; Interval Training; Rolling Movement

Highlights

Interval rolling improved ROM in boccia athletes with CP.

Pre- and post-intervention throwing ability showed a significant improvement.

IR training can improve physical function in boccia athletes with severe CP.

Introduction

Boccia is a Paralympic sport developed in Europe for people with severe cerebral palsy (CP) or similar motor skill limitations. It is a target sport where players compete for how close one can get to each other. Boccia's competition classes are classified into four categories: BC1 to BC4. (Table 1) In BC1, BC2, and BC4, players can grasp the ball and throw themselves. BC1 and BC2 are classes of CP. BC4 includes non-CP-associated impairments. BC3 is a class with the most severe disabilities, and because affected people cannot be thrown by themselves, it is thrown using a gradient tool called a ramp. Athletes in BC1 and BC2 have severe disabilities at levels IV–V in the Gross Motor Function Classification System (GMFCS) (Table 1).

The conventional approach to improving the performance of boccia players with CP has primarily included passive training methods, such as stretching aimed at reducing muscle tone in the upper limbs. We [1,2] implemented an exercise plan aiming to improve the strength of boccia athletes by focusing on the trunk, lower limbs, and upper limbs. According to the CP Rehabilitation Guidelines [3], muscle strength and endurance training for CP is effective, but only for relatively mild CP at GMFCS levels I to III. The effect of muscle strength and endurance training in severe CP (GMFCS levels IV to V), the target of boccia, is unknown. Most reports have focused on mild CP at the GMFCS I-III level, and the primary training methods used were walking [4], ergometer, and

swimming [5]. There are no current reports on the efficacy of muscle strength training in patients with severe CP.

In addition, severe CP has been reported to cause secondary muscle weakness, muscular endurance deficiencies, and cardiopulmonary function deterioration due to immobility [6,7]. Training for athletes with severe CP is often like those with mild CP. However, many movements are difficult to perform, and it is essential to select training items according to the participant's motor function level [1]. Therefore, movements that can be performed even for severe CP are incorporated into the training protocol and the training effect; therefore, it is necessary to incorporate actions that can be performed even in severe CP into the training protocol and verify the training effect. We introduced interval rolling (IR) as a training method for boccia athletes with severe CP. IR utilizes a series of rolling movements applied using the interval training method. As a result, we confirmed an increase in heart rate due to an increased exertion level in participants with severe CP [1] However, the physical effects of IR and its impact on throwing ability have not been clarified. Therefore, the purpose of this study was to evaluate the effect of IR on physical parameters, including the range of motion (ROM), muscle tension, and throwing ability of boccia athletes with severe CP.

Table 1: Boccia Classification.

Classification	Explanation of classification
BC1	Players in this class throw the ball with their hand or foot. They may complete with an assistant who stays outside of the competitor's playing box, to stabilize or adjust their playing chair and gives the ball to the player when requested.
BC2	Players in this class throw the ball with their hand. They are not eligible for assistance.
BC3	Players in this class have very severe locamotor dysfunction in all four extremities. Players in this class have no sustained grasp or release action and although they may have arm movement, they have insufficient range of movement to propel a Boccia ball the court. They may use an assistive device such as a ramp to deliver the ball. They may complete with an assistant; assistants must keep their back to the court and their eyes averted from play.
BC4	Players in this class have severe locamotor dysfunction of all four extremities as well as poor trunk control. They can demonstrate sufficient dexterity to ball onto the court. Players are not eligible for assistance.

(BISFed official HP: http://www.bisfed.com/about-boccia/classification/)

Methods

Participants

Participants included 10 CP players from the Japan Boccia Association, who throw in sitting positions that do not correspond to the BC1, BC2, and non-BC categories (Japan's class, from now on OP sitting class) (Table 2). The participants were athletes with no history of heart disease or respiratory illness. We obtained permission from their doctors to carry out training. At the start of the intervention, items related to ethical considerations, such as risks, burdens, benefits, and personal information confidentiality, were clarified. This study was carried out in accordance with the Declaration of Helsinki and was approved by the Research Ethics Committee of the Graduate School of Comprehensive Rehabilitation, Osaka Prefecture University (approval number: 2019-102). The study's purpose, method, and risks were explained to the participants in writing, and consent was obtained. If the subjects were minors, the same explanation was given to their parents and consent was obtained (Table 2).

Table 2: Boccia Classification and Motor Levels of Subjects.

	Boccia Classification	GMFCS	Sex
A	BC1	V	M
B	BC1	V	F
C	BC1	V	M
D	BC1	V	M
E	BC2	IV	F
F	BC2	IV	M
G	BC2	IV	M
H	OP Sitting	III	M
I	OP Sitting	III	M
J	OP Sitting	III	M

M: Male, F: Female

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Training procedure

Before starting the training, each participant's shoulder and hip joint ROM was measured. The muscle tone of the elbow, hip flexor, and extensor muscles was measured using the Modified Ashworth Scale (MAS). In addition, the athlete's boccia ball throwing distance was measured. The training was conducted three times a week for one month, and measurements were recorded following the training period. ROM and MAS measurements were performed according to guidelines. The IR training protocol consisted of workouts with 1 min of exercise to 30 sec of rest (Figure 1). One set included three workout intervals, and three sets were performed at each training session with 5min of rest between each set [6] It was assumed that turning over to the lateral decubitus position was repeated alternately on the left and right at the maximum speed (Figure 1).

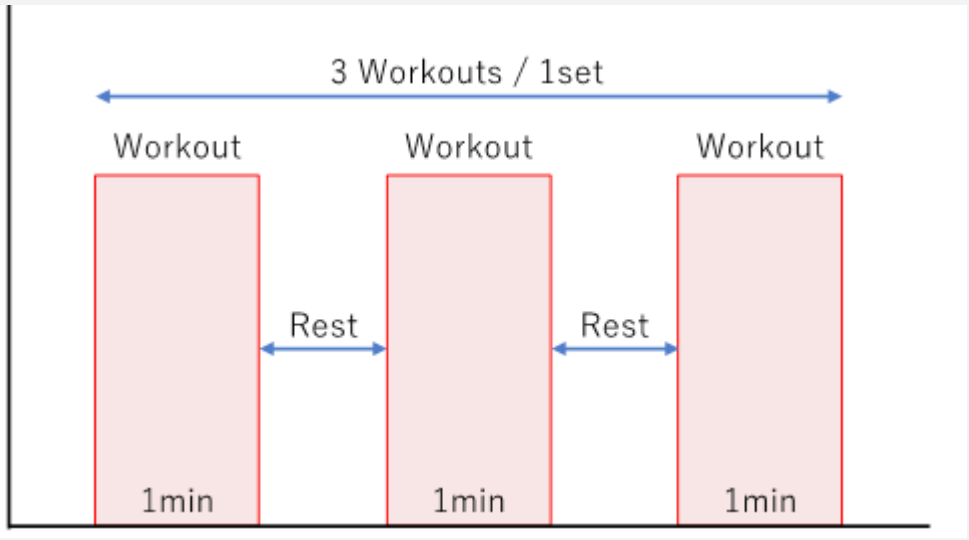

Figure 1: IR Training Protocol.

Data analysis

SPSS ver.25 (IBM, Armonk, New York, USA) was used for data analysis. The Shapiro-Wilk test was used to confirm normality. Then the corresponding t-test was performed for comparison of the changes in ROM and throwing distance before and after the training intervention. Muscle tone was compared using the Mann-Whitney U test. The significance level was set at < 5%.

Results

The overall training implementation rate was 100%, with no dropouts. In addition, none of the participants had any hypertonia or other physical abnormalities before or after the intervention. Joint range of motion (Figure 2) shows the change in the ROM of the shoulder joint before and after IR intervention. Fig. 3 shows the change in the ROM of the hip joint. In the shoulder joint, throwing side flexion ($p < 0.05$), abduction ($p < 0.01$), abduction ($p < 0.01$), non-throwing side flexion ($p < 0.05$), extension ($p < 0.01$), abduction ($p < 0.01$) significantly improved. In the hip joint, throwing side flexion ($p < 0.01$), extension ($p < 0.05$), adduction ($p < 0.01$), abduction ($p < 0.01$), internal rotation ($p < 0.05$), non-throwing side flexion ($p < 0.01$), adduction ($p < 0.01$), internal rotation ($p < 0.05$), and external rotation ($p < 0.05$) significantly improved. ROM improvement tended to be seen in both the shoulder and hip joints in the direction of movement, but there was no statistically significant difference. No reduction in ROM was observed in any of the participants compared to the pre-intervention measurements (Figure 2,3).

Muscle tone

Comparing the muscle tone before and after the IR intervention, a significant difference was observed in the muscle tone of the hip extensor muscle group bilaterally, and muscle tone improvement was observed in all athletes. (Right: Figure 4, Left: Figure 5). No significant difference was observed between the elbow joint on the throwing side and the flexor muscles of the bilateral hip joints. No increase in muscle tone was observed in any of the participants compared to before the intervention (Figure 4,5).

Throwing distance

There was a significant difference in throwing distance observed before and after IR intervention (Figure 6). In addition, throwing distance was improved in all players (Figure 7). None of the participants experienced a reduction in throwing distance (Figure 6,7).

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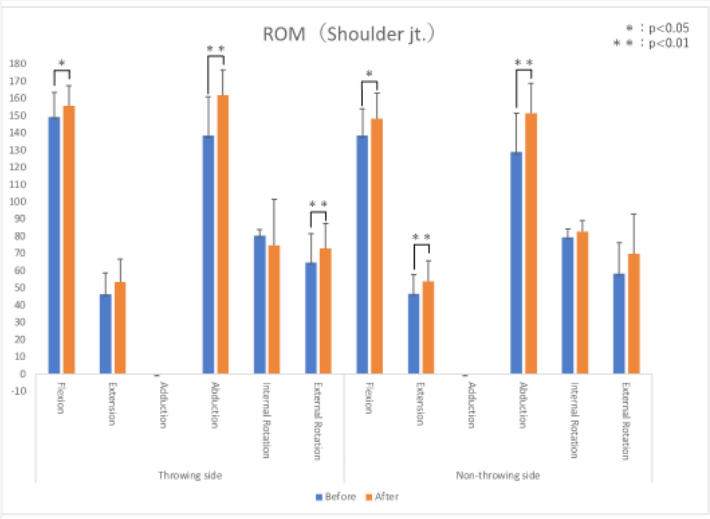

Figure 2: Results of ROM (Shoulder jt.).

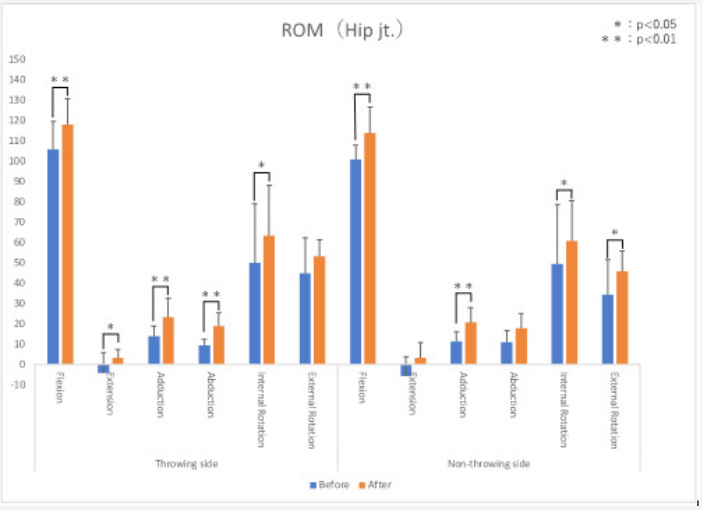

Figure 3: Results of ROM (Hip jt.).

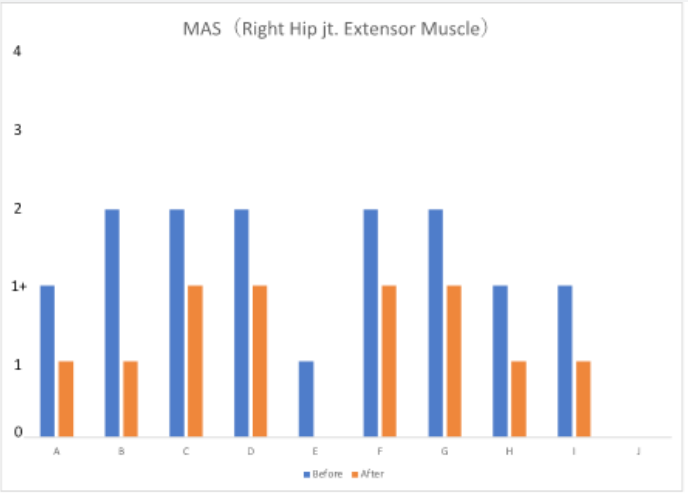

Figure 4: Results of MAS (Right Hip Jt. Extensor Muscle).

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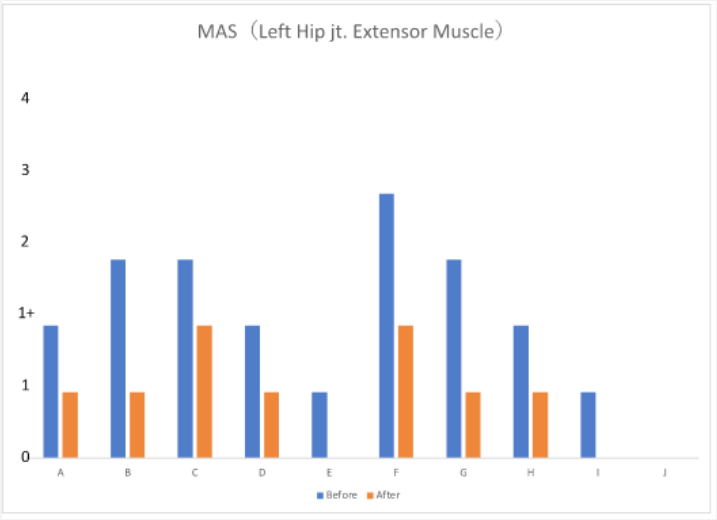

Figure 5: Results of MAS (Left Hip Jt. Extensor Muscle).

Figure 6: Results of Long Throw Distance (Overall Average).

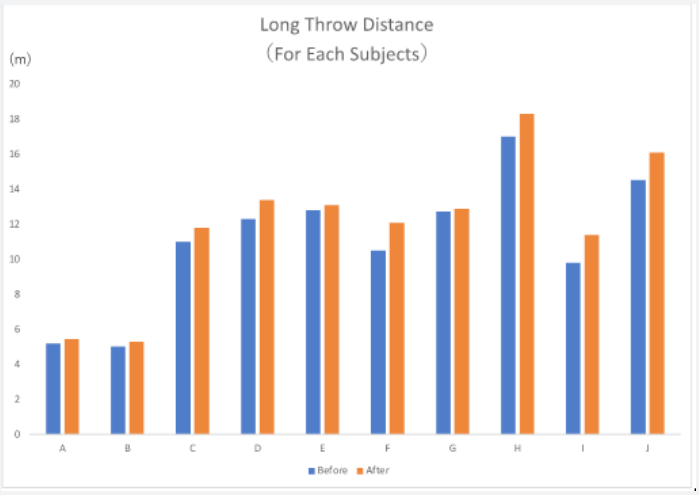

Figure 7: Results of Long Throw Distance (For Each Subjects).

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Discussion

This study focuses on activities of daily living movements that can be performed even in cases of CP. IR training repeatedly performs rolling movements in an interval format impacting physical parameters such as ROM and muscle tone. This study clarified the impact of IR training on the throwing ability of boccia athletes with severe CP. It was hypothesized that if ROM, muscle tone, and throwing distance improved following the intervention period, IR would be an effective training method for improving physical function and throwing ability in boccia athletes with severe CP. Significant differences were observed in many directions of motion before and after IR intervention, and there was a tendency for improvement in directions where there was no significant difference.

In addition, there was a significant difference in muscle tone between the hip extensor muscle groups bilaterally. The average throwing distance before and after IR intervention was significantly different, and the players' throwing distance improved following the training cycle. These results suggest that IR is an effective training method for improving physical function and throwing distance in boccia athletes with severe CP. Our study has shown that at least once weekly IR intervention for boccia athletes with severe CP is an effective training method for increasing heart rate and relative exertion. The IR intervention in this study was performed three times a week, and an associated increased heart rate due to greater exertion levels can be expected. IR is a repetition of rolling movements, which involves the whole body.

Nitta et al. [9] reported that the rolling motion impacts the trunk muscles, the reach or shoulder extension of the upper limbs for weight transfer, and the flexion or extension of the lower limbs for pelvic rotation. It is considered that the ROM and muscle tone were improved by repeating dynamic stretching in the shoulder and hip joints from continuous intrabody rotation, accomplished by repeating the rolling movement alternately on the left and right. Previous studies on baseball and softball athletes [10,11] have shown that external rotation of the scapula- brachial joint, posterior tilt of the scapula, and extension of the thoracic spine contribute significantly to throwing performance. In addition, when an athlete's trunk movement is insufficient, the force from the lower limbs is not sufficiently transmitted.

Without adequate trunk movement, the force exerted at the time of throwing depends on the power generated by the upper limbs. Boccia players have decreased trunk function due to disabilities, and since they throw in a sitting position, the transmission of force from the lower limbs to the trunk and upper limbs is poor. Therefore, it is considered that improving the upper limb ROM by IR facilitated exertion of greater force during the throwing motion, leading to an improvement in the throwing distance. Furthermore, it is considered that the activity of the rotator muscles of the trunk increased due to the rolling movement, and it became easier to transmit the force from the trunk to the upper limbs during the throwing motion. This stud muscles and that IR for boccia athletes with severe CP is useful for improving ROM of the shoulder and hip joints, muscle tone in the hip extensor muscles, and throwing distance. In the future, we will evaluate the strength of the trunk muscles, check the muscle activity during throwing, and examine the relationship with the IR effect and the differences due to CP patterns (spasticity type, athetosis type, etc.). By verifying this, we can build a more functional training method.

Conclusion

This study introduced a training Programme in which a rolling movement was repeated in an interval format for boccia athletes with severe CP. As a result, it was found that IR is an effective training method to improve physical function and throwing distance in boccia athletes with severe CP.

References

1. BIS Fed (Boccia International Sports Federation).
2. Yahagi K, Okuda K, Kataoka M, Imura S, Ichiba T (2021) Research of training method using repeated rolling movement for Boccia players with severe cerebral palsy. Japanese Journal of Physical Fitness and Sports Medicine 70: 229-235.
3. The Japanese Association of Rehabilitation Medicine (2014) Japanese guidelines for rehabilitation of cerebral palsy second edn, Tokyo: Kanehara, & Co., Ltd, pp. 131-134.
4. Kholod H, Jamil A, Katz Leurer M (2013) The associations between motor ability, walking activity and heart rate and heart rate variability parameters among children with cerebral palsy and typically developed controls. Neuro Rehabilitation 33(1):113-119.
5. Rogers A, Furler BL, Brinks S, Darrah J (2008) A systematic review of the effectiveness of aerobic exercise interventions for children with cerebral palsy: an AACP DM evidence report. Developmental Medicine and Child Neurology 50: 808-814.
6. Sato K (2001) Secondary disabilities of adults with cerebral palsy. Japanese Journal of Rehabilitation Medicine 38: 775-783.
7. Thorpe D (2009) The role of fitness in health and disease: status of adults with cerebral palsy. Developmental Medicine and Child Neurology 51(4): 52-58.
8. Israeli Mendlovic H, Mendlovic J, Michal Katz Leurer (2014) Heart rate and heart rate variability parameters at rest, during activity and passive standing among children with cerebral palsy GMFCS IV-V. Developmental Neurorehabilitation 17(6):398-402.
9. Nitta O, Yanagisawa K, Takaku N, Honjou Y (2003) Kinematic patterns of rolling over in children with cerebral palsy. Journal of Physical Therapy Science 15: 25-31.
10. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF (1995) Kinetics of baseball pitching with implications about injury mechanisms. American Journal of Sports Medicine 23(3): 233-239.
11. Miyashita K, Kobayashi H, Koshida S, Urabe Y (2009) Proportion of joint ankles in shoulder complex to shoulder maximum eternal rotation angle in throwing. Japanese Journal of Physical Fitness and Sports Medicine 58(8): 379-386.

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