Reliability of the Multi-Directional Reach Test in Children with Down Syndrome between 7 and 12 Years Old

ความเที่ยงของการทดสอบระยะทางการเอื้อมหลายทิศทางในเด็กดาวน์ซินโดรม อายุระหว่าง 7-12 ปี

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ABSTRACT

The Multi-Directional Reach test (MDRT) is a clinical test that used for measuring dynamic balance and limits of stability (LOS) in four directions. However, there is no study apply the MDRT in children with Down syndrome (DS). Thus, the reliability of the tester requires before applying the test in further study. The purpose in this study was to evaluate the intra-tester and inter-tester reliability of the MDRT in children with DS age between 7 and 12 years old. Two different testers investigated ten children with DS on the same day. Intra-class correlation-coefficient (ICC (3,1)) was computed. The intra-tester reliability ranged from moderate to excellent (ICC = 0.72-0.90) and the inter-tester reliability ranged from fair to excellent (ICC = 0.47-0.91). The MDRT is applicable to balance assessment in children with DS. The results from this study suggested that when assessing the dynamic balance and LOS with the MDRT, the pre- and post-test should be conducted by the same tester for reducing measurement error.

บทคัดย่อ

การทดสอบระยะทางการเอื้อมหลายทิศทางเป็นเครื่องมือทางคลินิกที่ใช้เพื่อทดสอบการทรงตัวขณะเคลื่อนไหวและขอบเขตความมั่นคงของร่างกายในสี่ทิศทาง อย่างไรก็ตามยังไม่มีการนำการทดสอบนี้มาใช้ในกลุ่มเด็กดาวน์ซินโดรม ดังนั้นการทดสอบความเที่ยงของผู้ประเมินมีความจำเป็นก่อนจะมีการประยุกต์ใช้เครื่องมือในการศึกษาต่อไป การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อทดสอบความเที่ยงของผู้ประเมินและระหว่างผู้ประเมินของการทดสอบระยะทางการเอื้อมหลายทิศทางในเด็กดาวน์ซินโดรมอายุระหว่าง 7 ถึง 12 ปี ทำการประเมินในวันเดียวกัน ค่าสัมประสิทธิ์สหสัมพันธ์ของความเที่ยงของผู้ประเมินอยู่ในเกณฑ์ปานกลางถึงดีเยี่ยม และความเที่ยงระหว่างผู้ประเมินอยู่ในเกณฑ์พอใช้ถึงดีเยี่ยม จากผลการศึกษาผู้วิจัยแนะนำในการทดสอบการทรงตัวขณะเคลื่อนไหวและขอบเขตความมั่นคงของร่างกายด้วยเครื่องมือนี้ ผู้ประเมินทั้งก่อนและหลังควรเป็นคนเดียวกันเพื่อลดความคลาดเคลื่อนของการวัด

Keywords: Reliability, Multi-Direction Reach Test (MDRT), Down Syndrome (DS)

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Introduction

Down syndrome (DS) is the most common chromosomal disorders, occurring in 1 out of every 800 infants around the world (Villamonte et al., 2010; Chen et al., 2015). The presentation of extra chromosome 21 is known as trisomy. The third copy of chromosome 21 causes many clinical symptoms (Malak et al., 2013). Poor postural control in individuals with DS related to motor coordination deficit, poor sensorimotor integration, neuro-muscular anomalies, slow reaction time and primary reflex persistence and cognitive functions (Malak et al., 2013; Aranha et al., 2016). Postural stability is essential for executing all complex movement in daily activities (Shumway-Cook, Woollacott, 2007). It involves the child's interaction with peers, playing, and social participation (Aranha et al., 2016). Body balance performances in individuals with DS are often lower than healthy people or other intellectual disability groups (Villamonte et al., 2010). The consequences of balance deficits lead to fall which related to injuries, lacking confidence to perform daily activities, and activity restrictions (Mancini, Horak, 2010). To identify the problem, balance assessment must be effective and reliable (Bandong et al., 2015). However, the clinical balance tests are more practical and inexpensive for clinical practice than laboratory tests.

The Multi-Directional Reach Test (MDRT) was developed by Newton (2001). The MDRT is reliable (ICC = 0.942) and valid (concurrent validity of MDRT with BBS and TUG r = 0.36 – 0.48, and r = 0.26-0.440, respectively) assessment tool for measuring dynamic balance and LOS in four directions (Newton, 2001; Tantisuwat et al., 2014). However, there is no study apply the MDRT in children with DS. The MDRT may be applicable for assessment dynamic balance in children with DS. Nevertheless, the differences between children with DS and other populations bring into question the suitability of this test in children with DS. Cognitive disability in children with DS may effect on understanding of the test instructions and the testing procedures. This problems lead to question their reliability. The reliability should be determined before apply the test in different population. Moreover, the reliability of the MDRT has been established in adult, elderly and children without DS. The errors can be related to variability in performance of participants or a tester's measurement (Katz-Leurer et al., 2008). The reliability of tester is important to investigate for reducing measurement error in further study. Therefore, the purpose of this study was to evaluate the intra-tester and inter-tester reliability of the MDRT in children with DS age between 7 and 12 years old.

Objective of the study

To investigate the intra- and inter- tester reliability of the Multi-Direction Reach Test (MDRT) in children with Down syndrome (DS) between 7 and 12 years old.

Methodology

This study was cross-sectional design. All study procedures were approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. A written informed consent were accomplished from all participants and participants' guardians.

Participants

A purposive convenience sampling technique of 10 children with Down syndrome (DS) (7 females and 3 males) was recruited from physical therapy department in Rajanukul Institute. The above sample size was estimated from previous study which investigated reliability of standing balance in children with DS (Aranha et al., 2016). The following inclusion criteria were applied: (1) a medical diagnosis is DS determined by physician; (2) aged 7-12 years; (3) able to stand and ambulate independently; (4) able to understand and follow command. Children were excluded from the study if they: (1) were medically diagnosed with comorbidity of autistic spectrum disorders, cerebral palsy, congenital heart defects, seizure, severe cognitive impairment; (2) had uncorrected visual problem; (3) had hearing impairment; (4) had a history of musculoskeletal problems within 6 months; (5) were taking medication that having the sedative effect within 24 hours before testing; (6) unable to complete the task.

Assessors

The Multi-Directional Reach Test (MDRT) was scores by two testers. They were pediatric physical therapists who had two-year and seven-year clinical experiences. Before data collection, two testers and a demonstrator were practiced the testing procedures and documenting scores.

Instrument

The assessment tool for the Multi-Directional Reach Test (MDRT) in this study was divided into 2 parts. The first part was measurement scale that made from stainless steel yardstick (100 cm). The measurement scale was fixed on the adjustable rail cloth. It was set parallel to floor at the level of participant's shoulder. The bubble level use to ensure that level of ruler was horizontal to the floor. The second part, slide pad made from acrylic sheets. The slide pad was used to slide along the stainless steel yardstick and touch the 3rd metacarpal of participants for evaluate reach distances.

Procedures

The participant's anthropometric data such as age, height, weight, length of upper and lower extremities were recorded. All participants had an Intelligence Coefficient higher than 35 or lower than 70 (according to the assessment of their clinical psychologist). Dominant leg and arm were evaluated by kicking a ball and drawing. The leg that use to stance was determined as dominant leg. The arm that used to draw was determined as dominant arm (Kaufman et al., 1978; Schneiders et al., 2010). In addition, the sequence of reaching directions was randomed by computer program. Prior collect data, participants were explained and demonstrated from tester. Each participant went through practice 3 trials. The participants were asked to standing with barefoot on sheet of paper which were fixed on floor. The tester traced an outline of feet to certify the unchanged foot placement for each trial. The stainless steel yardstick was adjusted as level of each participant's shoulder. The starting positions were follow as; 1) Forward and backward direction, participants were asked to raise dominant arm, shoulder parallel to the stainless steel yardstick, extend elbow, hand in a fist and the other arm was at their side (Figure 1). 2) Rightward and leftward direction, participants were asked to

abduct right/left arm with 90 degree of shoulder abduction, shoulder parallel to the stainless steel yardstick, extend elbow, hand in a fist and the other arm was at their side (Figure 2, 3). The tester recorded the length at the 3rd metacarpal as the initial each data. Then, the participants were instructed to "reach (direction given) together with demonstrator as far as possible, without lifting your feet or taking a step". For the backward direction, the participants were instructed to "lean back together with demonstrator as far as possible, without lifting your feet or taking a step". Each participant performed 3 trials in each direction/session. Multi-directional reach score was the difference between initial point and end point position. The best performance reach scores of three trials was utilized in the analysis data. In the inter-tester reliability test, the same procedure was repeated after breaks 10 minutes to investigate by tester 2. The intra-tester reliability test, the participants repeated the whole procedure again after one and half hours breaks to examined by tester 1 within the same day.

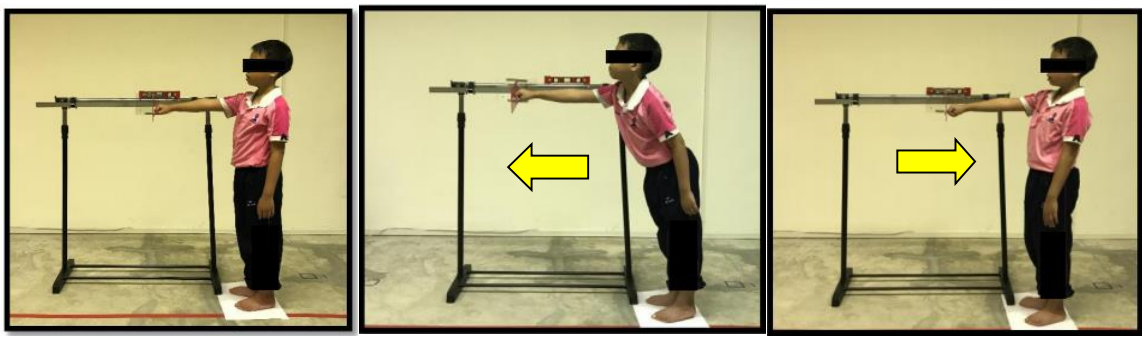

Figure 1 Starting position of forward and backward, reaching forward and backward

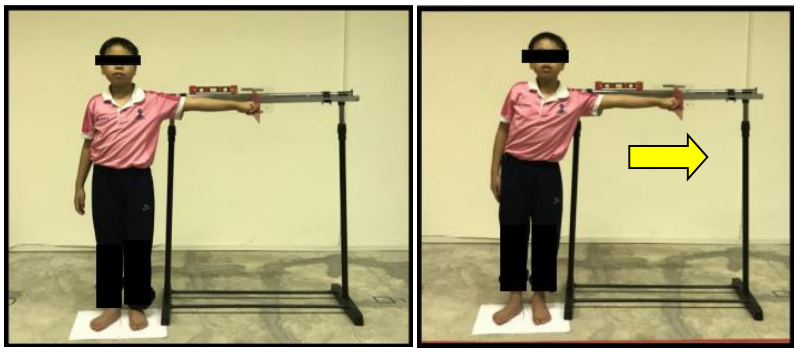

Figure 2 Starting position of leftward, reaching leftward

Figure 3 Starting position of rightward, reaching rightward

Data processing and data analysis

SPSS version 22.0 software was used in statistical analysis. The demographic characteristic and multi-directional reach score were presented by means and standard deviations. Intraclass correlation coefficients (ICC) model (3,1) was applied to compute the intra-tester and inter-tester reliability. The reliability was interpreted as follow: the value less than 0.25 represent no reliability, 0.25-0.50 represented fair reliability, 0.51-0.75 represented moderate reliability, and more than 0.75 represented excellent reliability (Portney, 2009).

Results

Ten children with DS (7 female, 3 male) completed test and retest phases. The demographic data that consisted of age, height, weight, BMI, intellectual disability, IQ level, upper and lower extremities length were described in Table 1. The mean and standard deviation (SD) for the multi-directional reach scores were presented in table 2. Table 3 also showed ICC values in each direction. The intra-tester reliability, ICC values data ranged from 0.72 and 0.90. For the inter-tester reliability, ICC values ranged from 0.47 and 0.91

Table 1 The demographic characteristics of participants (n = 10)

Characteristics	Participants (n = 10) Mean ± SD
Age (years)	9.26 ± 1.68
Gender (male/female)	3/7
Height (cm)	122.5 ± 7.79
Weight (kg)	30.55 ± 10.62
BMI (kg/m^2)	20.03 ± 5.35
Intelligence quotient level (50-69 (mild)/ 35-49 (moderate))	5/5
Dominant side (right/left)	10/0
Upper extremities length (right/left) (cm)	52.95 ± 1.41 / 52.80 ± 1.46
Lower extremities length (right/left) (cm)	63.90 ± 1.73 / 63.70 ± 1.77

Table 2 Mean ± SD of the multi-directional reach scores

Directions	Multi-directional reach scores (cm)		
	Tester 1		Tester 2
	Session 1	Session 2	
Forward	16.92 ± 5.06	16.71 ± 4.89	19.29 ± 4.31
Backward	7.99 ± 2.74	8.00 ± 2.24	7.60 ± 3.08
Leftward	14.24 ± 2.71	14.11 ± 2.99	13.46 ± 3.16
Rightward	14.99 ± 2.34	16.22 ± 2.29	14.30 ± 3.08

Table 3 The intraclass correlation coefficient, p-value of the multi-directional reach test

Directions	Intra-tester reliability		Inter-tester reliability	
	ICC (3,1)	p-value	ICC (3,1)	p-value
Forward	0.90	0.773	0.61	0.106
Backward	0.79	0.985	0.91	0.341
Leftward	0.75	0.842	0.65	0.342
Rightward	0.72	0.053	0.47	0.460

p-value, $p < 0.05$

Discussion and conclusion

This study is the first to evaluate the both intra-tester and inter-tester reliability of the Multi-Directional Reach Test (MDRT) in children with Down syndrome (DS). The result of this study, the intra-tester reliability of MDRT in children with DS ranged from moderate to excellent. Intra-tester reliability was excellent for forward and backward (0.90, 0.79, respectively) and moderate for leftward and rightward (0.75, 0.72, respectively). In this study, the excellent intra-tester reliability of forward reaching because it is the simplest direction and common performance in activity daily life. The result in this study was similarly with study of Sharma et al. (2014). They showed that intra-tester reliability was excellent level of the MDRT in eighteen typical development (TD) children aged between 5 and 19 years (ICC value = 0.94, 0.93, 0.95, 0.79 for forward, backward, leftward and rightward, respectively) (Sharma et al., 2015). The MDRT intra-tester reliability presented by Sharma was higher for all directions than that presented here. Since, Sharma used three test trials and used their average, while we used the highest score of the three MDRT scores. Moreover, children with DS have poor balance performance and less attention that are different from TD children.

From this results, the inter-tester reliability ranged from fair to excellent. Inter-tester reliability was excellent for backward (0.91), moderate for forward and leftward (0.61, 0.65, respectively) and fair for rightward (0.47). The fair inter-tester reliability of rightward reaching because all participants in this study had left dominant leg. The rightward reaching requires weight shifting on right leg which is less stability. Consequently, the weight shifting on right leg induced the variation during reaching to the right side. In addition, the inter-tester reliability was different from study of Holbein-Jenny et al. (2005) as expected. Holbein-Jenny et al. reported that inter-tester reliability was excellent for the MDRT in elderly (ICC = 0.91- 0.98) (Holbein-Jenny et al., 2005). The inter-tester reliability in current study was lower than previous study. Almost all children with DS have cognitive impairment such as poor intelligence, poor attention, learning and memory deficit (Malak et al., 2013). This impairments may be related to the deviation between children with DS and adults. The attention of participants in current study fluctuated during data collection procedure and affected their task performances. Therefore, testers need to increase facilitation for children with DS when compare with other groups. The strategies of tester that used for facilitation could have had impact on cooperation of participants (Bandong et al., 2015). The effective strategies depend on work experience with children with DS. The tester 1 had more experience in pediatric clinical practice and using the MDRT in children than tester 2. The low estimates could be due to differences of experience working with children between two testers as well. (Bandong et al., 2015).

This study presented the intra-tester reliability of MDRT in children with DS ranged from moderate to excellent (0.72 to 0.90) and the inter-tester reliability ranged from fair to excellent (0.47 to 0.91). The MDRT is applicable to investigate dynamic standing balance and limits of stability (LOS) in children with DS. From our point of view, increasing familiarity between testers and participants before collecting data might improve the inter-tester reliability values. The results from this study suggested that when assessing the dynamic balance and LOS with MDRT, the pre- and post-test should be conducted by the same tester. The tester who used this test should be practice testing procedure, documenting score, standardized instructions. The standardized instructions should to simply, easy to understand, briefly and appropriate for children with DS. Furthermore, this study modified methodology from original protocol that participants were asked to reach in any directions together with demonstrator. Due to cognitive

impairment, this methodology could improve the ability to understand and follow the testing instructions in children with DS. However, the demonstrator should be the same person and practice testing procedure before collecting the data.

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