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The Correlation of the Star Excusion Balance test, Star Excusion Balance Test, Visual Feedback Balance Test

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Abstract

Background/Objectives: The purpose of this study was to evaluate the relationship betweenStar Excusion Balance Test(SEBT), Y-Balnce Test(YBT) and Visual Feedback Balance Test(VFT).

Method/Statistical Analysis: Thirty subjects were recruited for this study. To verify the usefulness of the VFT, we compared the correlation with the existing SEBT and YBT scores.Pearson Correlation Analysis was conducted to determine the difference in each balance test.

Findings: In this study, there were statistically significant correlations between reach distance and composite scores in SEBT, YBT and VFT($p<0.01$).

Improvements/Applications: The results suggest that VFT may be able touse dynamic test equipment. The VFT can be used for dynamic balance exercise because it can intuitively visually check balance values.

Keywords: *Correlation, Dynamic balance, Star excursion balance test, Visual Feedback,Y-balance test*

Introduction

In the human body, balance is the ability to maintain the center of gravity on the base of support during movement[1]. The ability to maintain balance is an essential part of life because human have to adjust body's posture and balance with respect to space[2], such as when human stand up and sit down in everyday life. A well-balanced posture protects the body from injury and helps maintain its function[3].

Balance can be divided into static balance and dynamic balance. Static balance is the ability to keep the body's center in base of support without disturbance. Dynamic balance is the ability of the body to maintain balance as it moves and maintain the desired posture by placing the center of gravity within the base of support[4]. Balance is complex processes that monitor the body's motion through the sensory apparatus, enters the central nervous system and then sends it back to the muscular skeletal system to perform the response, which is an important element in everyday life. Therefore, balance test has been used in orthopedic, sports medicine[5] and rehabilitation[6].

Method of measuring static balance is include romberg test and one leg standing test[7,8] and method of measuring dynamic balance include timed up &go test[9], star excursion balance Test(SEBT) and Y-Balance Test(YBT)[10,11]. Especially SEBT and YBT are widely used in clinical practice. The reason is the most common and well-established balanced assessment, because both tests do not require high interventions and techniques. In particular, SEBT and YBT are often performed in clinical practice, because they are the most common and well-established balance assessment and because they do not need to perform high-level arbitration and techniques, they are used most often in cliniccanter[12-14].

SEBT is a dynamic balance test tool that measures strength, flexibility and the sense of motion of the legs and is measured with eight lines drawn on the ground at intervals of 45 degrees. The test is to measure the distance reached by supporting the ground with the

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dominant legs and extending as far as possible with the non-dominant legs in the specified direction[15,16]. SEBT was studied by many researchers, including changes in muscle activity towards the direction subjects with and without symptom.

YBT performs only three directions: anterior (AN), posterior-medial (PM) and posterior-lateral (PL). It has high inter ratorreliability (intraclass correlation coefficient (ICC) =. 88 to .99) compared to the higher repeatability and less test time and is widely used in clinic [16-18]. However, YBT can be performed when the assesor is present andhave to return the box to basic positon each time after the test. YBT also has the disadvantage of not receiving visual feedback during the balance test.

Several studies have been reported that visuals have affected balancing when visuals are blocked or limited. Postural fluctuations have been reported to increase by 20-70% in the absence of visual information. Visual feedback is combined with centripetal information from body sensations, contributing to postural coordination and reducing postural movements.

To address these problems, this study developed a VFT using visual feedback sensor system measurement technology. Therefore, the purpose of this study is to investigate the correlation with SEBT and YBT to determine the usability of VFT as an objective tool for the dynamic balanceassessment. The purpose of this study was to evaluate the relationship between, YBT, SEBT and VFT.

Method

SEBT is a dynamic balance measurement tool that evaluates muscle strength, flexibility anproprioception. This experiment used three of the eight directions, anterior, posterolecular and posteromedial. In addition, lines in the direction of posterolecular and posteromedial were marked with tape at 135 degrees points on both sides of the ground in relation to the forward direction.

Y Balance Test (Functional Movement Systems, Danville, VA, USA) is a modified dynamic balance measurement method by increasing the efficiency of SEBT, which was commonly used to measure the strength, flexibility and proprioception of the lower extremities. Unlike SEBT, YBT consists of only three directions: anterior, posteromedial and posterolateral. The YBT kit consists of a single plate with height and PVC pipe with three directions: AM and PL PM. The pipes in the PM and PL directions are at an angle of 90 degrees and the pipes in the front and rear directions are at an angle of 135 degrees. Each pipe is marked with a distance in 5 mm so that the distance can be expressed numerically. Each pipe is marked with a distance in 5 mm so that the distance can be expressed numerically.

VFT is performed in the same method as SEBT but the length is measured through the program without the assessor. During dynamic balance test, subjects can receive visual feedback from the screen.

SEBT was measured three times in each direction after sufficient practice until the subject could perform the experiment. The measuring method is to extend the leg as much as possible for 4 seconds and return to the starting position again. The weight was supported by the dominant leg and the distance to the maximum stretched point in cm was recorded while maintaining the balance along the line of the ground with the non-dominant leg[12]. To prevent muscle fatigue, subjects rested for 30 seconds after each measurement. If the supporting foot falls off the ground, supports the floor with an extended foot for balancing, or fails to return to the starting position after the foot is extended, it was considered a failure and remeasured. YBT was measured three times in each direction after practice until the experiment could be performed as much as possible and it was instructed to return to the starting position in four seconds with the legs stretched out as much as possible for four seconds.

YBT was measured three times in each direction after practice until the experiment could be performed as much as possible and it was instructed to return to the starting position in four seconds with the legs stretched out as much as possible for four seconds. The subject's second toe was placed on the instrument reaching direction line and the experimenters measured the distance from the center of the instrument to the predominant leg and to the maximum point in which the non-dominant leg extends from the center in three directions. To prevent muscle fatigue, subjects rested 30 seconds after each measurement. If the supporting foot falls off the ground, supports the floor with an extended foot for balancing, or fails to return to the starting position after the foot is extended, it was considered a failure and remeasured. It was also considered to be a failure if the end of the body moved while reaching the foot from an unstable support surface when the end device was kicked to reach the maximum reach distance.

VFT is a method of measuring the maximum length reached by extending the legs in each direction on a tape attached to the ground like SEBT. If the leg is extended during the measurement, the ultrasound program on the machine automatically records the distance. After practicing until the experiment could be performed as much as possible, three measurements were taken in each direction and with the hands fixed to the waist, the legs were stretched for 4 seconds as much as possible and the instruction was made to return to the starting position again at 4 seconds. The subject supports the weight with the dominant leg and balances along the line of the ground with the non-dominant leg, stretching the leg as far as possible and recording the distance to the point in cm. If the supporting foot falls off the ground, supports the floor with an extended foot to balance, or fails to return to the starting position after reaching out, it is considered a failure and remeasured.

The Pearson correlation analysis of the reach and composite scores of SEBT, YBT and VFT was performed. And the correlation coefficient (r) was used to determine the reliability between the two variables. The r values were classified as poor reliability below .69, good reliability between .70 ~ .79 fair reliability, good reliability between .80 ~ .89 and high reliability above .90 ~ .99. All statistics were processed by SPSS ver. 22.0 program (SPSS Inc, Chicago, IL, USA) was used.

Result and Discussion

1. Reach distance correlation of SEBT, YBT, VFT

The results of the reach distance correlation of SEBT, YBT and VFT are as follows [Table1-3].

Table 1.Pearson correlation of AN

AN reach distance	**PEARSON Correlation Coefficient**		**significance probability (**p<0.01)**		
	YBT	VFT		YBT	VFT
SEBT	.602**	.619**	SEBT	.000	.000
YBT		.485**	YBT		.007

Table 2. Pearson correlation of PM

PM Reach Distance	**PEARSON Correlation Coefficient**		**Significance probability(**p<0.01)**		
	YBT	VFT		YBT	VFT
SEBT	.670**	.651**	SEBT	.000	.000
YBT		.621**	YBT		.000

Table 3.Pearson correlation of PM

PL Raach Distance	**PEARSON Correlation Coefficient**		**Significance probablity(*p<0.05),(**p<0.01)**		
	YBT	VFT		YBT	VFT
SEBT	.416*	.491**	SEBT	.022	.006
YBT		.600**	YBT		.000

2. Composite Score Correlation of SEBT, YBT, VFT

The results of the composite score of SEBT, YBT and VFT are as follows[Table 4-6].

Table 4.Pearson correlation of AN

AN Composite Score	**PEARSON Correlation Coefficient**		**Significance probablity (**p<0.01)**		
	YBT	VFT		YBT	VFT
SEBT	.578**	.760**	SEBT	.001	.000
YBT		.636**	YBT		.000

Table 5 : Pearson correlation of PM

PM Composite Score	**PEARSON Correlation Coefficient**		**Significance probablity(**p<0.01)**		
	YBT	VFT		YBT	VFT
SEBT	.639**	.749**	SEBT	.000	.000
YBT		.661**	YBT		.000

Table 6.Pearson correlation of PL

PL Composite Score	PEARSON Correlation Coefficient		Significance Probablity(**p<0.01)		
	YBT	VFT		YBT	VFT
SEBT	.669**	.787**	SEBT	.000	.000
YBT		.684**	YBT		.000

Result and Discussion

The purpose of this study is to identify the correlation between the reach distance and the composite score of the dynamic balancing test, SEBT, YBT and VFT. Dynamic balance testing is the ability of the body to maintain balance during the performance of the movement. During the movement, the body center is placed on the support surface to evaluate the performance of the movement. SEBT and YBT are dynamic balance tests performed frequently in clinical use and VFT is an instrument that can provide visual information to users during dynamic balance tests. The purpose of this study is to examine the correlation between the range of distance and composite scores of the existing clinical evaluation tools SEBT, YBT and VFT and whether the test tool can be used as an objective tool for balance evaluation.

In this study, there were statistically significant correlations between AN, PM, PL reach distance and composite scores during SEBT, YBT and VFT ($p < 0.01$). SEBT has traditionally been widely used in clinical practice to assess dynamic balance. YBT is an instrument that is made by modifying and improving SEBT and it is measured using only three directions (AN, PM, PL) unlike SEBT that extends in eight directions. YBT consists of three pipes and a plate with height. The PVC pipe of PM and PL are located at 135° each in the AN direction and the angle between the two pipes of PM and PL is 90°. According to the study of Coughlan et al. (2012), when the reach of SEBT and YBT in each direction is compared, the reach distance of anteiordirections is correlated because the reach of SEBT is longer than that of YBT[16].Plisky et al. (2009)reported higher in Inter-rater reliability in YBT compared to SEBT, which he claimed was because the use of standardized kits in YBT reduced errors[18]. However, YBT has the hassle of having the tester check each record, record it on the test sheet and inform the subjects.

Our findings showed statistically significant correlation results in the reach distance and composite score reached not only in SEBT and YBT, but also in VFT. Visual information can be integrated with afferent information coming from vestibular and somatosensory to contribute to postural agitation, improving dynamic balance. Uchiyama and Demura(2008) showed that when providing visual information, pre- and post-pressure center point shifts were reduced compared to when no visual biofeedback was given[19].

The VFT applied in this study was applied to the evaluation of dynamic balance by integrating visual feedback which is essential for the motor control factor. This is because the ability to control motion is essential for dynamic balancing capabilities and visual biofeedback is necessary for proper motor control, which changes the control of motion. VFT is a functional test performed on the ground that does not require three pipes and plates and does not change in height, unlike the YBT, which is performed on a high plate, the same conditions as in everyday life. VFT is an automated system using ultrasonic sensor system measurement technology with visual feedback, allowing the experimenter to return the boxed plate to its original position and eliminate visual errors between the subject and each time during the balance measurement. Therefore, VFT is not only suitable as testunobtrusiveequipment for dynamic balance ability, but also as a tool for balance exercise. The limitation of this study is that the VFT did not confirm inter-rater reliability. In future studies, it will be necessary to examine the inter-rater reliability during VFT.

Conclusion

This study was conducted to investigate the correlation between SEBT, YBT and VFT and to find out whether VFT can be used as a balance assessment. As arsults, VFT is not only suitable as testequipment for dynamic balance ability, but also as a tool for balance exercise.Further research will require study of motion analysis during VFT.

Ethical Clearance: Not required

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Conflict of Interest: Nil

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