The effect of developing vestibular apparatus functionality on static balance, dynamic balance and performance level on spring floor exercise

Mohamed Mahmoud El- Dosoky

Department of Theories and Applications of Gymnastics, Exercises and Sports Shows, Faculty of Physical Education, Zagazig University, Egypt
D_mdosoky@yahoo.com

Abstract: Objective: The present study investigates the effect of developing vestibular apparatus functionality on static balance, dynamic balance and performance level on spring floor exercise. This investigation will allow us to know the effect of special exercises on skills performance on spring floor exercise. **Methods:** A case-control study design was conducted to compare the skills performance level on spring floor exercises between experiment and control groups as gymnastic students in faculty of physical education at Zagazig University. Thirty-two students participated in this study, sixteen students as experiment group and sixteen students as control group. The participants were measured functionality test of the vestibular system, static balance test, dynamic balance test and performance level on spring floor exercises. **Results and conclusions:** The results demonstrate that the static and dynamic balance abilities and performance level on spring floor exercises are generally better in experimental group compared to control group students. The difference between both groups in post-test results can be explained by the effectiveness of training program contents. The superior functionality of vestibular apparatus plays an important role for gymnasts and improves the joint position and static and dynamic balance, while perform movement exercises on spring floor exercise event.

[Mohamed Mahmoud El- Dosoky. **The effect of developing vestibular apparatus functionality on static balance, dynamic balance and performance level on spring floor exercise**. *J Am Sci* 2013;9(9):325-328]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 42

Keywords: Vestibular apparatus, static balance, dynamic balance and spring floor exercise.

1. Introduction

Gymnastics, like many sports, requires physical training, which builds the overall fitness of the player. Therefore, performing complex motor skills, such as those performed by gymnasts, requires a great sense of balance.

The vestibular system encodes self-motion information by detecting the motion of the head in space. In turn, it provides us with our subjective sense of self-motion and orientation thereby playing a vital role in the stabilization of gaze, control of balance and posture **(Angelaki & Cullen, 2008)**.

Balance is the process of maintaining the position of the body's center of gravity vertically over the base of support and relies on rapid, continuous feedback from visual, vestibular and somatosensory structures and then executing smooth and coordinated neuromuscular actions **(Nashner, 1997)**.

(Hrysomallis, 2011) demonstrates that the difference between balance kinds and suggested that, static balance is the ability to maintain a base of support with minimal movement. Dynamic balance may be considered as the ability to perform a task while maintaining or regaining a stable position. Balance is important for the athlete. If the athlete's strategies to maintain balance are unsuccessful, a fall will result. Inefficient balance strategies will result in poor athletic performance. Additionally, the risk of injury may be increased if the athlete cannot maintain balance during performance. **(Galal, 1989)** suggested, factors which, influence balance include sensory information obtained from the somatosensory, visual, and vestibular systems and motor responses that affect coordination, joint range of motion.

A spring floor exercises is one of the essential devices in gymnastic, which depends upon the coach as an entry point in the preparation of the players in terms of physical, technical and psychological. The technical performance movement in gymnastic sport is important point of research, which is commonly considered by all researchers in gymnastic field. The motivation of the current study was the students' low skill performance level on spring floor exercise event, with consequent difficulties in maintaining balance during and after the spring floor exercise performance and low scores as results.

Therefore, the aim of this study is to establish a training program exercises for gymnastic students to develop the static balance, dynamic balance and skills performance level on spring floor exercise.

2. Material and Methods:

A case-control study design was conducted to compare the skills performance level on spring floor exercises between experiment and control groups as

gymnastic students in faculty of physical education at Zagazig University. It was hypothesized that the difference between both groups would be detected the training program exercises, which could be improve the skills performance level on spring floor exercises. The students underwent for training program exercises of 3 lectures per week and every gymnastic lecture about 120 minutes.

Subject

Thirty-two students participated in this study, sixteen students as experiment group and sixteen students as control group. Experiment students group showed a mean (±SD) of 20.80 (0.55) years for age, 173.55 (4.13) cm for height and 68.90 (3.25) kg for weight. Control students group showed a mean (±SD) of 20.70 (0.60) years for age, 172.25 (4.40) cm for height and 68.00 (3.73) kg for weight (Table 1). The participants were measured functionality test of the vestibular system, static balance test, and dynamic balance test and performance level on spring floor exercises.

Table 1: Descriptive statistics mean ± standard deviation (SD)

Variables	Experiment Group (n = 16)	Control Group (n = 16)
Age (year)	20.80 ± 0.55	20.70 ± 0.60
Height (cm)	173.55 ± 4.13	172.25 ± 4.40
Body weight (kg)	68.90 ± 3.25	68.00 ± 3.73

Study Procedures

Pre-test and post-test measurements were conducted on one day separately. After standard anthropometrics tests all gymnastic students warmed up for 15 minutes and followed by stretching exercises, then the testing session began with functionality test of the vestibular system, static balance test, dynamic balance test and skill performance level on spring floor exercises.

Functionality Vestibular System Test

The aim of this test is to measure the functionality of the vestibular system for gymnastic students. From standing position, the student turning around his front foot 5 continuous times with sides arms. After 2 seconds in stability position, the student perform 2 frontal rolling and then walk on specified straight line of 4 meters length, which is attached on the ground and installed with plaster 2 cm wide. The student repeats this procedure test again and ends the test with standing position. The students were evaluated in this test by measuring the extent of deviation from a straight line (right and left), while walking and during a frontal rolling, as an indicator of the efficiency of the functionality of the vestibular system.

Static Balance Test

The aim of this test is to measure the static balance ability. For this test, it was used a plate of wood with attached bar in the middle (H 20 cm X L 60 cm and T 3 cm) and stopwatch. The student stands with one foot horizontally on the middle bar and another foot on the plate wood or on the ground. After the commend signal of tester, the student hip his free leg extend at front horizontal position and stay with another foot on the middle bar as long time as possible. The students were evaluated in this test by time score in seconds, which student stay with for a long time statically on the bar, as an indicator of the ability of the static balance.

Dynamic Balance Test

The aim of this test is to measure the dynamic balance ability. For this test, it was used a tape measure, stopwatch and 11 mark (1 inch) size installed on the ground at length position of 12 meter. The student stands with his right foot on the first mark and jumps with left foot to the next mark and stay on for maximum 5 seconds and jumps again with right foot to the next mark and stay on for maximum 5 seconds. The student continues with both foots toward marks until end at standing position. For every success jump, the tester scored 10 points for the student, who stands correctly with his foot exactly on the marks and stay time on the marks. The total point of this test was 100 points.

Performance Level on Spring Floor Exercises

Every student performs a complete gymnastic movement skill on spring floor exercises. The performance level evaluated by judgments committee, who evaluate the performance level based on the total score of the performance, which was 15 points. Each student performed 3 trials, and the best of them will be accepted for statistical analysis.

Statistical Analysis

Descriptive statistics were derived for all test variables using SPSS (15.1). Differences in test parameters between experimental and control groups were assessed by an independent samples t-test. Statistical significance was accepted at an alpha level of p-value ≤ 0.05.

3. Results

The results for this study are outlined in the next two tables (Table 2, Table 3).

Table 2: Pre-test of study measurements (mean ± SD) and independent t-test (*p*) between experiment and control groups

Variables	Groups	Mean ± SD	Mean Difference	*p*
Deviation to right A (cm)	Exp	22.50 ± 3.17	-0.50	0.44
Deviation to right A (cm)	Con	22.00 ± 3.02		
Deviation to left A (cm)	Exp	25.00 ± 4.95	-0.40	0.23
Deviation to left A (cm)	Con	24.60 ± 4.47		
Deviation to right B (cm)	Exp	24.76 ± 5.13	-0.76	0.42
Deviation to right B (cm)	Con	24.00 ± 5.20		
Deviation to left B (cm)	Exp	28.50 ± 5.68	-0.75	0.16
Deviation to left B (cm)	Con	27.75 ± 4.99		
Static balance (sec)	Exp	39.19 ± 3.42	-0.69	0.57
Static balance (sec)	Con	39.88 ± 3.15		
Dynamic balance (point)	Exp	60.50 ± 6.19	-0.50	0.23
Dynamic balance (point)	Con	61.00 ± 5.97		
Performance level (point)	Exp	8.50 ± 1.02	-0.50	1.28
Performance level (point)	Con	8.00 ± 1.11		

Exp = Experiment, Con = Control and sec = Seconds

The results of above table demonstrate no significant difference between experiment and control groups overall study parameters ($p \geq 0.01$).

Table 3: Post-test of study measurements (mean ± SD) and independent t-test (*p*) between experiment and control groups

Variables	Groups	Mean ± SD	Mean Difference	*p*
Deviation to right A (cm)	Exp	15.00 ± 2.94	-4.23	0.00**
Deviation to right A (cm)	Con	19.23 ± 2.58		
Deviation to left A (cm)	Exp	16.50 ± 4.24	-3.50	0.00**
Deviation to left A (cm)	Con	20.00 ± 3.99		
Deviation to right B (cm)	Exp	17.00 ± 4.01	-4.00	0.00**
Deviation to right B (cm)	Con	21.00 ± 4.17		
Deviation to left B (cm)	Exp	20.00 ± 5.15	-4.95	0.00**
Deviation to left B (cm)	Con	24.95 ± 4.02		
Static balance (sec)	Exp	51.37 ± 3.28	-3.76	0.00**
Static balance (sec)	Con	47.61 ± 2.89		
Dynamic balance (point)	Exp	74.81 ± 5.35	-6.81	0.00**
Dynamic balance (point)	Con	68.00 ± 4.66		
Performance level (point)	Exp	12.00 ± 1.59	-2.00	0.02*
Performance level (point)	Con	10.00 ± 1.63		

Exp = Experiment, Con = Control, sec = Seconds, * $p \leq 0.05$ and ** $p \leq 0.01$

The results of above table demonstrate significant difference between experiment and control groups overall study parameters ($p \leq 0.01$).

4. Discussion

Aim of current study was to establish a training program exercises for gymnastic students to develop the static balance, dynamic balance and skills performance level on spring floor exercise. The results of current study demonstrate that the static and dynamic balance abilities and performance level on spring floor exercises are generally better in experimental group compared to control group students. The difference between both groups in post-test results can be explained by the effectiveness of training program contents, which includes a specific exercises of three movement axes (horizontal – vertical – sagittal), and reflect the development of vestibular apparatus efficiency.

The results of current study confirmed the relation between vestibular apparatus efficiency and improving the static and dynamic balance and the skill performance level on spring floor exercise. The results of current study consisted with study of **(Abd-El-Maksoud, 2000)**, who reported that the balance exercises could be improve the efficiency and functionality of vestibular apparatus to maintaining balance. The finding results of current study confirmed the suggestion of **(Balter et al., 2004)** who

reported, gymnasts often practice motionless balance skills on the balance beam, similar to skills required in the gymnastic sport. Hence, gymnasts may develop superior attention focus on cues that alter balance performance, such as small changes in joint position and acceleration.

According to the findings of current study and other studies of **(Zakaria & Ibrahim, 1993; Cohen et al., 1995; K. M. El-Sadiq, 2000; I. M. El-Sadiq, 2001; El-Akkad, 2003; Balter et al., 2004; Angelaki & Cullen, 2008)** who confirmed that, the highly trained athletes demonstrate a significantly lesser error RPP and RAP and better balance during the one-legged stance and single-limb hopping course which implies enhanced neurosensory pathways. It is thought that the athletes are able to develop enhanced neurosensory pathways as a result of long-term athletic training and the quality of functional efficiency of vestibular apparatus could be leads improvement in static and dynamic balance.

The results of current study indicate that the experimental group students had better proprioceptive ability than the control group students in all tests (Table 3). It seems that extensive special training with established exercises has a positive influence on balance and proprioception in addition to increasing the muscle tone of any joint, which leads a clear improvement during a skill performance level on spring floor exercises. This findings of current study consists with **(Allawi & Nasr-El-Din-Radwan, 2001)**, who confirmed that, players who are high performance level showed highly in abilities of static and dynamic balance. Also **(Walder, 1994; Baumgartner & Jackson, 1998)** reported that the balance is considered the starting point of the dynamic behavior and can't perform any movement successfully, if it beginning to learn the skill or training. The player who lost the balance during a preparation phase, it couldn't be to inaccuracies the technical performance in main phase, and hence the low level of performance.

Conclusions

The superior functionality of vestibular apparatus plays an important role for gymnasts and improves the joint position and static and dynamic balance, while perform movement exercises on spring floor exercise event. Experimental group students in this study demonstrated a higher incidence of balance and superior joint position sense in their ankle than the control group students as measured by the functionality test of the vestibular system, static balance test, dynamic balance test and performance level on spring floor exercises. The result of current study can be useful for designing programs to aimed improvement balance. It is suggested that future study in this field conducted with a larger sample size and in different athletes. In addition, it is recommended that the special training exercises for students include balance training and, more specifically for gymnasts, balance programs that incorporate elements of their gymnastic routines, could be useful to improve their performance level on spring floor exercises.

References:

1. **Abd-El-Maksoud, E. (2000)**: *Theories of the movement*. Cairo-Egypt: Center of book publication.
2. **Allawi, M. H., & Nasr-El-Din-Radwan, M. (2001)**: *Tests of motor performance*. Cairo-Egypt: House of Arab thought.
3. **Angelaki, D. E., & Cullen, K. E. (2008)**: Vestibular system: the many facets of a multimodal sense. *Ann. Rev. Neurosci, 31*, 125-150.
4. **Balter, S. G., Stokroos, R. J., Akkermans, E., & Kingma, H. (2004)**: Habituation to galvanic vestibular stimulation for analysis of postural control abilities in gymnasts. *Neurosci Lett, 366*(1), 71-75. doi: 10.1016/j.neulet.2004.05.015
5. **Baumgartner, T. A., & Jackson, A. S. (1998)**: *Measurement for evaluation in physical education and exercise science* (6th ed. ed.). Boston, Mass.: WCB/McGraw-Hill.
6. **Cohen, H., Kane-Wineland, M., Miller, L. V., & Hatfield, C. L. (1995)**: Occupation and visual/vestibular interaction in vestibular rehabilitation. *Otolaryngol Head Neck Surg, 112*(4), 526-532.
7. **El-Akkad, A. M. (2003)**: The impact of the development of the functionality of the vestibular system on the performance of some of the skills of gymnastics pupils Floor deaf and dumb. *Journal of Sports Science and Art, 41*(1),65.
8. **El-Sadiq, I. M. (2001)**: The impact of the development of the functionality of the vestibular analyzer to perform the movement of the bow and the back rear confrontation of some psychological traits in wrestling. *Faculty of physical education of men, Zagazig university*.
9. **El-Sadiq, K. M. (2000)**: The impact of the development of the functionality of the vestibular apparatus on the dynamic equilibrium in some sports activities. *College of physical of men, Zagazig university*.
10. **Galal, A. (1989)**: The impact of a training program proposal at the level of functional efficiency of the device vestibular to the youth 13-15 years old and players of the first class in the sport of gymnastics. *Zagazig physical education journal, 5*(6),24-25.
11. **Hrysomallis, C. (2011)**: Balance Ability and Athletic Performance. *sports Med, 41*(3), 221-232.
12. **Nashner, L. M. (1997)**: Practical biomechanics and physiology of balance. In G. P. Jacobson, C. W. Newman & J. M. Kartush (Eds.), *In Handbook of balance function testing* (pp. 261-279). San Diego: Singular Publishing Group.
13. **Walder, P. (1994)**: *Mechanics and sport performance*. New Milton: Feltham.
14. **Zakaria, Y., & Ibrahim, A. M. (1993)**: the impact of improving the functional efficiency of the central nervous system using pregnancy lobby- motor at the level of performance somersault front on the hands by lifting individual and landing double. *The scientific journal of physical education and sports, Alexandria University, 5*.