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Study to Compare the Effects of Balance Exercises on Swiss ball and Standing, on Lumbar Reposition Sense, in Asymptomatic Individuals

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ABSTRACT

Background and Purpose: Swiss ball has been extensively used as an effective appliance that improves balance by providing unstable surface and thereby reinforcing the proprioceptive feedback from joints and muscles. The purpose of this study was to testify this very fact. Swiss ball exercises were tested against standing balance exercises in normative individuals to see the anticipated changes in proprioception and this data was compared with a control group to see the deviation away from placebo. **Methods:** Thirty normative, healthy subjects with sedentary lifestyle were recruited with informed consent and divided randomly into three different groups. Group A performed Swiss ball exercises while Group B performed standing balance exercises. Control group, Group C was asked to perform a random set of exercises not intended to improve lumbar proprioception. Lumbar reposition error was tested in all three groups with gravity inclinometer before the commencement of study and at its termination. **Results:** While comparing both sets of exercises, Group B with standing balance training showed a significant reduction in lumbar reposition error over the course of two weeks as compared to Group A with swiss ball training. Group C, the control group, showed no significant difference in initial data and last data obtained. **Conclusion:** The study proves that the specific lumbar reposition sense, a marker of balance, improves better with standing proprioceptive and balance exercises as compared to the swiss ball proprioceptive and balance exercises.

Key Words: Lumbar reposition sense; Reposition error; Swiss-ball balance training; Standing balance training.

INTRODUCTION

In the middle of the 20th century, when polyvinyl plastic age opened a new frontier in plastic industry, the initial trend was to use it to manufacture small toys and figurines. At the same time an Italian manufacturer, "Aquilino Casini", was working on his inventive technology of molding plastic, intending to make some larger objects for commercial use, and the first thing that he manufactured it was a round puncture-resistant "exercise ball!"[1].

The exercise ball or Swiss-ball gained popularity all over Europe and, shortly after, all over the world. It became an immensely popular sports product, especially among physical therapists.

Our study aims at finding a scientific proof behind the popular notion of using "Swiss Ball" balance exercises over standing balance exercises to improve the lumbar proprioception which plays a key role in maintaining erect posture and adequate balance in a normal, healthy adult.

Proprioception is the modality that provides feedback solely on the status of the body internally. This sense indicates whether the body is moving with required effort and where the body parts are located at specific time. Balance is an ability to maintain the centre of gravity of a body within the base of support with minimal postural sway[2]. It requires concurrent processing of inputs from multiple senses, including vision, equillibrioreception, pressure senses from different peripheral structures and proprioception while the motor system continuously acts to correct it. The product of continuous proprioceptive input is correct balance. A project completed by K.P. Granata and S.E. Wilson proposed that the spinal stability is influenced by posture, which in turn is the product of correct proprioceptive input[3].

Stability is the equilibrium achieved by some specific body part and, henceforth, proprioception becomes an important factor in determining balance[4].

The aim of the study was that comparing standing and Swiss-ball exercises to assess which one improves lumbar reposition sense and, thus,

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balance? Therefore, the study was done to see the importance of segmental involvement of spine and overall recruitment of body and compare its effects on lumbar proprioception and balance.

METHODS

An experimental method was used with thirty normal, healthy individuals recruited from SBSPGI, Dehradun, in the study. Subjects who were healthy and had no physical complaints were selected for the study. In particular all of them had sedentary lifestyle. Exclusion criteria for subjects involved, 1) Limited spinal ROM 2) Spinal pathology like disc problems and trauma 3) History of LBA or radiating pain 4) Subjects having any spinal deformity as scoliosis, kyphosis or lordosis 5) Subjects with hip deformity or knee deformity as genu varum or valgum 6) Limb length discrepancies 7) Subjects suffering from hamstring tightness and iliopsoas tightness.

The study included thirty subjects to whom detailed explanation of procedure was given and then informed consent was obtained. The thirty subjects were then randomly divided into three different groups. The subjects were informed in detail with the specific sets of exercises designed for them. Group A performed Swiss-ball balance training; Group B performed standing balance exercises; and group C, the control group was given random exercises not intended to improve proprioception and balance. Two weeks' exercise protocol was used with no reduction or addition of other sets of exercises.

Gravity inclinometer was used as a standard device to measure Lumbar Reposition Sense (LRS)[5]. Assessment of LRS with three trials at commencement of study followed by three trials at the end of study was done and the mean readings of both were noted.

Group A performed Swiss-ball exercises that included,

1. While seated on Swiss ball, balancing oneself on Swiss ball and then pushing it down on firm platform.
2. While seated on Swiss ball, balancing oneself on Swiss ball and then pushing it down on unstable platform.
3. While seated on Swiss ball, performing outreach activities.
4. While seated on Swiss ball performing forward and backward leaning.
5. While seated on Swiss ball, moving sideways.

Exercises were performed eyes closed as to block any visual feedback to maximize proprioception on work.

Group B performed standing balance exercises that included,

1. Standing on one leg with eyes closed.
2. Standing in tandem stance with eyes closed.
3. Tandem walk.
4. Jumping on trampoline.
5. Standing on wobble-board.

Exercises were performed eyes closed as to block visual feedback and, therefore, to maximize proprioceptive feedback.

Group C was instructed to perform some random exercises like bending arms, forearms and shoulder. All the exercises didn't include any activity of lumbar spine.

Statistics

SPSS software (version 16.0) was used to analyze the results. Intra-group analysis was done with one way ANNOVA to compare the mean value of initial LRS scores in all three groups. It was again used to compare the inter-group mean values of LRS reading between three groups prior to study and at the end of study after around two weeks. Paired-t test was used to compare the mean values of LRS reading at commencement of study and at the end of the study. A significance level of 0.05 was selected.

RESULTS

Thirty patients (mean age 22.2 ± 1.24) participated in this study. They were divided into three groups with 10 subjects in each group: Group A (Swiss-ball group, mean age 22.5 ± 1.26), Group B (standing group, mean age 21.9 ± 0.99); and Group C (control group, mean age 22.2 ± 1.47).

Statistical analysis of data revealed that the initial analysis done with one way ANNOVA to see the LRS reading between groups A, B and C at commencement of study established the baseline error for all the three groups. During initial recording a high margin of error was noted in Group B (standing group) at this stage. (Table 1, Figure 1).

Comparison of obtained data was again done at the end of 2nd week between the initial readings and end readings of Groups A, B and C. Group B had significantly reduced lumbar reposition error as obtained at the end of second week, thus justifying that the standing balance training reduced the baseline error marginally (Table 2, Figure 2). The two other groups, A and C (Swiss-ball group and

Table 1. Comparision between the LRS reading between Group A, B, and C at 0 week- (Anova)

Group	0 Week LRS Reading
A	1.53 ± 0.39
B	3.26 ± 1.68
C	1.79 ± 0.72
f-value	7.453
Significance	.003

N.S. = Not Significant. (p> 0.05) S = Significant (p< 0.05)

Table 1 shows the mean LRS reading taken at the commencement of study. It establishes the base-line value of LRS for all the three groups.

Figure 1. ANNOVA applied for comparing the initial readings of LRS, this establishes the baseline value of LRS for all the three groups.

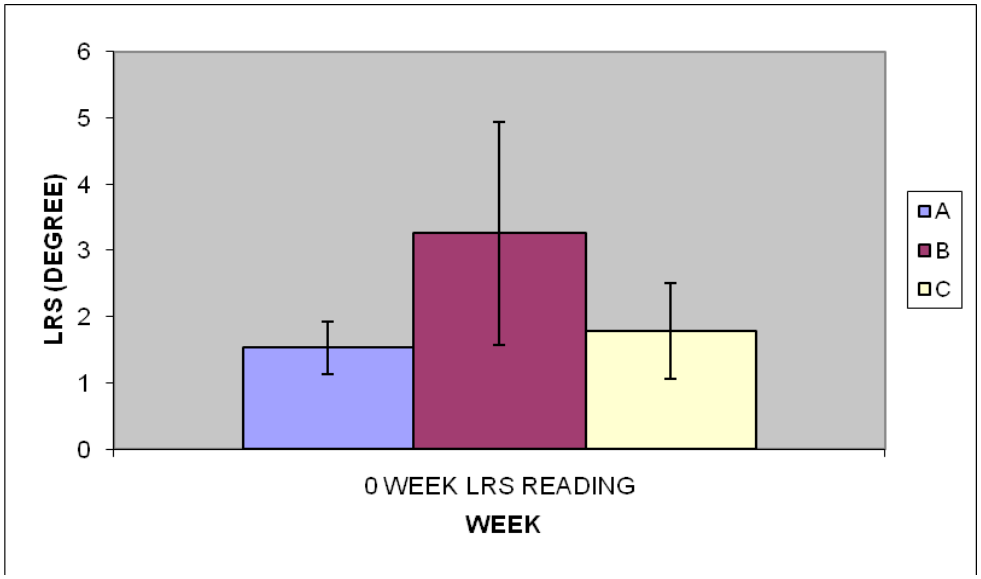

Table 2. Comparision between the LRS reading at 0 week and 2nd week between Group A, B, and C. (Anova)

	LRS 0-week reading	LRS 2-week reading
Group- A	1.53 ± 0.39	1.66 ± 1.70
Group- B	3.26 ± 1.68	1.12 ± 0.84
Group- C	1.79 ± 0.72	1.93 ± 0.69
f-value	7.453	1.219
Significance	S	NS

N.S. = Not Significant. (p> 0.05) S = Significant (p< 0.05)

Table-2 shows the ANNOVA test for inter-group comparison of baseline value of LRS reading at initial week and at the end of 2nd week.

Figure 2. Annova for week-0 and week-2

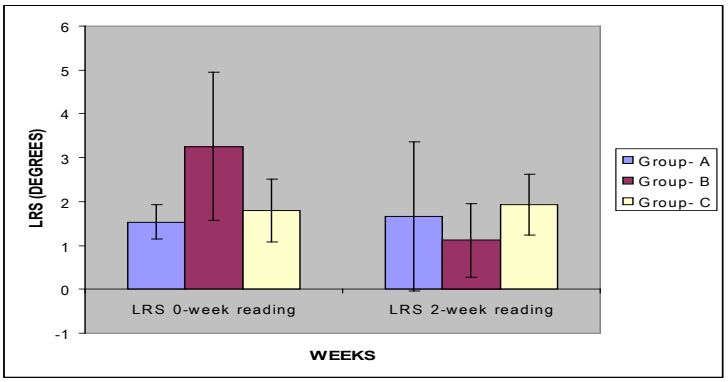

Figure 2 : ANNOVA Applied for comparing the initial readings of LRS and end reading of LRS. Figure demonstrates the marked reduction in Lumbar Reposition Error of Group B, the standing balance exercise Group.

control group) saw no differences in initial reading and reading at the end of two weeks, suggesting that with regards to lumbar proprioception, Swiss ball had no marked effects as compared to that of placebo (Table 3, Figure 3).

Table 3. Comparision between the final and initial reading of LRS between group A, B, and C. (Paired T-test)

	GROUP-A	GROUP-B	GROUP-C
0-WEEK	1.53 ± 0.39	3.26 ± 1.68	1.79 ± 0.72
2-WEEK	1.66 ± 1.70	1.12 ± 0.84	1.93 ± 0.69
t-VALUE	-.242	3.014	-.414
SIGNIFICANCE	NS	S	NS

N.S. = Not Significant. ($p > 0.05$) S = Significant ($p < 0.05$)

Table-3 shows the intra-group comparison with paired-t test between the initial LRS reading and LRS reading at the end of exercise protocol. A high significance level of group B suggests marked improvement in Lumbar Reposition error with standing balance exercises.

Figure 3. Paired t-test for week 0 and 2

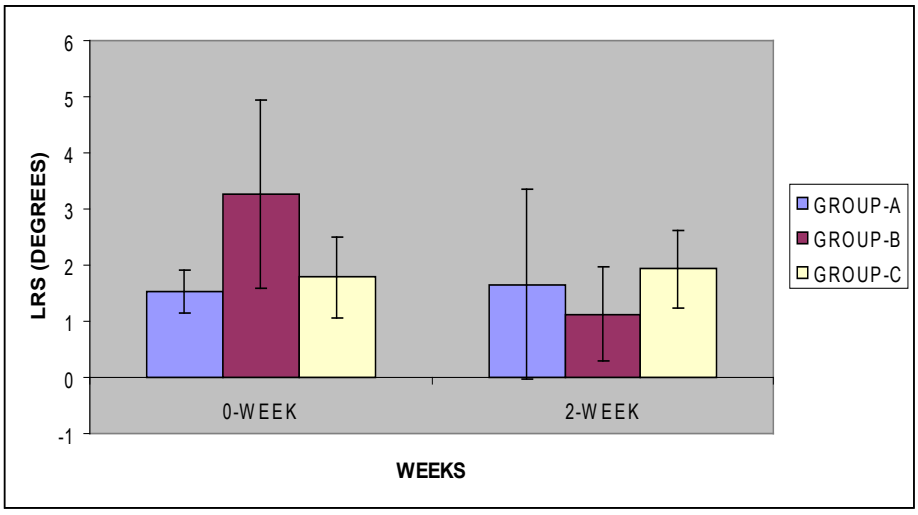

Figure 3 : Paired t-test applied for evaluating the intra-group LRS reading at the commencement of study and at the end of 2 weeks. The marked reduction of 2nd week LRS reading as compared to baseline LRS value suggests Group B with standing balance training had better improvement of proprioception.

DISCUSSION

Popularity of Swiss ball since the past few decades has made it a common tool for recreational activity as in gymnasiums, spas, and houses, as a therapeutic tool in clinics; in general fitness routines, athletic training; and in alternative exercises like Yoga and Pilates. The versatility of the device makes it a common tool in various activities, viz. physical therapy and exercises as well. It has been used in weight-lifting programs and in gynecology too[6].

Earlier studies and some present studies have validated Swiss ball as a tool of choice for strengthening as well as muscle activation purpose. Swiss ball as compared to other conventional devices is said to increase the amplitude of EMG signals during abdominal exercises, which has been attributed to the proprioceptive input[7].

Studies have claimed that the abdominal and back muscles are constantly engaged and active in order to maintain proper posture and balance on the ball[8, 9]. A report published in 2001 by Scibek, J.S., and K.M. Guskiewicz, et al. has stated that the core stability is improved by the inclusion of Swiss ball training into an existing training program.[10].

Peoples who are in favor of Swiss ball as a more suitable device for exercise regimens have argued that the adaptations following these exercises occur primarily in the nervous system[11].

Many studies claime the suitability and usefulness of Swiss ball as an alternative to conventional exercise regimen, but, to date, on the ground of reality, their contribution to enhance physical performance still remains uncertain. Therefore, there is a greater need of further studies that demonstrate its effectiveness to enhance physical performance.

Though some studies also suggest that prolific and universal use of Swiss balls in physical therapy and athletic preparation demands further investigation to validate their use in physical training programs[12].

One such research which incorporates the use of more reliable tools like EMG presents a different idea altogether. A study published in Dynamic Medicine, Gregory J Lehman and Trish Gordon et al., has provided groundwork by clarifying that replacing an exercise bench with a Swiss ball is not a guarantee for increased trunk muscle activation, and, in fact, individuals respond differently to unstable surfaces. They observed that if the justification of incorporation of Swiss ball is an aid to "train the core", i.e. recruit agonist-antagonist trunk muscles, then this can't be supported by the results of their study[13].

Furthermore, a study conducted by Gregory J Lehman has stated that individual factors may play a big role in how muscle activation levels are affected by the addition of an unstable surface. He stated that in all trunk muscles they included in their study, viz. upper and lower erector spinae, rectus abdominis, external oblique, and lower abdominal stabilizers, there were no differences in muscle activation levels between altered surface conditions, either labile surface like Swiss-ball or stable grounds[14].

Our study bears the same idea where a significant improvement in lumbar proprioception has been induced with two weeks of standing proprioceptive exercises. This is presumably because of involvement of whole trunk and lower limb musculature and joints which add up to a sum total of proprioception.

Therefore, our study confirms that using a Swiss ball as an efficient device that improves the core stability is rather a concept that is restricted to specific muscles and also not generalized to whole population.

The clinical significance emerges from the evidence based practice for involvement of standing proprioceptive exercises for subjects with normal back muscle strength and no biomechanical faults.

This study may be utilized by rehabilitation clinicians when designing a rehabilitation program for acutely suffering young population. During this, it should be remembered that merely adding the labile surface as provided by Swiss ball doesn't always increase the load on neuromuscular system in every patient and individual responses to it vary greatly[14].

If the aim of a therapist is to rehabilitate or prevent low back injury, then sound biomechanically justified or clinically proven rehabilitation protocols should be advocated. Kavcic et al. provides biomechanical support for ground based simple exercises to adequately train the spinal stabilizers while minimizing the compressive/shear penalty and ensuring adequate spinal stability[15].

Limitations of the study

1. The study was done in normative asymptomatic population and not in the patients.

2. The comparison was done between simple standing and Swiss-ball exercises. But more detailed explorations are needed for the same with varying modifications of these tools.

3. Limited trials of two weeks were undertaken; a longer duration of trial phase is required in future

studies.

Future scope

1. A series of experimentations are needed to compare the same effects in subjects with balance disorder.

2. The study addresses the requirement of correct exercise prescription.

3. Prolonged study duration may yield a significant result of same study in people with proprioceptive/ balance problems.

4. The subject range of this study was narrow; involvement of more subjects for the same study will certainly reduce the chances of possible errors.

CONCLUSION

While comparing Swiss ball training with standing balance training, it emerged that standing balance training is more effective in providing proprioceptive feedback. The comparison of Swiss-ball training and standing balance training with control group additionally ruled out any difference other than placebo.

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