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A profile of Senaptec Strobe on functional balance in football players

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Background: Stroboscopic visual training (SVT) is an approach that involves wearing specialised eyewear to improve visual and perceptual abilities, potentially leading to enhanced motor performance in sports.

Aim: The aim of this study is to assess and improve balance in football players using SVT.

Setting: The study was conducted at the Sports Vision Centre, Department of Optometry, Faculty of Allied Health Sciences, Dr. M.G.R. Educational and Research Institute.

Methods: Ninety-eight male athletes were assigned to the experimental group (EG = 49) and the control group (CG = 49). The pre-tests, including the modified star excursion balance test (m-SEBT), arrowhead agility test and single leg hop test, were done. The EG group underwent SVT and proprioceptive training (PT) for 8 weeks, and the CG group underwent their regular football training. Post-tests were taken after 8 weeks of training. Then the pre- and post-tests were analysed and concluded.

Results: After 8 weeks of SVT, the EG showed significant improvement in their performances compared to the CG, which had a significant improvement in m-SEBT right leg stance ($P \leq 0.001$), m-SEBT left leg stance ($P \leq 0.001$), arrowhead agility right-side test ($P \leq 0.001$), arrowhead agility left-side test ($P \leq 0.001$), single right-leg hop test ($P \leq 0.001$) and single left-leg hop test ($P \leq 0.001$).

Conclusion: The 8-week stroboscopic and PT had a great impact on improving balance, agility and jump performance in young football players. This shows that the SVT and PT can be implemented as training regimens in various sports.

Contribution: Stroboscopic visual training and PT can be included in a football training regimen to increase strength and balance.

Keywords: Stroboscopic visual training; proprioceptive training; football players and balance.

Introduction

The ability to maintain the body's centre of gravity (CoG) above its base of support is known as postural balance. A continuous feedback system that processes visual, vestibular and somatosensory inputs and performs neuromuscular actions is responsible for controlling balance.[1] Balance ability was found to be associated with competition level in various sports, with more skilled players exhibiting stronger balance. Though it is unclear how balancing skill and athletic performance are related, balance has been demonstrated to be essential to many athletic activities and sport-specific posture control. The ability to balance can help an athlete perform better. The head's posture and movement in relation to the objects around it are controlled by vision. Vision-based information is crucial for sustaining balance.[2]

Vision training, which combines visual exercises with athletic conditioning, improves sports performance and reduces injury risk by enhancing neuro-visual processing and brain function.[3]

An approach known as stroboscopic visual training (SVT) involves subjecting people to intermittent vision conditions while frequently wearing specialised eyewear to improve their visual and perceptual abilities. Such improvements could therefore, in theory, lead to enhanced motor performance from a sporting aspect.[4] A type of cognitive-motor training, known as strobe

Note: This article was republished with an updated ethical considerations statement, acknowledgement statement and Table 1. This does not alter the study's findings of significance or overall interpretation of the study's results. The publisher apologises for any inconvenience caused.

training, involves doing the motor task in periodically dark environments. One piece of modern innovation that helps with multisensory integration's sensory reorientation is strobe spectacles.[5]

Stroboscopic spectacles, which have been developed more recently owing to technological advancements, have been demonstrated to lessen this dependence and push the performer's visual system to train in more challenging environments, possibly improving performance when the eyewear is taken off.[6] The lenses, which use liquid crystal technology, flicker between clear and opaque, eliminating visual information and requiring the wearer to integrate information more quickly.[4] The stroboscopic eyewear's flickering effect causes a visual disturbance for the wearer that impairs visual cognition. It may be helpful in motor control rehabilitation programmes and offer visual feedback for postural control in those with somatosensory problems. Additionally, stroboscopic training has been suggested as a method to aid in anterior cruciate ligament rehabilitation and prevent reinjury.[7]

It is possible to include the Senaptec Strobe in current training routines and activities.[4] It is logical to believe that individuals will be forced to rely less on online visual input if visual information is interrupted. People will have to use the little amount of visual information that is available more effectively because of the lack of visual input. As a result, primary visual-motor control may be supported by improved perception and attentional skills.[8]

By disrupting the regular flow of visual information—whether through intermittent or stroboscopic means—visual input provides a compelling method for experimental manipulation, as it reduces the availability of sensory feedback required for real-time movement regulation. Consider attempting to catch a ball in a stroboscopic setting, for instance. You must make assumptions between discrete visual samples because you are unable to observe constantly to accurately determine the speed of the ball. When the stroboscopic rate is high enough, there is regular visual input, and catching the ball is not difficult. But as the rate drops, there is a longer lag between visual samples, which results in the loss of crucial visual information. It becomes very challenging to grab a thrown ball under these circumstances.[9] The advantages of specific stroboscopic intervention in general perceptual-cognitive and motor skills have been frequently reported by scientific research. Significant improvements were obtained with stroboscopic intervention in visual and visuomotor function; the enhancement in visuomotor function was higher than in sensory processing. Reactive agility was also improved with stroboscopic training, with short-term changes showing more performance gains than long-term ones.[10]

The ability of humans to sense their own body's position, movement speed and general or particular resistance is known as proprioception. In sports, proprioception is crucial because it plays a part in joint stability and injury prevention.[11] Proprioception training (PT) characterises the reaction to stimuli produced inside an organism and includes both conscious and unconscious knowledge of postural balance, muscular feeling and joint stability.

The BOSU Balance Trainer is a workout apparatus that improves core strength, proprioception and balance. The apparatus is comprised of a level 25-inch surface featuring two integrated handles and an expandable rubber dome raised to a height of roughly one foot. Each side can be used in a different way to produce different scenarios, depending on the activity. Balance training is a common use for this apparatus.[12] For football players to perform at their peak on the field, stability and coordination must be improved. These can be achieved by including the BOSU Balance Trainer in a physical therapy programme. Sportsmen can improve their overall performance and lower their chance of injury by working their core muscles and proprioception. Additionally, the BOSU Balance Trainer can be utilised for plyometric exercises to improve power and agility in soccer players. Incorporating this versatile tool into a PT programme can help athletes enhance their overall physical performance on the field.

The study hypothesises that an 8-week intervention of SVT and PT will significantly enhance functional balance, agility and jump performance in young university football players compared to conventional football training.

'The primary objective of numerous visual performance assessments and training programmes is to evaluate and optimise the efficiency of visual information processing.'[13] Thus, the aim of this study is to assess and improve the functional balance, including agility and jump performance, in young university football players using SVT and PT training over a period of 8 weeks.

Methodology

This research is a comparative study. The total study population was 98, which was randomly divided into two groups: an experimental group (EG = 49) and a control group (CG = 49). The participants were university football players who had undergone training for more than 5 years and ranged in age between 18 and 25 years.

Participants' body composition was analysed using Bioelectrical Impedance Analyzer or Body Composition Analyzer (BIA) (OMRON), which includes age, height, weight, fat mass and muscle mass. Performance training eyewear, called the SENAPTEC STROBE, was used in this study. The lenses, which use liquid crystal technology, flicker between clear and opaque, eliminating visual information and requiring the wearer to integrate information more quickly. The Senaptec Strobe is included in training to enhance visual processing, reaction time and coordination with the BOSU Ball Balance Trainer. The BOSU Balance Trainer is a workout apparatus that improves core strength, proprioception and balance. The apparatus is comprised of a level 25-inch surface featuring two integrated handles and an expandable rubber dome raised to a height of roughly one foot. Each side can be used in a different way to produce different scenarios, depending on the activity. Balance training is a common use for this apparatus.

Procedure

Following informed consent from the participants and the university, a total of 150 football players were assessed. Based on inclusion criteria (footballers aged 18–25 years, male, with more than 5 years of football experience) and exclusion criteria (individuals with ocular diseases, neurological or cardiovascular conditions, including epilepsy, migraines, or psychiatric disorders, as well as those with any current systemic illness), 98 athletes with similar perceptual and motor skills were included in the study. The participants underwent a brief ocular and systemic history, and the preliminary examinations, which include visual acuity, stereopsis, near point of convergence, anterior segment and posterior segment evaluations, were done. After completion of preliminary examinations, the pretests of arrowhead agility test[11] modified star excursion balance test (m-SEBT),[14] and single-leg hop test[15] were done.

Stroboscopic training

The participants were randomly divided into EG (EG = 49) and CG (CG = 49). The EG group was given an 8-week training of stroboscopic training and PT using Senaptec Strobe and BOSU Ball Trainer, as shown in Figure 1. During the training period, the difficulty of the strobe frequency level was increased every week from level 1 to level 8, and the modes of eyewear were changed every 2 weeks from mode A to mode D. These levels refer to the speed change from clear to opaque in the lenses. The slower the change, the more difficult it is to adjust. Both stable and unstable surfaces of the BOSU Ball Trainer were altered according to the training protocols. The following training regimen[11] is used:

A total of 8 weeks of training, which was 3 days/week, 15–30 min per session, was given. Each balance training was given on both foam and firm surfaces of the BOSU Ball Trainer. The training was performed with a recovery time of 30 s and sets of 4 × 10 per limb.

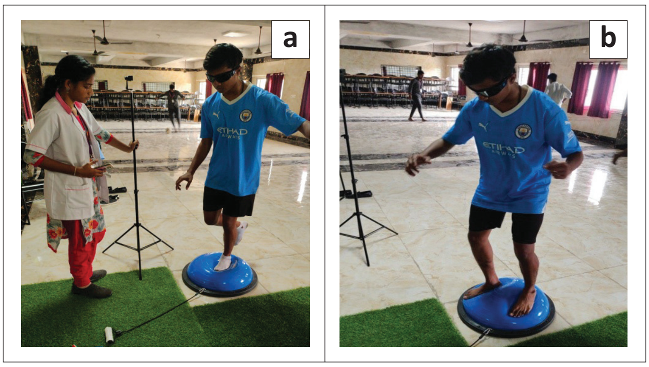

FIGURE 1: (a, b) Image of an experimental group participant practicing balancing drills while wearing stroboscopic **spectacles** within the stroboscopic visual training programme.

Balance training

- Standing on the BOSU ball, perform two-leg squats.
- One-leg standing squats on a BOSU ball; four-by-10 for each limb.
- While standing on the BOSU ball with one foot, swing one leg forward, backward and laterally.
- One-footed forward jumps from the ground onto a BOSU ball, maintaining the landing posture.
- Lateral jumps on one foot, lateral jumps from the ground on the BOSU ball and retaining the landing position for 2–3 s.
- Jump forward on two BOSU balls.
- Kicking a football hit by a teammate while standing with both feet on a BOSU ball.
- Kicking a football thrown by a teammate while standing on one foot on a BOSU ball.
- Heading a football launched by a teammate while standing on one foot on a BOSU ball.
- Leap forward from one BOSU ball to another, landing in the same spot for 2–3 s while kicking a football tossed by a teammate.
- Kick a football tossed by a teammate while standing on one foot on the BOSU ball with an elastic band tied around both feet.
- Move the football around the BOSU ball while standing on one foot on the BOSU ball.

Data analysis

Statistically, the pre-test and post-test data of the experimental and CGs were analysed using the paired sample *t*-test and Wilcoxon signed test in SPSS software.

Ethical considerations

The study was approved by the Institutional Ethics Committee (IEC) of ACS Medical College and Hospital (Reference Number: 1320/2024/IEC/ACSMCH, dated 17 October 2024) and was registered with the Clinical Trials Registry - India (CTRI) under the registration number CTRI/2024/12/078768.

Results

Table 1 presents the demographic characteristics of participants includes mass, and mass, and muscle mass in both the experimental and control groups. As presented in Table 2, statistical analysis of pre- and post-test data demonstrated a significant improvement in balance, as indicated by the modified Star Excursion Test, in both right- and left-leg stances within the EG compared to the CG ($P \leq 0.001$). These findings suggest that the intervention effectively enhanced postural stability.

TABLE 1: Demographic data of experimental and control groups.

Groups	Age (years)		Height (cm)		Weight (kg)		Fat mass (%)		Muscle mass (%)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Experimental group	19.87	1.03	177.51	10.02	59.42	8.74	14.51	5.63	36.73	2.41
Control group	19.18	1.66	173.22	9.04	58.12	7.54	16.04	6.57	36.16	2.63

s.d., standard deviation.

TABLE 2: Comparison of modified star excursion balance test scores between experimental and control groups.

Tests	Groups	Phase	Test scores (%)		*P**
			Mean	s.d	
m-SEBT right-leg stance	Experimental	Pre-test	78.74	9.35	**≤ 0.001**
		Post-test	87.91	11.18	
	Control	Pre-test	125.23	27.72	0.428
		Post-test	125.33	27.83	
m-SEBT left-leg stance	Experimental	Pre-test	77.31	8.92	**≤ 0.001**
		Post-test	84.59	14.80	
	Control	Pre-test	128.07	29.00	0.757
		Post-test	128.05	28.96	

Note: The bold value indicates statistical significance at 0.001 ($P < 0.001$).
s.d., standard deviation; m-SEBT, modified star excursion balance test.
*, Paired *t*-test.

TABLE 3: Comparison of right-side arrowhead agility test scores.

Tests	Groups	Phase	Test scores (seconds)		*P**
			Mean	s.d	
Arrowhead agility test – right side	Experimental	Pre-test	9.97	0.62	**≤ 0.001**
		Post-test	9.47	0.45	
	Control	Pre-test	9.49	0.47	0.200
		Post-test	9.50	0.47	

Note: The bold value indicates statistical significance at 0.001 ($P < 0.001$).
s.d., standard deviation.
*, Paired *t*-test.

TABLE 4: Comparison of left-side arrowhead agility test scores.

Tests	Groups	Phase	Test scores (seconds)		*P*
			Mean	s.d	
Arrowhead agility test – left side	Experimental	Pre-test	10.41	0.60	**≤ 0.001****
		Post-test	9.58	0.57	
	Control	Pre-test	9.59	0.57	0.054**
		Post-test	9.58	0.57	

Note: The bold value indicates statistical significance at 0.001 ($P < 0.001$).
s.d., standard deviation.
**, Wilcoxon signed-rank test.

As shown in Table 3, statistical analysis revealed a significant improvement in agility in the EG compared to the CG, as indicated by the arrowhead agility test on the right side ($P \leq 0.001$). The reduction in the mean difference of post-test scores in the EG further supports this improvement.

As presented in Table 4, the EG demonstrated a statistically significant improvement in the arrowhead agility test on the left side compared to the CG ($P \leq 0.001$). The mean difference observed in the EG indicates a substantial impact on athletes' performance.

The intervention training also had a great impact on jump performance, which showed a highly significant value of $P \leq 0.001$ in the single right-leg hop test of the EG compared to the CG, which had an insignificant value of $P = 0.247$, as detailed in Table 5.

TABLE 5: Comparison of single right-leg hop test results between experimental and control groups.

Tests	Groups	Phase	Test results (cm)		*P*
			Mean	s.d	
Single right-leg hop test	Experimental	Pre-test	197.29	24.73	**≤ 0.001****
		Post-test	205.98	25.38	
Single right-leg hop test	Control	Pre-test	196.73	20.61	0.247*
		Post-test	196.83	20.62	

Note: The bold value indicates statistical significance at 0.001 ($P < 0.001$).
s.d., standard deviation.
*, Paired *t*-test; **, Wilcoxon signed-rank test.

TABLE 6: Comparison of single left-leg hop test results between experimental and control groups.

Tests	Groups	Phase	Test results (cm)		*P**
			Mean	s.d	
Single left-leg hop test	Experimental	Pre-test	195.71	23.24	**≤ 0.001**
		Post-test	204.21	25.07	
	Control	Pre-test	199.28	24.78	0.601
		Post-test	199.38	24.93	

Note: The bold value indicates statistical significance at 0.001 ($P < 0.001$).
s.d., standard deviation.
*, Paired *t*-test.

Table 6 shows statistically significant improvement in jump performance in the EG when compared to the CG ($P < 0.001$).

Discussion

The goal of this study was to improve balance using SVT. The athletes were randomly split into experimental and CGs. Then, the EG underwent SVT for 8 weeks, whereas the CG had no training. After 8 weeks of training, the improvements were analysed using the pre- and post-tests of parameters, including m-SEBT, arrowhead agility test and single-leg hop test. The values were statistically analysed using the paired *t*-test and Wilcoxon test by SPSS software.

The results revealed that the EG showed significant improvement in all three parameters compared to the CG. It shows significant improvement in the balance skills of football players. The result of m-SEBT of both right-leg stance and left-leg stance was significant, which reveals a great improvement in the balance skill of athletes. The mean difference achieved by the EG was much higher than the CG. In addition to stroboscopic training, proprioceptive training (PT) also contributes significantly to the improvement of balance in athletes. This finding is supported by a prior study,[16] which reported a statistically significant enhancement in balance following PT intervention, consistent with the results observed in the present study. Moreover, training on unstable surfaces has been demonstrated to exert a considerable effect on balance performance. Evidence further suggests that the neuromuscular mechanisms responsible for postural control can be effectively stimulated and enhanced through unilateral stance exercises performed on a BOSU.

A similar study suggested that proprioceptive exercises improved balance scores in athletes with chronic ankle instability. These findings support our results in the m-SEBT, demonstrating significant balance improvements.[17] It is believed that the proprioceptive exercise programme is a useful therapy strategy for easing CAI patients' symptoms.

The stroboscopic balance training had shown results in enhancing balance effects in chronic ankle instability athletes, which is in agreement with the present study of improving balance using SVT.[7] These results suggest that stroboscopic training may be clinically beneficial not only for improving balance measures in athletes with CAI but also for integrating sport-specific rehabilitation phases by reducing visual input and reinforcing motor control.

The findings of our study indicate a significant improvement in the arrowhead agility parameter on both the right and left sides. This is consistent with previous research demonstrating a notable enhancement in agility bilaterally.[11] Furthermore, evidence suggests that the foam surfaces of a BOSU ball are more effective than firm surfaces in optimising proprioceptive components. This is supported by posture and balance measurements conducted on surfaces with varying degrees of flexibility.

Previous research has demonstrated significant improvements in single-leg jump performance, which aligns with our findings of enhanced single-leg hop performance on both the right and left legs.[15] Additionally, studies indicate that exposure to SVT enhances anticipation and visual response time in athletes, corresponding to our findings on improved agility performance.[4]

A review of earlier studies suggests that unstable surface training enhances muscle strength, stability, and balance in athletes, supporting our findings on PT using a BOSU ball.[12] Furthermore, research emphasises that balance control relies on sensory inputs, reinforcing our hypothesis that increased visual feedback through SVT enhances balance.[18]

Collectively, these studies suggest that the combination of stroboscopic and PT plays a crucial role in improving balance, agility and jump performance.

Our study has certain limitations, particularly in assessing the long-term effects and retention of training benefits from Senaptec Strobe training. The lack of follow-up assessments leaves uncertainty regarding the sustainability of these improvements over time. Future research should examine the long-term adaptation of neuro-visual skills and determine whether periodic reinforcement is necessary to maintain performance gains. After completing the 8 weeks of stroboscopic training, the participants were asked to fill out a series of questions which were adapted from questionnaires to know about their experience regarding the usage of strobe and its impact on their performances.[19] Participants were asked to give their feedback on a scale of one to seven, which indicates 1 (totally disagree) and 7 (totally agree) with some opinions. The feedback received from the participants had shown that they had greatly agreed with their performance improvement, and many suggested implementing the training on a regular basis to achieve better performances.

Conclusion

The study concluded that the 8-week SVT and PT had shown great impact in improving balance together with agility and jump performance in young football players, thus showing that the SVT and PT can be implemented as a training regimen in various sports.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

S.J.: Writing the original draft, review and editing the article, methodology, formal analysis, data curation, conceptualisation and investigation. J.D.: Supervision and methodology. K.K.: Review and editing the article and supervision.

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Data availability

The data that support the findings of this study are available from the corresponding author, S.J., upon reasonable request.

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