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Effects of a 12-week yoga intervention on postural sway in rugby union players

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KEYWORDS

Exercise;
Proprioception;
Sports performance;
Balance training.

ABSTRACT

In an attempt to reduce the risk of injury that accompanies poor balance, many strength and conditioning coaches and trainers incorporate balance and postural control training into players' training regimes. However, relatively few balance interventions involve yoga. Therefore, the purpose of this study was to evaluate the effect of a modified yoga programme on postural sway in rugby union players. Twenty-nine male rugby union players, (19 ± 1.3 years old, mean ± SD) were randomly assigned to two groups: a yoga group (YG, n =15), which practiced yoga for one hour, two times a week alongside their regular rugby training, and a control group (CG, n = 14), which only participated in their standard rugby training. Postural sway was measured during various 30s balance activities at baseline (pre-season) and at the end of the 12-week playing season (post-season) on a force platform. The yoga group showed a significantly reduced sway signal in the 2-legged eyes closed balance test in the antero-posterior (-109.7% ± 82.9 mean ± 95% CI, *p*-value < 0.005) and medial-lateral (-115.5% ± 92.1, p-value < 0.005) directions. However, no significant between-group change was found in the 1-legged eyes closed or 1 or 2-legged eyes open balance tests. The results suggest that practising yoga may reduce postural sway in specific directions which may improve balance in rugby union players.

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Introduction

Rugby union (hereinafter referred to as "rugby") is a field-based contact sport with a growing player base of approximately 9.1 million players registered worldwide, making it one of the most popular sports in England, Ireland, Australia, and New Zealand[1]. Rugby players are typically strong and engage in many bouts of high-intensity activity[2] including running, jumping, kicking, and other quick, agile movements[2]. The fast pace and physical contact in rugby makes it essential that players are able to quickly control posture and return to a steady position when exposed to balance perturbations[3]. In addition, rugby players need to maintain a stable posture for the safe execution of efficient and effective movements[4, 5]. Therefore, better postural stability, or improved balance, plays a vital role in rugby players' performance.

Rugby is dynamic in nature, and rugby players are required to actively balance their body weight depending on the game situation[2]. As part of the game, rugby players tackle opposing players to gain possession of the ball or are occasionally required to kick the ball while running, which requires good balance, sometimes on one leg as well as in compromising positions[3]. To control posture, a player must maintain control of his centre of gravity by remaining as close to the centre as possible using hip and ankle balance strategies[2,6]. If the change in the centre of gravity is large due to either inappropriate neuromuscular strategies selected by the player or an impaired ability to use the sensory feedback efficiently, the player may develop impaired balance and increased postural instability[5], which have been associated with an increased risk of injury[7].

Postural sway is a method of observing the sway of a player's centre of pressure (COP) displacement and body weight distribution and can be used as a measure of balance[8,9]. To reduce postural sway, an efficient sensory-muscular feedback response is required[8,10] and any delay or inattention to this response may increase postural sway, particularly in the anterior -posterior and medial-lateral planes, which may result in undesired movement patterns, which could possibly affect a player's performance[10,11]. Hatha yoga, the yoga used in this study, is an ancient Indian system involving various static and dynamic stretching positions, as well as breathing, and relaxation techniques. It is progressive in nature and low-cost, only requiring a trained yoga teacher and no specialised equipment. While yoga has been shown to improve balance in athletes[12,13] and older adults[14,15] little research has addressed the contribution of yoga towards enhancing the balance of rugby union players. This study is designed to determine the effects of a 12-week yoga intervention on single- and double-legged postural sway of male rugby union players.

Materials and methods

A yoga intervention was exclusively designed for rugby players and delivered by a yoga instructor (registered exercise professional, New Zealand). The number of participants required for the study was calculated using a spreadsheet with the smallest worthwhile change in performance being 1.0% and the typical error or within-subject SD in similar tests of 0.7%[16]. This calculation estimated we needed 7 participants in each group in a controlled trial research design. All participants were in the same yoga class, and all sessions were completed in a large open fitness room. The centre of pressure (COP) is evaluated by collecting the raw data on the magnitude of the force signals applied from the player's body through his feet in the anterior-posterior, and the medial-lateral, directions. COP is also derived from the data collected in the vertical direction on the force platform. To assess postural sway, the movement of the COP is computed by calculating the pressure applied in the direction of the action and then the system measures the associated pressure underneath the foot of the player on the platform. The mean velocity of the raw signal received in anterior-posterior, medial-lateral, and vertical directions and a combination of all were used to assess postural sway using COP[17]. During the intervention, players spent the first 10 min performing a set of 12 dynamic stretching postures used as a warm-up (sun-salutation sequence), an easy to follow routine to standardise the practice throughout the study. Players then performed 17 sets of 30 s stretches focussing on quadriceps, hamstring, calves in five different postures, three postures with 13 sets of 20 s stretches focusing on hamstring, 17 sets of 10 s stretches focussing on gluteal and lower back area in eight postures, 10 sets of 15 s stretches focussing on shoulders, upper-back, and abdominal area in six postures, 4 sets of 15 s stretching focussing on middle back in four posture, and 4 sets of 20 s stretching focussing on hip abductor and hip adductors in two postures. The postures performed during the intervention are typically a combination of joints and muscles.

Participants

The inclusion criteria for the study included currently playing rugby at club level, having no past experience of yoga, and having no current or previous injury which may affect their participation in the study. Twenty-nine male club-level rugby union players (19 ± 1.3 years, mean ± SD) (Table 1) volunteered to participate in the study, and were divided into two groups: a yoga group (YG n =14), which practiced yoga for one hour, two times a week in addition to normal rugby training and a control group (CG n = 15), that completed their normal rugby training without yoga. During the study, players were asked to refrain from physical activities that might affect balance outside of those provided by their strength and conditioning coach. All players completed a medical questionnaire (Physical Activity Readiness Questionnaire) and reported no contraindications to engaging in maximal exercise. All players were also informed about the possible risks of volunteering for this study and provided written informed consent prior to the study. Following the Declaration of Helsinki, this research was approved by the institutional Human Ethics Committee.

Table1 Baseline characteristics of the players

Characteristics	Yoga Group (n = 15)	Control Group (n = 14)
Age (y)	19 ± 1.3	19 ± 2.0
Height (cm)	181.3 ± 8.4	182.7 ± 4.2
Weight (kg)	88.9 ± 18.7	85.5 ± 9.8
BMI (kg/m^2)	26.9 ± 4.8	25.6 ± 2.8

Note: Data are mean ± SD.

Yoga intervention

A registered yoga instructor led the 60 min yoga intervention classes twice a week for 12 weeks, with the intervention starting at the beginning of the rugby season. Each yoga session consisted of a warm-up of 10 min (Surya-namaskar a dynamic stretching sequence of postures), followed by 35 min of yoga postures (10 min standing, 10 min sitting, and 15 min of supine and prone postures and a mix of static and dynamic postures), and 10 min relaxation in the final resting position (lying in supine position without any stretching exercise). A total of 5 min was allocated for the transition between the yoga postures. The sessions consisted of 32 yoga postures (including standing, sitting, forward bending, backward bending, spinal twist, core engagement and body inversion), targeting the major muscle groups of the body (e.g., gastrocnemius, hip flexors, hip extensors, abdominals, and trapezius). Basic breathing and relaxation techniques were taught in the first 2 weeks of the intervention after the initial session players practised these two techniques for the remaining six weeks. The yoga postures were modified to improve the range of motion, and promote the progression of difficulty and intensity with the support of yoga props (such as blocks, straps, or ropes), so movements were performed as accurately as possible without inducing pain beyond that experienced with stretching.

Postural sway measurement

Data were collected over a 30 s period with a sampling frequency of 100 Hz in the morning between 0900-1200 using a force platform (Bertec Corp, Columbus, OH) which amplifies, filters, and digitises the raw signals from the strain gauge amplifiers inside the force plate. The resulting output is a six-channel 16-bit digital signal containing the forces and moments in the x, y, and z axes. The digital signals were subsequently converted via an external analogue amplifier (AM6501, Bertec Corporation). The initial centre of pressure signals was calculated with respect to the centre of the force-plate before normalization. Data were collected on two occasions (baseline and after the 12-week intervention). The players were instructed to stand normally on the force platform barefoot, with feet in the centre of a marked area and their arms hanging by their side. While standing on the force platform, players were asked to concentrate on a fixed spot on the wall in front of them and to maintain their balance as much as possible (or to maintain balance for as long as possible in the eyes closed test). The data was collected once players said they were comfortable with their standing position. The leg(s) was/were tested (right, left, and 2-legged) and the order of each task was randomly allocated. During testing, the players were asked to complete the following tasks: 1-legged stance with eyes open (right and left leg), a 2-legged stance with eyes open and eyes closed. Each position was held for 30 s and players were given a 1-min rest between each task, where they chose to either sit or stand and were allowed to drink water. The measurement took approximately 5-6 min for each player to complete. All players were required not to perform any strenuous exercise for 24 hours prior to testing. The testing was completed at the same time of day under similar climatic conditions for both testing days.

Statistical analysis

Data were collected from the force platform which included movement in the: antero-posterior, medial-lateral, and vertical directions, and also included centre of pressure in anterior-posterior and medial-lateral directions, and exported to Microsoft excel and analysed using R studio (2019) (Boston, MA, USA). To analyse the raw data, a protocol described by Önell[18] was employed. Firstly, the players' body mass was normalised with the signal collected. To remove the body oscillations due to the heartbeat, the signal was sent through a 4th-order Butterworth high pass filter with a cut-off frequency of 0.1 Hz. The signal was also low pass filtered with a cut-off frequency of 15 Hz to reduce measurement noise to remove slow drifts in the signal which are not directly associated with spontaneous sway. The standard deviation of the mean of each 30 s signal was used as an indicator of postural sway variability.

A total of 9 measures were recorded, since the data were normalised with mass of the player, mass signal was removed from the analysis and the following measures were used for the final analysis. The standard deviation (SD) of the antero-posterior, medial-lateral, and vertical, directions and centre of pressure in antero-posterior and medial-lateral directions. The data presented in the table 2 are the mean and the standard deviation of each task within the group. The between-group percentage change from baseline to post-intervention was then calculated. Changes within and between groups were estimated using a mixed modelling procedure (Proc Mixed) in the Statistical Analysis System (Version 9.3, SAS Institute, Cary, North Carolina, USA) with an alpha level of 0.05.

Results

The average yoga session attendance rate was 21 sessions (75%), with some players attending all 24 sessions and some attending only 16 sessions (60%), however no players missed two consecutive sessions. Total time spent on stretches amounted to 35 ± 2 min (mean ± SD) at each yoga session. Players spent approximately 25 ± 3 min performing dynamic stretching, which included 10 min of sun-salutation practice, and around 12 - 15 min in both dynamic and static stretching postures. Players were also required to complete 10 min of a mindful relaxation or mental recovery (savasana) at the end of each session.

Compared to the control group, the yoga group that incorporated 12 weeks of yoga into their rugby training routines had a significantly reduced postural sway in the 2-legged eyes closed antero-posterior -109.7% ± 82.9 and medial-lateral -115.5% ± 92.1 (mean ± 95% CI, *p*-value < 0.005) directions (Table 2). The yoga group demonstrated, in most cases, non-significant decreases in postural sway in a number of balance markers in all stance conditions (right leg eyes open, left leg eyes open, both legs eyes closed, both legs eyes open), when compared to the control group (Table 2).

Table 2 Data of balance tests before and after 12 weeks of yoga in the yoga and control groups and the between group differences

Balance markers	Control group		Yoga group		Pre-post between group differences (%) Mean ± 95%CI
	Baseline	12-week Post	Baseline	12-week Post	
One-legged Right Leg Eyes Open					
Medio-lateral	0.04 ± 0.02	0.04 ± 0.01	0.03 ± 0.02	0.02 ± 0.01	-84.0% ± 155.4
Antero-posterior	0.03 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.03	-69.1% ± 143.6
Vertical	0.05 ± 0.03	0.08 ± 0.02	0.05 ± 0.03	0.05 ± 0.04	-133.4% ± 289.2
Medio-lateral COP	0.00 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	15.4% ± 246.9
Antero-posterior COP	0.00 ± 0.01	0.00 ± 0.00	0.00 ± 0.01	0.00 ± 0.00	-48.2% ± 269.6
One-legged Left Leg Eyes Open					
Medio-lateral	0.04 ± 0.02	0.05 ± 0.02	0.03 ± 0.02	0.03 ± 0.01	-59.5% ± 90.2
Antero-posterior	0.03 ± 0.01	0.06 ± 0.02	0.03 ± 0.01	0.03 ± 0.01	-39.2% ± 68.3
Vertical	0.05 ± 0.03	0.11 ± 0.05	0.05 ± 0.03	0.05 ± 0.02	-101.7% ± 277.7
Medio-lateral COP	0.02 ± 0.05	0.00 ± 0.00	0.01 ± 0.02	0.00 ± 0.00	83.1% ± 274.1
Antero-posterior COP	0.01 ± 0.03	0.00 ± 0.00	0.01 ± 0.02	0.00 ± 0.00	-14.5% ± 273.8
Two-legged Eyes Open					
Medio-lateral	0.01 ± 0.01	0.03 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	-64.2% ± 90.0
Antero-posterior	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	-62.7% ± 80.5
Vertical	0.01 ± 0.01	0.04 ± 0.01	0.01 ± 0.00	0.01 ± 0.00	-141.9% ± 221.5
Medio-lateral COP	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	-38.7% ± 58.4
Antero-posterior COP	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	-45.8% ± 97.1
Two-legged Eyes Closed					
Medio-lateral	0.03 ± 0.03	0.02 ± 0.00	0.02 ± 0.01	0.01 ± 0.00	-115.5% ± 92.1*
Antero-posterior	0.01 ± 0.00	0.02 ± 0.00	0.00 ± 0.01	0.00 ± 0.01	-109.7% ± 82.9*
Vertical	0.01 ± 0.00	0.05 ± 0.01	0.00 ± 0.01	0.00 ± 0.01	-175.7% ± 197.7
Medio-lateral COP	0.01 ± 0.02	0.00 ± 0.00	0.00 ± 0.01	0.00 ± 0.00	-33.7% ± 242.1
Antero-posterior COP	0.00 ± 0.01	0.00 ± 0.00	0.00 ± 0.01	0.00 ± 0.00	-113.4% ± 281.4

Note: Data are mean ± SD of each group and the difference between groups given as the percent mean difference ± 95% confidence interval. *Statistically significant between groups (p-value < 0.05). COP, Centre of pressure.

Discussion

Findings of this study suggest that 12 weeks of practising a standard yoga routine twice weekly for one hour in addition to normal rugby training can maintain and, in some cases, improve postural sway in male rugby union players. The improvement was particularly prevalent in the antero-posterior and medial-lateral directions in the 2-legged eyes closed stance. Although there were no significant differences in the other sway characteristics of either 1-legged or 2-legged stances, the yoga group mostly showed improvements in all balance measures, when compared to the control group. The results of this study supports previous findings indicating that regular yoga practice may decrease postural sway and improve balance for athletes[12,13] and other individuals[19-21]. The yoga group also had the lowest signal magnitude in the vertical direction in all standing positions, suggesting a more stable stance than the control group. This reflects reduced underfoot activity and improved perceptual-motor skill, allowing the player to maintain a steady position[22].

In this study, the yoga intervention integrated a series of mind-body exercises together with breathing, alignment, relaxation, flexibility and stretching as used by previous researchers[23-26]. Practicing mind-body exercises can result in significantly improved balance[23-25, 27]. For example, Gatts and Woollacott[25] reported that Tai-chi, a routine similar to yoga, improved neuromuscular activation in older adults when compared to a control group that did not practice Tai-chi.

There is mounting evidence that an efficient musculo-skeletal system improves muscle proprioception which may result in improved balance[4,5,23,24,28]. It has been reported that yoga helps individuals to improve their balance, enhances feedback from the muscles and tendons surrounding the joints[29], and reduces underfoot activity[22]. A rugby player uses the lower body extensively to run at various speeds[30], and uses a hip-ankle strategy to change the direction swiftly[2]. Thus, the improved balance of players in the yoga group may help them in the directional play required in rugby.

Consequently by practicing yoga postures included in the current study, players may have upregulated strategies to maintain balance[21,31], thereby leading to an efficient musculo-skeletal system which improved muscle proprioception and resulted in less sway and possibly better balance[4,5,23,24,28]. Efficient functional movement requires the intergration of sensory feedback systems to maintain stability and balance. These systems are particularly important in tasks that occur at high speed and when directional change is involved[32]. If the improved static balance witnessed as a result of yoga in this study, also translates to improved dynmamic balance, it will benefit athletes like rugby players, by improving their agility[33] and ability to maintain balance while performing movements during the rugby game.

Previous research has also indicated that balance training with eyes closed may also have a positive effect on the vestibular system[34]. Performing balance tasks without visual feedback increases the reliance on the somatosensory stimuli[35] which may have a training effect. Therefore, a combination of mind-body exercises including postures with eyes closed (as in some of the postures in the yoga group of this study) may have improved neural and sensory feedback systems thereby increasing sensitivity to somatosensory and vestibular feedback which may have improved balance and reduced postural sway in the yoga group.

Limitations

In the current study, only male players were contacted to participate in the study, therefore the application of these results is limited to males and further research is required to investigate the possible effects on females. The fact that all players were from the same club, means that the intervention practised and information provided to the yoga group, may have reached the control group also, and some control subjects may have practiced the intervention without our knowledge. Another limitation of the study was the fact that the assessor of the of the balance variables was not blinded to the intervention groups which may introduce some bias. However, since the results are mainly objective measures (e.g. force platform signals), the possibility of bias is reduced. The study could have been improved with a larger sample size, or a crossover design with sufficient time for washout of effects. Finally, while the sway significantly improved in the 2-legged eyes-closed test for the yoga group, the relevance of an eyes-closed balance test to balance control during a rugby game (with eyes open) is unknown. Hence, the results will remain exploratory until a more thorough longitudinal study is conducted on a larger sample with more applied balance tests for rugby players.

Conclusion

In conclusion, practicing yoga for 12 weeks significantly improved postural sway in the yoga group in the antero-posterior and medial-lateral directions in the two-legged eyes-closed balance task. If a reduction in postural sway is equivalent to improved balance, the yoga group improved balance compared to the control group (at least the antero-posterior and medial-lateral directions in two-legged eyes-closed task). Such balance improvements may assist rugby players by reducing unwanted movements on the rugby field, keeping joints and body parts aligned and possibly reducing injuries. Postural sway was also improved in most other balance tasks although the reductions in postural sway did not meet statistical significance. Therefore, the overall effect of yoga on 1-legged and 2-legged eyes open balance tasks remains speculative until further research can consistently show a positive

Take home messages

Yoga helps to reduce postural sway in the double-legged eyes-closed balance test in rugby players. Including yoga into the training routines of rugby players may therfore help to improve their balance, resulting in better stability and muscular control.

Conflicts of interest

The authors declare no conflict of interest.

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