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Original Research Paper

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KINEMATIC ADAPTATIONS IN SHOULDER AND PELVIC ALIGNMENT FOLLOWING A SIX-WEEK PACE BOWLING TRAINING PROGRAMME

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ABSTRACT

The purpose of this study was to examine the effect of a six-week coaching programme on selected kinematic variables of pace bowling, namely shoulder alignment at Back Foot Contact (BFC), pelvic alignment at BFC, minimum shoulder alignment, shoulder alignment at Front Foot Contact (FFC), pelvic alignment at FFC, pelvic–shoulder separation angle, and shoulder counter rotation in junior pace bowlers. Twenty male junior pace bowlers (aged 14–18 years) from cricket clubs in West Bengal were randomly assigned to an experimental group (n = 10) and a control group (n = 10). The experimental group participated in a six-week bowling technique coaching programme (4 sessions per week, 60 minutes per session), while the control group continued their regular training. Kinematic data were collected using four Sony HD digital video cameras and analysed with Kinovea 8.27 software. Independent and paired t-tests were employed to compare pre-test and post-test values at a significance level of 0.05. No significant differences were observed between the experimental and control groups at baseline or post-test for most kinematic variables. However, within the experimental group, Shoulder Alignment at Front Foot Contact (FFC) showed a statistically significant improvement following the six-week coaching programme ($t = 3.01$, $p < 0.05$). The percentage improvement was highest for Shoulder Alignment at FFC (13.70%), followed by Shoulder Alignment at BFC (2.58%), Minimum Shoulder Alignment (2.06%), Pelvic Alignment at FFC (1.57%), Pelvic Alignment at BFC (1.40%), Shoulder Counter Rotation (0.39%), and Pelvic–Shoulder Separation Angle (0.002%). The findings indicate that a six-week coaching programme can effectively improve specific aspects of pace bowling biomechanics, particularly shoulder alignment at front foot contact. Although improvements in other kinematic variables were not statistically significant, positive trends suggest that longer-duration coaching programmes with larger samples may produce greater biomechanical adaptations and contribute to improved bowling performance and reduced injury risk.

KEYWORDS : Cricket, Pace Bowling, Coaching Programme, Biomechanics, Shoulder Alignment, Pelvic Alignment, Front Foot Contact, Junior Pace Bowlers.

INTRODUCTION

In cricket, fast bowling demands extreme accuracy. This accuracy is dependent upon the ability of the performer to control and coordinate perfectly all movements in the delivery and release of the ball. Good balance is necessary for a constant arm action. Arm action decides the general direction which the ball will take. Release of the ball decides the direction of spin of the ball during its rolling through the alley. The direction of spin, speed of the ball, and the surface of the alley decide if the ball follows a straight path or a curved one and when it does.

For a fast bowler, high-speed deliveries are key weapons that are lying in their stock because it reduces the reaction time of a batsman. Faster bowling has a link with the amount of front knee flexion during the delivery stride it has been reported in several studies that faster bowlers who show a relatively braced (straight) front knee can bowl faster (Foster et al., 1989; Portus et al., 2004). On the other hand, by having a straight leg during delivery stride performance of the fast bowler can be improved at the same time there exists some connection between particular bowling actions and low back injury (Portus et al., 2004). When training the fast bowlers, one of the objectives of fast bowling coaching is modification of the bowlers' technique for performance improvement and prevention of injury associated with fast bowling. Fast Bowling Coaching Technique Modification Literature In the literature related to fast bowling in the game of cricket, only two or three experiments have been done to check the effectiveness of fast bowling technique modification where the subjects in the experimental group were young fast bowlers with average age of 13 years (Elliott and Khangure, 2002; Wallis et al., 2002). Elliott and Khangure (2002), in their three to four year experiment, started with a half-day coaching clinic followed by six small coaching sessions.

The finding stated that the shoulder counter-rotation during the delivery stride was reduced due to the coaching programme which was successful. On the other hand, Wallis et al. (2002) have used a harness system that was attached to the lower trunk and the front arm. In other words, this attachment helps to keep the shoulders and pelvis in the same position when making contact with the back foot, however, the other elements of the delivery stride remained unchanged such as shoulder counter-rotation, trunk extension, and lateral-flexion of the trunk. The better comprehension of the process of the occurrence of bowling technique development is very important for the educators, coaches, and players who can benefit from it in order to create coaching guidelines and develop an in-season program. This study aims to assess the effects of six-month coaching programme on pace bowling technique.

Statement of the Problem

The purpose of the study was to find out the effect of six weeks coaching programme on pace bowling technique with special reference to the Shoulder alignment, pelvic alignment, Pelvic Shoulder Separation Angle, and Shoulder counter rotation of junior level pace bowlers.

Objectives of the study

1. To determine the effect of a six-week coaching programme on the pace bowling technique of junior-level pace bowlers, with special reference to shoulder alignment, pelvic alignment, pelvic–shoulder separation angle, and shoulder counter-rotation.

2. To evaluate the effectiveness of the six-week coaching programme in improving the biomechanical efficiency of junior-level pace bowlers.

3. To examine whether the coaching programme enhances bowling performance while reducing the risk of injury among junior-level pace bowlers.

METHODOLOGY

Selection of Subjects

For the study 20 male junior pace bowlers (10 Experimental and 10 Control Group) of West Bengal were the subject of this study. Their age ranges 14-18 years. The subjects were selected from West Bengal Cricket clubs at random.

Selection of Variables

Selected kinematic variables were followed:

- Shoulder Alignment at Back Foot Contact (BFC)
- Pelvic Alignment at Back Foot Contact (BFC)
- Shoulder Alignment at Front Foot Contact (FFC)
- Pelvic Alignment at Front Foot Contact (FFC)
- Minimum Shoulder Alignment
- Pelvic Shoulder Separation Angle
- Shoulder Counter Rotation

Criterion Measure

The selected kinematic Variables namely Shoulder alignment at Back Foot Contact (BFC), Pelvic alignment at Back Foot Contact (BFC), Minimum Shoulder Alignment, Shoulder Alignment at Front Foot Contact (FFC), Pelvic Alignment at Front Foot Contact (FFC), Pelvic Shoulder Separation Angle, and Shoulder Counter Rotation were measure by Degree

Design of the Study

The experimental design used in this study will be a pretest-posttest design. The subjects will be divided at random into one experimental group and a control group. The experimental Group (GE) underwent the progressive bowling programme while the control group (GC) will carry out their normal cricket training sessions. The coaching programme will be for six weeks, 4 days a week with duration of 60 minutes per day.

Data Collection

The data of selected kinematic variables were obtained by administering the following procedure.

Filming Protocol

To obtain selected kinematic variables subjects were filmed by using four Digital HD Video cameras of Sony. One overhead camera was mounted especially for getting the data of the transverse plane. All the cameras were placed at a distance of 12 mts. and the height of the lens was 1.43 mts. from the ground. The experimental configuration is shown in figure no. 1

Kinematic Variables

To obtained kinematic variables, all videos were analyzed by using Kinovea 8.27.

Analysis of Shoulder Alignment at Back Foot Contact

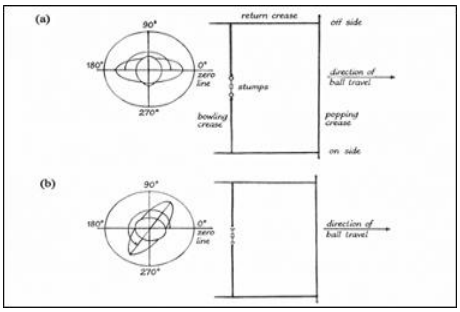
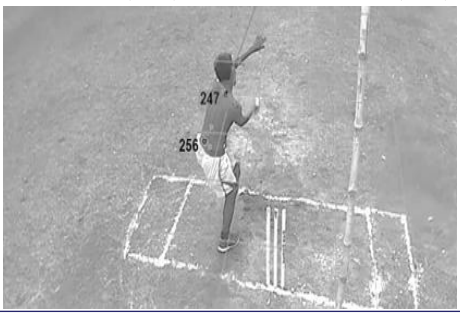


Figure No.: 1 The experimental configuration.

a. A Side On Bowler (180°) B. A Front-on Bowler (240°)



Shoulder Alignment

Right and Left shoulder joint centers at the horizontal plane (180^0 = side-on, 270^0 = shoulders aligned with bowling crease)

Statistical Techniques

To test the homogeneity of the subject's descriptive statistics was applied, to test the effect of the programme, the collected data from the two groups before and after investigation on Pace bowling performance variables were statistically analyzed by using a T-test. (Data Analysis of Microsoft Excel). In all the cases the level of confidence is fixed at 0.05 to test the significance. The rate of changes was calculated by the percentage method.

Analysis and Interpretation of Data Findings

Table No.: 1 General Characteristics of Pace Bowlers at the Baseline of Training

	Experimental Group	Control Group
Age	18.1±0.94	17.1±0.84
Height	1.70±0.02	1.60±0.03
Weight	57.8±5.38	49.8±5.28
Ball Release Speed	19.75 ± 2.74	19.39 ± 1.46

At baseline, the experimental group had a slightly higher mean age (18.1 ± 0.94 years) than the control group (17.1 ± 0.84 years). The experimental group was also taller (1.70 ± 0.02 m vs. 1.60 ± 0.03 m) and heavier (57.8 ± 5.38 kg vs. 49.8 ± 5.28 kg). The mean ball release speed was marginally greater in the experimental group (19.75 ± 2.74 m/s) compared with the control group (19.39 ± 1.46 m/s), indicating that both groups had relatively similar bowling performance at the start of the training period.

Table No.: 2 Mean Standard Deviation and T-Test of Experimental Group and Control Group at Pre-Test

Sl no	Variables	Experimental group Pre –test Mean ±sd	Control group Pre-test Mean ±sd	T - test
1	Shoulder alignment at Back Foot Contact (BFC)	234.7 ± 6.30	237.7 ± 9.77	0.81
2	Pelvic alignment at Back Foot Contact (BFC)	233.4 ± 5.23	236.5 ± 10.22	0.85
3	Minimum Shoulder Alignment	206.1± 13.21	208.7 ± 14.01	0.42
4	Shoulder Alignment at Front Foot Contact (FFC)	224.6 ± 15.57	217 ± 17.48	1.02
5	Pelvic Alignment at Front Foot Contact (FFC)	224.5 ± 14.10	220.1 ± 16.78	0.63
6	Pelvic Shoulder Separation Angle	2.1 ± 0.87	1.6 ± 0.51	1.55
7	Shoulder Counter Rotation	27.9 ± 11.63	29 ± 11.68	0.21

Table 6 showed that the mean value of the experimental group and control group at Pretest for Shoulder Alignment at Back Foot Contact (BFC) 234.7 and 237.7 , Pelvic Alignment at Back Foot Contact (BFC) 233.4 and 236.5 , Minimum Shoulder Alignment 206.1 and 208.7 , Shoulder Alignment at Front Foot Contact (FFC) 224.6 and 217 , Pelvic Alignment at Front Foot Contact (FFC) 224.5 and 220.1 , Pelvic Shoulder Separation Angle 2.1 and 1.6 , Shoulder Counter Rotation 27.9 and 29 No significant difference was observed in other variable mean values of the experimental group and control group at Pretest.

Table No. : 3 Mean, Standard Deviation and T-test of Experimental Group Post Test And Control Group Post-test

Sl No	Variables	Experimental Group Post –Test Mean ±SD	Control Group Post-Test Mean ±SD	T-Test
1	Shoulder Alignment at Back Foot Contact (BFC)	233.6 ± 8.65	238.3 ± 8.12	1.3
2	Pelvic Alignment at Back Foot Contact (BFC)	234± 8.27	237.6 ± 8.22	0.97
3	Minimum Shoulder Alignment	207.1± 12.95	211.5 ± 13.02	0.75
4	Shoulder Alignment at Front Foot Contact (FFC)	218.5 ± 10.65	220.2 ± 15.71	0.28
5	Pelvic Alignment at Front Foot Contact (FFC)	223.8 ± 10.16	222.4 ± 16.57	0.22
6	Pelvic Shoulder Separation Angle	2 ± 1.15	1.5 ± 0.70	1.16
7	Shoulder Counter Rotation	26.5 ± 9.11	26.8 ± 12.21	0.06

Table 7 showed that the mean value of the experimental group and control group at Post-test for Shoulder Alignment at Back Foot Contact (BFC) 233.6 and 283.3, Pelvic Alignment at Back Foot Contact (BFC) 234 and 237.6, Minimum Shoulder Alignment 207.1 and 211.5, Shoulder Alignment at Front Foot Contact (FFC) 218.5 and 220.2, Pelvic Alignment at Front Foot Contact (FFC) 223.8 and 222.4, Pelvic Shoulder Separation Angle 2 and 1.5, Shoulder Counter Rotation 26.5 and 26.8. No significant difference where observe in other variable mean value of the experimental group and control group at Pretest.

Table No.: 4 Mean, Standard Deviation and T-test of Experimental Group during Pre-Test and Post-test

Sl No	Variables	Pre –Test Mean ±SD	Post-Test Mean ±SD	T- test
1	Shoulder Alignment at Back Foot Contact (BFC)	234.7 ± 6.30	233.6 ± 8.65	1.02
2	Pelvic Alignment at Back Foot Contact (BFC)	233.4 ± 5.23	234± 8.27	0.48
3	Minimum Shoulder Alignment	206.1± 13.21	207.1± 12.95	0.34
4	Shoulder Alignment at Front Foot Contact (FFC)	224.6 ± 15.57	218.5 ± 10.65	3.01*
5	Pelvic Alignment at Front Foot Contact (FFC)	224.5 ± 14.10	223.8 ± 10.16	0.32
6	Pelvic Shoulder Separation Angle	2.1 ± 0.87	2 ± 1.15	0.20
7	Shoulder Counter Rotation	27.9 ± 11.63	26.5 ± 9.11	0.44

**Significant at 0.05 level*

Table 8 showed that the mean value of the experimental group during pre-test and Post-test for Shoulder Alignment at Back Foot Contact (BFC) 234.7 and 233.6, Pelvic Alignment at Back Foot Contact (BFC) 233.4 and 234, Minimum Shoulder Alignment 206.1 and 207.1, Shoulder Alignment at Front Foot Contact (FFC) 224.6 and 218.5, Pelvic Alignment at Front Foot Contact (FFC) 224.5 and 223.8, Pelvic Shoulder Separation Angle 2.1 and 2, Shoulder Counter Rotation 27.9 and 26.5, Significant Difference was observed only for the variable of Shoulder Alignment at Front Foot Contact (FFC) for the experimental group at Pretest to posttest.

Table No.: 5 Mean, Standard Deviation and T-test of Control Group during Pre Test and Post-test

Sl No	Variables	Pre –Test Mean ±SD	Post-Test Mean ±SD	T-Test
1	Shoulder Alignment at Back Foot Contact (BFC)	237.7 ± 9.77	238.3 ± 8.12	0.64
2	Pelvic Alignment at Back Foot Contact (BFC)	236.5 ± 10.22	237.6 ± 8.22	1.04
3	Minimum Shoulder Alignment	208.7 ± 14.01	211.5 ± 13.02	1.17
4	Shoulder Alignment at Front Foot Contact (FFC)	217 ± 17.48	220.2 ± 15.71	1.03
5	Pelvic Alignment at Front Foot Contact (FFC)	220.1 ± 16.78	222.4 ± 16.57	0.75
6	Pelvic Shoulder Separation Angle	1.6 ± 0.51	1.5 ± 0.70	0.55
7	Shoulder Counter Rotation	29 ± 11.68	26.8 ± 12.21	0.85

Table 9 showed that the mean value of the control group at Pretest and Posttest for Shoulder Alignment at Back Foot Contact (BFC) 237.7 and 283.3, Pelvic Alignment at Back Foot Contact (BFC) 236.5 and 237.6, Minimum Shoulder Alignment 208.7 and 211.5, Shoulder Alignment at Front Foot Contact (FFC) 217 and 220.2, Pelvic Alignment at Front Foot Contact (FFC) 220.1 and 222.4, Pelvic Shoulder Separation Angle 1.6 and 1.5, Shoulder Counter Rotation 29 and 26.8. No significant differences were observed in other variable mean value of the control group at Pretest and Post-test.

Table No.: 6 RATE OF IMPROVEMENT IN PACE BOWLING OF EXPERIMENTAL GROUP FROM PRE-TEST TO POST-TEST

Sl. No	Variables	Percentage
1	Shoulder Alignment at Back Foot Contact (BFC)	2.58 %
2	Pelvic Alignment at Back Foot Contact (BFC)	1.40 %
3	Minimum Shoulder Alignment	2.06 %
4	Shoulder Alignment at Front Foot Contact (FFC)	13.70 %
5	Pelvic Alignment at Front Foot Contact (FFC)	1.57 %
6	Pelvic Shoulder Separation Angle	0.002 %
7	Shoulder Counter Rotation	0.39 %

The above table 10 showed that the rate of improvement in pace bowling of experimental group from pretest to posttest for Shoulder Alignment at Back Foot Contact (BFC) 2.58%, Pelvic Alignment at Back Foot Contact (BFC) 1.40%, Minimum Shoulder Alignment 2.06%, Shoulder Alignment at Front Foot Contact (FFC) 13.70%, Pelvic Alignment at Front Foot Contact (FFC) 1.57%, Pelvic Shoulder Separation Angle 0.002%, Shoulder Counter Rotation 0.39%.

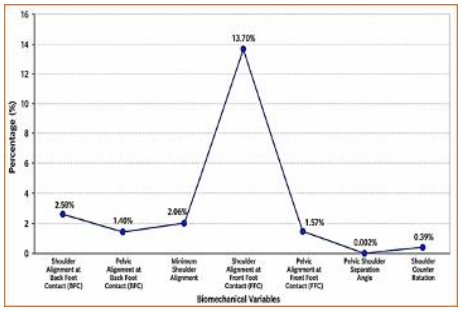


Figure 2: Graphical Representation of Percentage Contribution of Shoulder and Pelvic Alignment Variables

Discussion of Findings

The purpose of the study is to find out the effect of a coaching programme on pace bowling technique over six weeks of junior level pace bowlers. After Video Analysis Seven common technical problems like Bowling action associated with

Shoulder Alignment at Back Foot Contact (BFC), Pelvic Alignment at Back Foot Contact (BFC), Minimum Shoulder Alignment, Shoulder Alignment at Front Foot Contact (FFC), Pelvic Alignment at Front Foot Contact (FFC), Pelvic Shoulder Separation Angle, Shoulder Counter Rotation. All the factors of bowling analysis were assumed that a right-handed bowler bowling to a right-handed batsman.

Twenty (20) non-elite slow-medium pace bowlers (10 EG and 10 CG) were participated in this study and had ball release speeds of 19.57±2.09 m.s-1. Six of these bowlers shows shoulder alignment as front-on at back foot contact and the remaining fourteen were semi-action.

The mean score of Shoulder Alignment at Back Foot Contact (BFC), Front Foot Contact (FFC), Pelvic Alignment at Back Foot Contact (BFC), Front Foot Contact (FFC), Minimum Shoulder Alignment, Pelvic Shoulder Separation Angle, and Shoulder Counter Rotation of the experimental group were better in comparison to the mean score of the control group to the selected kinematic variables.

The study shows that experimental group during the training period the Shoulder Alignment at Back Foot Contact (BFC), Pelvic Alignment at Back Foot Contact (BFC), Minimum Shoulder Alignment, and Pelvic Alignment at Front Foot Contact (FFC), Pelvic Shoulder Separation Angle, and Shoulder Counter Rotation, which shows insignificant result during the training period. So it is concluded that the experimental group has significantly improved one selected kinematic variable during the 6- week technique training period.

The primary findings of the present study indicated that bowling technique training alone may be a positive training stimulus to change the bowler's technique, to improve performance. These findings of the present study are in agreement with the study Elliott and Khangure, (2002); Wallis et al., 2002 where they concluded that specific factors can be changed in pace bowlers in bowling technique over a training period and the change may be due to the coaching programme.

The present study demonstrates that the Shoulder Alignment at front foot contact is significantly different from pretest to post-test. This may be due to the correct positioning of front foot during the delivery stride because of the displaced front foot to the offside which suggests for the more front-on action. Reduction in the angle of Shoulder Alignment at front foot contact may lead to a decrease in shoulder counter-rotation. The results of this study coincide with the results obtained by previous researchers who have used coaching (Elliott and Khangure, 2002) and a back harness (Wallis et al., 2002) to decrease the shoulder counter-rotation in fast bowlers.

Furthermore, the result of the current study also demonstrates that the mean scores of the chosen kinematic variables show that there was a little improvement during the experimental period but statistically were not significant in comparison to pretest. These variables include Shoulder Alignment at Back Foot Contact (BFC), Pelvic Alignment at Back Foot Contact (BFC), Minimum Shoulder Alignment, Pelvic Alignment at Front Foot Contact (FFC), Pelvic Shoulder Separation Angle, and Shoulder Counter Rotation. Low values of tabulated T of these variables as a result of training effect are due to small sample size, lack of sophisticated equipment and short training period since the results have been significantly affected on some kinematic variables during the training period.

CONCLUSION

Within the limitation of the study, it may be concluded that:

1. The experimental group of pace bowlers shows a significant improvement in specific kinematic aspects of fast bowling technique in non-elite players over six weeks and this may be attributed to a coaching programme.

2. The shoulder alignment at the front foot contact was significantly reformed during the bowling technique training programme.

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