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## Influence of segmental joint angle and flexion at delivery stride on pace bowling in cricket

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### Abstract

**Introduction:** Body segments are considered to be rigid bodies for the purposes of describing the motion of the body. Joint angle (also called inter-segmental angle) is simply the angle between the two segments on either side of the joint, usually measured in degrees. Bowling, in cricket, is the action of propelling the ball towards the wicket with the help of this segmental force.

**Methodology:** For the purpose of conducting the study, eight male pace bowlers, medium to medium-fast, were purposively selected from various first division club of Kolkata league under C.A.B., age ranging from 20 to 30 years. Ball release velocity, selected segmental angles i.e. Ankle joint angle, Knee joint angle and Hip joint angle at front foot contact, same segmental angles at the time of ball release and the flexions of those joints from front foot contact (FFC) to ball release (BR) were considered as the variables for the study. The bowling delivery actions of the selected bowlers were recorded using two video camera which were stabilised on the tripods. The video was analysed by using the Kinovea-0.8.24 motion analysis software. Mean, standard deviation and Pearson Product Moment Correlation tests were employed to analyse the data statistically.

**Results and Discussion:** The statistical analysis revealed that the selected segmental joint angles (Ankle joint angle, Knee joint angle and Hip joint angle) at front foot contact were positively correlated with Ball Release Velocity whereas the same segmental angles at ball Release were found to be negatively correlated with Ball Release Velocity. At the same way, flexions of all three joints from FFC to BR are also positively correlated with ball release velocity. Among the all parameters, only Hip joint angle at Ball Release ( $r = -0.753$ ) and hip flexion from FFC to BR ( $r = 0.746$ ) were found to be significantly correlated with the Ball Release Velocity.

**Conclusions:** From the result and discussion, it may be concluded easily that lesser hip joint angle at the time of ball release and greater hip flexion from front foot contact to ball release, can help the pace bowlers to maximise their ball release velocity.

**Keywords:** Medium pace, bowling, segmental joint, angle, ball release velocity, cricket

### Introduction

One of the primary weapons in a pace bowler's arsenal is pace of the ball or Ball Release Velocity. At higher speeds, the reaction time for the batter is significantly reduced. A fast bowler delivering at 140+ km per hour leaves the batter with only fractions of a second to decide whether to play or leave the ball, which increases pressure and often results in poor shot selection. Faster deliveries are also harder to judge when it comes to footwork, and even slight misjudgements can lead to dismissals like bowled, caught behind, or leg before wicket (LBW).

Additionally, speed enhances the effectiveness of other variations that pace bowlers use. For instance, bouncers, when delivered at high speed, rise sharply off the pitch, challenging batters to defend or evade them quickly. Similarly, Yorkers, when bowled at extreme pace, become much harder for the batter to dig out because they reach the toes almost instantly. Even a slower ball becomes more deceptive if the bowler has consistently maintained high speeds beforehand, making the drop in pace harder for the batter to detect.

The segmental joints in the body act like a series of interconnected levers that work together to generate and transfer force. Proper synchronization and coordination of these joints allow a bowler to deliver the ball with maximum speed. If any part of this chain is inefficient or misaligned, it can result in a loss of speed, power, and even control. Therefore, the

researcher’s intention is to investigate the relation of various segmental joints angle at front foot contact and at the time of ball release, and same segmental flexion from front foot contact (FFC) to ball release (BR) with ball release velocity.

**Methodology**

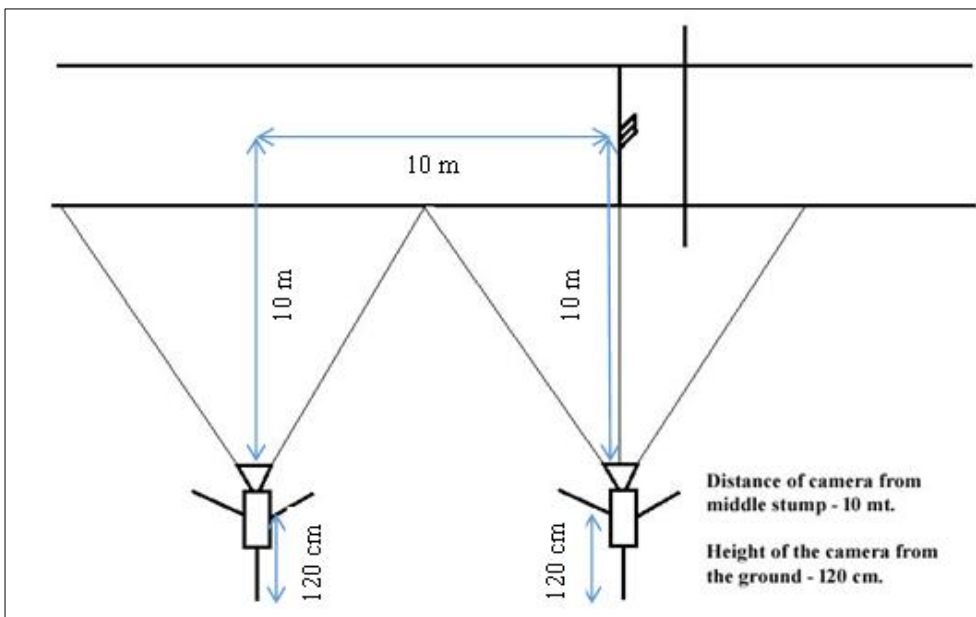
**Selection of Subjects:** For the present study, eight male pace bowlers, medium to medium-fast, have been selected purposively, who have played for various First division club of Kolkata league under C.A.B., ranging the age from 20 to 30 years. All of them were right-handed players, active participants and they had no pre-existing injury at the time of data collection.

**Selection of Variables:** Selected segmental angles i.e. Ankle joint angle, Knee joint angle and Hip joint angle at front foot contact (FFC) and at the time of ball release (BR), and same segmental flexion from front foot contact (FFC) to ball release (BR) were considered for the study as independent variables and Ball release velocity was considered as the dependent variable of the study.

**Instruments and Tools:** For collecting and analysing the data, two cameras with tripod stand- [Canon 1200D (50fps: Camera-1) and Nikon 5100D (30fps: Camera-2)], Kinovea-0.8.24 motion analysis software, computer system,

Stadiometer, steel tape, weighing machine, standard Cricket balls, well equipped Cricket pitch, measuring tape, lime dust and nails were used.

**Procedure for Data Collection:** Two fixed camera were used for recording the video of bowling action. To record the ball delivery, Camera-1 was placed at the sagittal right plane of the bowling approach, perpendicular to the pitch in a distance of 10m from the middle of the pitch and at a height of 120cm from the ground. Camera-2 was placed at the sagittal right plane of Run-up path to record the Run-up approach of the players. It was fixed in the same way as Camera- 1 was fixed parallelly in a distance of 10m from Camera- 1 and perpendicular to the run-up path. A reference scale (a high jump post: 1.5m) was also recorded by both the cameras calibrate the recorded distance with the original distance. Each subject has bowled three times but the fastest one was selected for analysis. The recorded video was transferred to the computer and it was digitized and analysed by using Kinovea 0.8.24 motion analysis software. In order to investigate the existence of the effect of bowlers' different segmental Joint Angles in different position (Front foot contact and Ball release) and flexions of those joints on the Ball Release Velocity in cricket, Pearson Product Moment Correlation was implied and the level of significance was chosen at 0.05.



**Fig 1:** Filming environment for recording the bowling action



**Fig 2:** Video analysis of calculating ball release velocity



**Fig 3:** Video analysis of segmental joints angle at front foot contact



**Fig 4:** Video analysis of segmental joints angle at ball release

**Results and Discussions**

General and Anthropometrics Characteristics of the Subjects, descriptive statistical analysis of the kinematic

data collected on 8 male first division pace bowlers of Kolkata league and the correlations of selected independent variables with Ball Release Velocity have been presented in the following tables.

**Table 1:** General and Anthropometrics Characteristics of the Subjects

Variables	Mean	Std. Deviation
Age (Year)	24.25	4.68
Height (cm.)	172.31	5.70
Weight (kg.)	64.25	8.00

Anthropometric Characteristics of the subjects for the purpose of the study were: age  $24.25 \pm 4.68$  year, height  $172.31 \pm 5.70$  cm, weight  $64.25 \pm 8.00$  kg which were quite normal and suitable for the further investigations.

**Table 2:** Descriptive Statistics of the Kinematic Variables

Sl. No.	Variables	N	Minimum	Maximum	Mean	Std. Deviation
1	Ankle Joint Angle at Front foot contact (Degree)	8	121	136	129.00	5.18
2	Knee Joint angle at Front foot contact (Degree)	8	151	175	161.88	7.75
3	Hip angle at Front foot contact (Degree)	8	124	141	131.88	5.44
4	Ankle Joint Angle at Ball release (Degree)	8	109	130	119.88	7.61
5	Knee Joint Angle at Ball release (Degree)	8	136	182	160.63	16.93
6	Hip angle at Ball release (Degree)	8	94	124	106.38	10.68
7	Ankle Flexion from FFC to BR (Degree)	8	1	25	9.13	7.64
8	Knee Flexion from FFC to BR (Degree)	8	-14	28	1.25	14.66
9	Hip Flexion from FFC to BR (Degree)	8	4	40	25.50	12.49
10	Ball release velocity (Km/h)	8	101.71	117.94	110.18	6.39

The above table describe the descriptive statistics of all the variables. From this table, it is observed that the Mean  $\pm$  SD of Ankle Joint, Knee Joint and Hip Joint at FFC are  $129.00 \pm 5.18$ ,  $161.88 \pm 7.75$  and  $131.88 \pm 5.44$  respectively. On the other hand, the Mean  $\pm$  SD of the same joints at BR are  $119.88 \pm 7.61$ ,  $160.63 \pm 16.93$  and  $106.38 \pm 10.68$  respectively. Here it is clearly seen that the mean value of all three segmental angle is reduced at the time of ball release from front foot contact. That means the bowlers generated final momentum by flexing all these joints. It is also observed from this table that the Mean  $\pm$  SD of

angular flexions of all these segmental joints from FFC to BR are  $9.13 \pm 7.64$ ,  $1.25 \pm 14.66$  and  $25.50 \pm 12.49$  respectively. The range (-14 to 28) and the Mean  $\pm$  SD ( $1.25 \pm 14.66$ ) of Knee flexion from FFC to BR indicate that there were few cases where the angle was increased or extended at the time of ball release instead of flexion.

From this table, the Mean  $\pm$  SD of Ball Release Velocity was found to be  $110.18 \pm 6.39$  which ranged from 101.71 to 117.94. This indicates that all the subjects were medium to medium-fast pace bowlers.

**Table 3:** Coefficient of Correlations (r) of Independent Variables with Ball Release Velocity

Sl. No.	Independent Variables	Coefficient of Correlations (r) with Ball Release Velocity	Sig. (2-tailed)
1	Ankle Joint Angle at Front foot contact (Degree)	0.153	0.718
2	Knee Joint angle at Front foot contact (Degree)	0.383	0.349
3	Hip angle at Front foot contact (Degree)	0.235	0.575
4	Ankle Joint Angle at Ball release (Degree)	-0.293	0.481
5	Knee Joint Angle at Ball release (Degree)	-0.149	0.725
6	Hip angle at Ball release (Degree)	-0.753*	0.031
7	Ankle Flexion from FFC to BR (Degree)	0.395	0.332
8	Knee Flexion from FFC to BR (Degree)	0.374	0.361
9	Hip Flexion from FFC to BR (Degree)	0.746*	0.034

\* Correlation is Significant at 0.05 level  $r(0.05(6)) = 0.707$

From the above table, it is clear that the segmental angles (Ankle, Knee and Hip) at Front Foot Contact had positive relations with Ball Release Velocity. Whereas, the segmental angles (Ankle, Knee and Hip) at Ball Release were negatively correlated with Ball Release Velocity. On the other hand, the flexions of segmental joints (Ankle, Knee and Hip) from FFC to BR had again positive relation with Ball Release Velocity. The positive correlations of all three segmental flexions

from FFC to BR clearly depict that, in general, the bowlers have generated the final resultant force to the ball by flexing all these three segmental joints. This happens when a bowler starts delivery stride with extended angles and finishes with flexed angles. That is why, all three segmental angles at FFC are positively correlated and same angles at BR are negatively correlated with Ball Release Velocity. But as per the above table only hip joint angle at BR ( $r = -0.753$ ) and hip flexion from FFC to BR ( $r = 0.746$ ) are significantly

proven to have influences on Ball Release Velocity. As all the other variables are not statistically significant, it can not be said that the variables, other than the Hip Angle at FFC and the Hip Flexion from FFC to BR, have any relation with Ball Release Velocity. The reason behind this is, in case of Knee and Ankle joint, the force may be generated either by flexing or extending these segmental joints during FFC to BR. In this study, we have considered only flexions of those joints. But in reality, all the subjects of this study did not perform flexion of Knee and Ankle joints during FFC to BR, rather few of them performed extension instead. Therefore, the coefficient of correlation of rest of the variables with Ball Release Velocity could not be significant.

### Conclusion

From the result and discussion, it may be concluded easily that the Hip Joint Angle at the time of Ball Release has significant impact on the Ball Release Velocity in pace bowling. Bowlers, bowling with lesser hip joint angle at Ball Release, can gain faster Ball Release Velocity.

It also may be concluded that hip flexion from Front Foot Contact to Ball Release is also a positive significant determinant of ball release velocity for the pace bowlers.

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