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# KINEMATIC ANALYSIS OF FLAT SERVE IN TENNIS

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## ABSTRACT

This research paper presents the analysis of the tennis serve kinematic ally with reference to selected variables. It also attempts to describe and explain effects of other kinematic factors on the performance of the player. The author also draws a focus on biomechanical analysis of the corresponding racket and ball dynamics, presented together with its analogy with angles at various joints. The goal of the study is to help the coaches in finding out the shortcomings in the execution of particular movement. To acquire kinematical data, a digital Nikon D-5200 video recording camera with a frame rate of 30 frames per second, were used during the execution by placing it left side of horizontal bar and perpendicular to the sagittal plane. The selected kinematic variables were drawn at the time of execution of service by using joint-point method and C.G was found by using segmentation table suggested by hay (1993). On the basis of results it is concluded that C.G plays an important role in executing an effective skill. If the C.G falls forward/ behind the base of support then it affects the performance in many ways.

**Keywords**: Kinematic, Quantitative measurement and 3-Dimensional (3-D) body motions.

## INTRODUCTION

The major role of biomechanics is to enhance the performance of players and to eliminate /to diminish the risk of injury. Biomechanics is basically the study of forces and the effects produced by them. The analysis of human body movement can be done in various ways such as Anatomical analysis, biomechanical analysis, kinematic analysis etc.

Kinematics is an area of biomechanics dealing with determination and description of the human body movements. Quantitative measurement of the motion of interest and subsequent analysis based on the computed kinematic quantities allow investigators tom go in-depth understanding of the movement itself and the common pattern of movements. The human body is a mechanical system with a large number of degrees of freedom and isolating a set of key performance characteristics/components is of crucial importance for effective performance enhancement in complex 3-dimensional (3-D) body motions such as the serve in Tennis. The kinematic assessment requires both knowledge of the movement characteristic and the ability to observe and analysis. Success in tennis needs a combination of playing skills, good equipments, effective coaching and the knowledge of biomechanical aspects related to the performance of player. The advancement in sports biomechanics has given a new recognition to the tennis. If we see the development of tennis, biomechanics has contributed a lot. Tennis has changed entirely from being stylish to comfort. In tennis, an athlete transfers the energy of his body to ball through the tennis racket to generate spin and speed in ball. Energy can be in any form either potential or kinetic. The energy stored in spring under tension will be considered as potential energy.

### Methodology

The Purpose of the study to find out the kinematics variables for analysis the subjects who have represented Amity University in North zone Tennis inters university. Selected kinematics variables:

- Angle at Various Joints.
- Position of Centre of Gravity.
- Height of Centre of Gravity
- Position of Racquet at the time of contact with ball.

### Experimental Filming Protocol

The data were collected in outdoor tennis court of Amity university (AUUP). who have represented Amity university in North Zone inter university tournament- were recruited as subjects for the conduct of research. Two cameras one in sagital plane and other in frontal plane were placed to record the data .Sophisticated camera (Nikon d5200) was used for analysing the data.60 digital snapshots with good quality and successfully performed were selected.

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Fig. 1: Execution of Flat Service

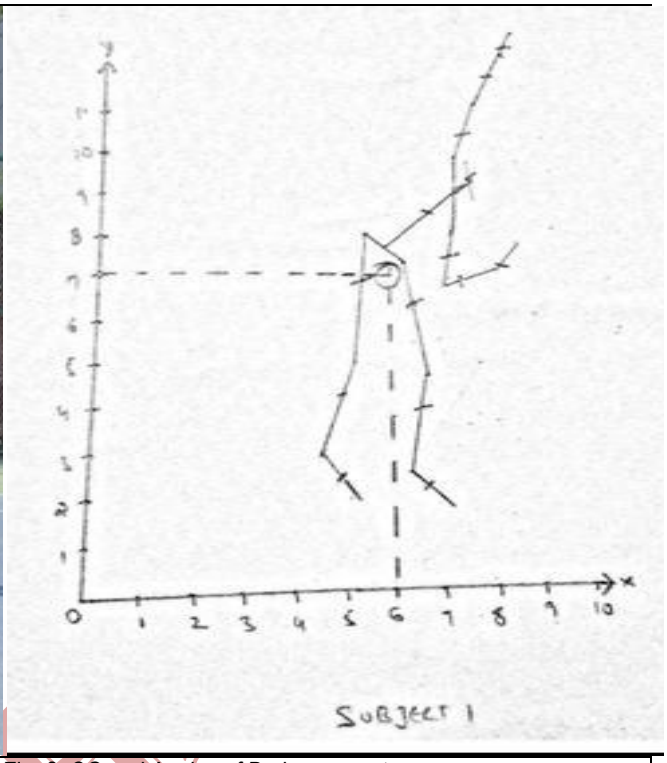


Fig. 2: CG and Angles of Body segments

Centre of Gravity (CG) of the subject lying within the base of support which reveals that the subject is in properly balanced position to execute the drive. From the fig. 2 it clearly visible that when the drive is being executed the subject would gradually move from rear to front leg. However at the time of execution moment that is the moment when the ball contacts with the head of the racquet, the subject has fully extended the elbow which helps in building more racket head speed. The knee is bent which allows player to push harder off the ground and launch up more into the shot.

Table1: Segmentation Table

| Body Segment | Relative Weight | CG | OX | OY | Momentum (OX) | Momentum (OY) |
|---|---|---|---|---|---|---|
| HEAD | 0.073 | 0.4 | 7.2 | 9.4 | 0.6 | 9.4 |
| TRUNK | 0.507 | 0.7 | 6.8 | 8.5 | 4.3 | 8.5 |
| THIGH(R) | 0.103 | 1 | 6.5 | 6.4 | 0.6 | 6.4 |
| THIGH(L) | 0.103 | 1.1 | 5.5 | 6.9 | 0.7 | 6.9 |
| CAIF(R) | 0.403 | 0.8 | 6.6 | 3.9 | 0.1 | 3.9 |
| CALF(L) | 0.403 | 0.8 | 5 | 4.2 | 0.1 | 4.2 |
| FOOT(R) | 0.015 | 0.5 | 6.8 | 2.2 | 0.03 | 2.2 |
| FOOT(L) | 0.015 | 0.6 | 5.1 | 2.4 | 0.03 | 2.4 |
| UPPER ARM(L) | 0.026 | 0.7 | 7.6 | 7.4 | 0.2 | 10.4 |
| FOREARM(L) | 0.016 | 0.5 | 8.1 | 11.8 | 0.1 | 11.8 |
| UPPER ARM(R) | 0.026 | 0.6 | 7.3 | 7.4 | 0.1 | 7.4 |
| FOREARM(R) | 0.016 | 0.3 | 7.5 | 6.9 | 0.1 | 6.9 |

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Fig. 3: Execution of Flat Service

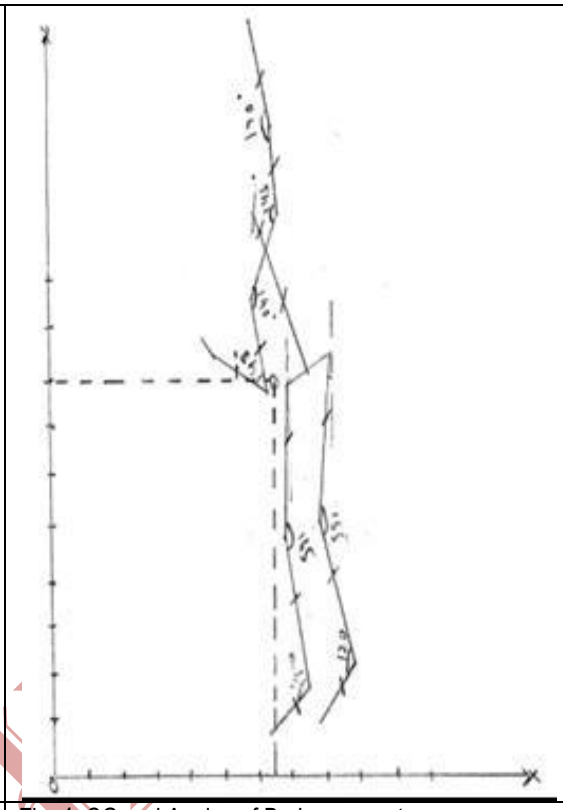

Fig. 4: CG and Angles of Body segments

The player is transferring his body weight on the right foot so that he can add more power to service. Subject CG is falling slightly forward which shows that he is in quite imbalanced position to play the stroke. The contact of the racquet with the ball is far ahead and it should have been made slightly behind so that greater linear velocity has been imparted to the ball.

Table 2: Segmentation Table

| Body Segment | OX | Relative Weight | Moment (OX) | OY | Moment (OY) |
|---|---|---|---|---|---|
| HEAD | 6.3 | 0.075 | 0.4 | 11.1 | 0.8 |
| TRUNK | 6.9 | 0.507 | 3.4 | 9.7 | 4.9 |
| UPPER ARM(L) | 6.2 | 0.026 | 0.1 | 8.7 | 0.2 |
| FOREARM(L) | 5.6 | 0.016 | 0,08 | 8.3 | 0.1 |
| FOREARM(R) | 6.3 | 0.016 | 0.1 | 14.2 | 0.2 |
| UPPERARM | 6.6 | 0.026 | 0.1 | 12.3 | 0.3 |
| THIGH(L) | 7 | 0.103 | 0.7 | 6.8 | 0.7 |
| THIGH(R) | 8.2 | 0.103 | 0.8 | 7.3 | 0.7 |
| CALF(L) | 7.2 | 0.043 | 0.3 | 3.6 | 0.1 |
| CALF(R) | 8.3 | 0.043 | 0.3 | 4.1 | 0.1 |
| FOOT(L) | 7.2 | 0.043 | 0.1 | 1.4 | 0.02 |
| FOOT(R) | 8.5 | 0.015 | 0.1 | 1.9 | 0.02 |

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Fig. 5: Execution of Flat service

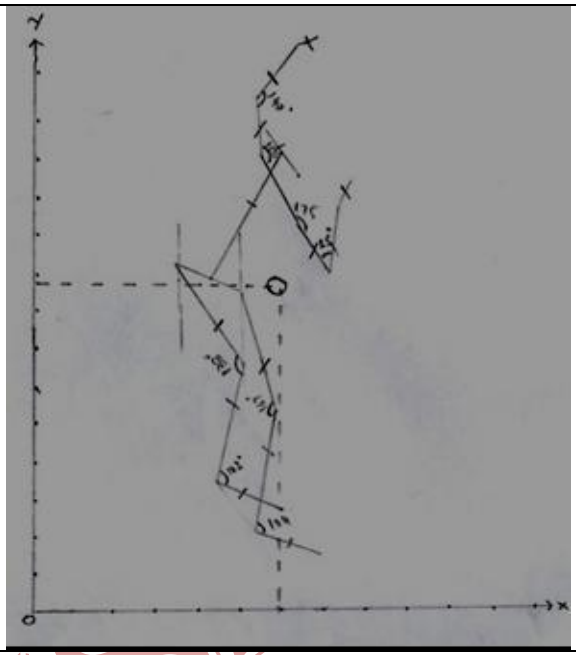

Fig. 6: CG and angles of Body segments

The techniques of subject 3 has some false as subjects elbow is not fully extended at the time of contact of ball with the racket which have more of a problem with letting the ball pass the contact point than not actually the ball reaching it. If he extends his elbow he should be able to nearly draw a straight line from his hitting arm elbow to his non dominant shoulder He is properly balanced to execute the backhand drive because his Cg falls within the base. The contact of the racquet head and ball is at the right moment. He is also shifted his body weight on the right foot so that he able to execute more power to his stroke.

Table 3: Segmentation Table

| Body Segment | OX | Relative Weight | Moment (OX) | OY | Moment (OY) |
|---|---|---|---|---|---|
| HEAD | 5.9 | 0.075 | 0.4 | 12.3 | 0.8 |
| TRUNK | 5.2 | 0.507 | 2.6 | 10.9 | 5.5 |
| UPPER ARM(L) | 6.2 | 0.026 | 0.1 | 9.7 | 0.2 |
| FOREARM(L) | 7.2 | 0.016 | 0.1 | 9.6 | 0.1 |
| FOREARM(R) | 5.7 | 0.016 | 0.09 | 14.3 | 0.2 |
| UPPERARM(R) | 5.4 | 0.026 | 0.1 | 12.9 | 0.3 |
| THIGH(L) | 5.6 | 0.103 | 0.5 | 6.6 | 0.5 |
| THIGH(R) | 4.4 | 0.103 | 0.4 | 7.6 | 0.4 |
| CALF(L) | 4.2 | 0.043 | 0.2 | 4.2 | 0.1 |
| CALF(R) | 5.5 | 0.043 | 0.2 | 5.5 | 0.2 |
| FOOT(L) | 5.6 | 0.043 | 0.08 | 1.8 | 0.02 |
| FOOT(R) | 5 | 0.015 | 0.07 | 3.2 | 0.04 |
| WRIST(R) | 6.6 | 0.007 | 0.04 | 15.1 | 0.1 |
| WRIST(L) | 6.2 | 0.007 | 0.04 | 11.2 | 0.07 |

**Conclusion**

Based on the analysis and within the limitation of present study following conclusion were drawn that:

If at the time of impact the back foot is behind the front foot therefore it allows trunk to rotate which helps in generating the force.

If the C.G. falls within the base then the player is in the most stable state to execute the skill.

If the weight shifts from rear to front leg which enables player to generate more amount of thrust against the ground therefore generating more powerful jump in to the air.

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