LUNGE POSITION ANALYSIS OF MEN'S SINGLE BADMINTON PLAYER BY KINEMATICS AND KINETICS ANALYSIS

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Introduction: Badminton is a sport that requires fast, sudden movement, and repetitive movements. To achieve maximum performance, a badminton athlete needs to perform movements that are considered to result in various types of injuries. Injury in badminton players due to excessive muscle use as a percentage of up to 36% [1]. In badminton, the spine is a part of the body that is potentially injured by up to 21% [2]. However, there is rarely research on back pain injuries in badminton. Two of the extreme movement to receive shuttlecock are lunges and overhead. The repetition of these movements in single' category reaches up to more than 80 times for each match in a tournament. This study aimed to analyze the lunges position mechanism and use to predict the likelihood of back pain injury caused by fatigue.

Methods: 8 single men's badminton players (Mean ± SD; age = 16-21 years; height (cm) = 174.5 ± 4.85 ; weight (kg) = 68.27 ± 10.53; body fat (kg) = 16.53 ± 4.22) from Sangkuriang Graha Sarana (SGS) PLN Badminton Club who actively compete in national and international tournament participate in this study. The movement of lunges captured using multi-camera motion capture consists of 5 GoPro cameras and active LED markers. The location of the markers for analyzing back movement is the thoracolumbar part, the pelvis, and the femoral [3]. The lunges movement in this study is divided into five stages; stage 1 is when the player starts the lunges movement, stage 2 is when the players move 1 step to the front, stage 3 is the maximum position of lunges movement while the player performs lowest neck position and knee angle at 90 degrees, stage 4 is when the player performs balance position, and stage 5 is when player steps back to the initial position. Kinematics and kinetics data processing from the motion capture system was successfully implemented. The kinematics data algorithm implemented includes the calculation of position data, speed data, acceleration data, filtering, and normalization. The algorithm is based on the formula of speed and instantaneous acceleration. LPF filters are used to eliminate noise. Normalization is applied to the x-axis to convert from the time dimension to the percent movement. The kinematics result is visualized in a graph by dividing the movement into 5 stages (figure 1)

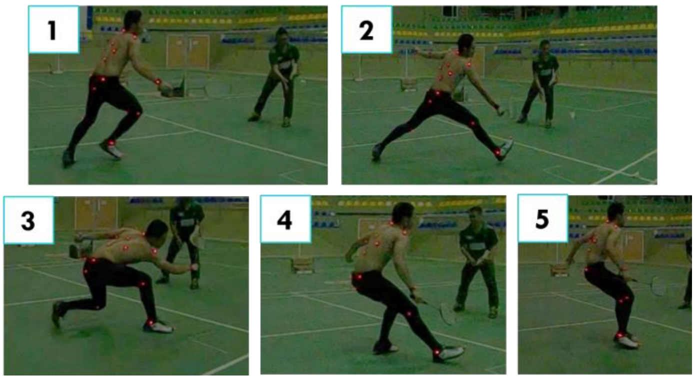

Figure 1: 5 stages of lunge movement

Results: This study focus on mechanics of the back bone in lunges movements. The maximum acceleration occurs in stage 3 of lunge movement where player at lowest position for neck (9.10 ± 1.37 ms^{-2}) . While the maximum acceleration for thoracolumbar 12 (T12) and sacral 3 (S3) was in

stage 4 when player lift up his back to balance (6.36 ± 0.79 ms^{-2} and 5.06 ± 0.46 ms^{-2}. During the lunge's movements, there was no significant difference in neck and S3 in each stage. However, T12 acceleration was change 1.5 times bigger from stage 2 (4.2 ± 1.09 ms^{-2}) into stage 3 before it reduces back in stage 5 (4.96 ± 0.67 ms^{-2}). Acceleration on the neck, was the highest in all stages.
In table 1, T12 and S3 has the highest force in all stages with the maximum forces is stage 4; 91.22 ± 12.08 N and 48.50 ± 7.04 N. Whilst, the maximum force in the neck at stage 3 is 49.00 ± 6.60 N.

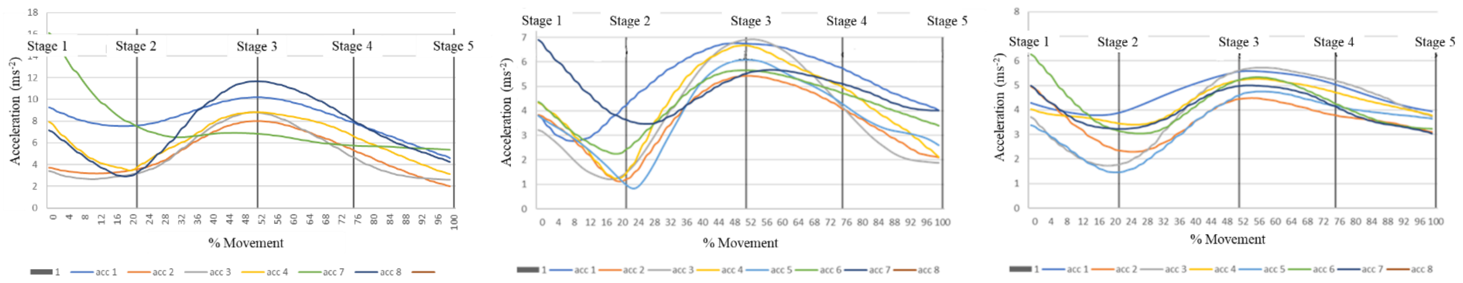

Figure 2 : Acceleration of neck (left), T12 (middle), and S3 (right) in % movement

Table 1 : Force of neck, T12, S3 in each stage

Part	Force (N)				
	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**
Neck	41.62 ± 32.89	40.76 ± 32.26	49.00 ± 6.60	48.30 ± 6.52	34.84 ± 7.31
T12	63.01 ± 26.19	62.09 ± 25.64	90.29 ± 11.52	91.22 ± 12.08	71.62 ± 13.65
S3	44.30 ± 11.74	43.44 ± 11.46	47.02 ± 7.41	48.50 ± 7.04	42.59 ± 6.40

Discussion: There are two phenomena showed in this study, the neck maximum acceleration and force appear in stage 3, while the maximum acceleration and force of T12 and S3 exist in stage 4. During the lunge movement from stage 1 to stage 3, the muscle and strength in upper extremities take major part since the player has to bend down to take the shuttlecock near the net area. After stage 3 movement, in stage 4, the player has to balance himself first before straighten his back and step back to get ready to receive the next shuttlecock. This transition required a good muscle strength in lower extremities. In agreement with this, the neck movement stop in the lowest position while T12 and S3 biggest role was in stage 4 as part of balancing force.

Conclusion: This study shows that men's single player required to have a good muscle strength both in upper and lower extremities while doing lunge movement. Additionally, with the repetition of almost reach 100 in each competitive match this could lead to fatigue.

References:

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