Kinematic indicators of “block” technical movement of volleyball players

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Abstract

Purpose: The primary aim of the research is to analyze the kinematic indicators of volleyball players during the execution of the blocking technique, with a specific focus on trunk and neck movements. By capturing detailed biomechanical data, the study seeks to provide insights into how these movements contribute to blocking effectiveness, performance optimization, and injury prevention in elite-level volleyball players.

Methods: The study employed advanced 3D motion analysis technology to conduct a detailed biomechanical evaluation of the blocking technique in volleyball. The research was carried out in the high-tech laboratory at the Uzbekistan State University of Physical Education and Sports. The subject was a candidate athlete for Master of Sports in volleyball, and their blocking performance was captured using a high-resolution 3D motion capture system. Multiple infrared cameras were strategically placed around the laboratory to track the athlete’s movements from different angles. Reflective markers were positioned on key anatomical points, including the shoulders, spine, hips, knees, and ankles, to capture precise data on joint angles, body posture, and the coordination of trunk and neck movements. This setup enabled a thorough analysis of the kinematic indicators that are crucial for executing an effective block in volleyball.

Results: A player’s ability to adjust neck flexion and extension is essential for visual tracking and timing during the block. Flexibility in this plane allows players to maintain focus on the ball as they anticipate the opponent’s attack, while proper control over flexion ensures optimal timing when extending arms to block (Gabbett & Georgieff, 2007).

Lateral flexion refers to the sideways movement of the neck, either to the right or left. In the blocking technique, lateral neck flexion may occur as players adjust their head to track the ball or position themselves in response to an attacker’s angle of approach.

Minimum Angle (Min): -19º ± 1.64. The minimum value represents lateral flexion to the left, indicating that players often tilt their head to the left side during blocking, likely in response to a ball trajectory coming from the left.

The maximum lateral flexion to the right shows that players can tilt their head by 15±2.1º in this direction during blocking.

The total range of lateral flexion is 34±4.º, which highlights the need for mobility in the neck as players adjust their head positioning dynamically during blocking.

Conlcusion: These findings emphasize the need for targeted training that enhances **trunk flexibility** and **neck mobility** to improve blocking performance and reduce the risk of injury. Volleyball players, particularly those in blocking positions, can benefit from drills that focus on these specific movement patterns, ensuring they are better equipped to respond to the dynamic demands of the game. Future research could further explore the correlation between these kinematic indicators and performance outcomes in competitive play.

Keywords: volleyball, kinematic indicators, blocking technique, trunk movement, neck movement, flexion and extension, lateral flexion, rotation.

Introduction

Blocking is a critical component of volleyball defense, intended to prevent the ball from crossing the net or to deflect it back into the opponent's court. An effective block requires not only upper body strength but also precise timing and coordination. The movement of the trunk and neck plays a vital role in the successful execution of this skill. The trunk's anterior/posterior tilt and lateral flexion enable players to adjust their body positioning dynamically, while the neck’s flexion, lateral flexion, and rotation are essential for maintaining visual contact with the ball and reacting to the attacker’s movements.

Previous research has focused on the mechanics of jumping and arm movement in volleyball blocking, but little attention has been paid to the specific role of trunk and neck motion. This article seeks to fill that gap by analyzing the kinematic indicators of both trunk and neck movements, providing an in-depth understanding of how these motions contribute to blocking effectiveness. By examining flexion, extension, lateral flexion, and rotation, the study offers key insights into the biomechanics of volleyball blocking.

The kinematic aspects of volleyball, particularly in the context of blocking, have been studied extensively, though much of the focus has been on arm movements, jumping mechanics, and timing. Less attention has been given to the roles of the trunk and neck, despite their importance in maintaining balance, stability, and visual tracking during defensive actions like blocking. This review explores key research on the biomechanical and kinematic fac-

tors affecting blocking performance, with an emphasis on trunk and neck movements.

Trunk movements are crucial in providing stability and power in volleyball, particularly during blocking, where precise control over posture and balance is essential. Häkkinen (1993) noted that the trunk plays a significant role in explosive actions such as blocking, where core strength and flexibility are needed to reach and intercept high-speed attacks. The ability to effectively tilt and flex the trunk influences a player's capacity to adjust their body position in mid-air, enhancing their reach and coverage at the net.

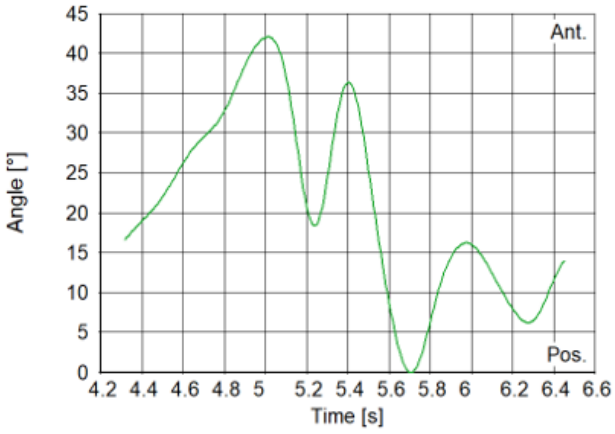
Studies like those conducted by Drikos et al. (2012) have emphasized the importance of trunk stability in maintaining balance during blocking. The anterior/posterior tilt of the trunk allows players to lean forward to meet the ball at the optimal point, maximizing their blocking surface. This motion has been shown to correlate directly with the success of the block, as the forward flexion of the trunk enables better positioning and reach. Additionally, lateral flexion of the trunk plays a critical role in adjusting to balls hit at different angles, allowing players to quickly shift their blocking stance based on the attacker's movements.

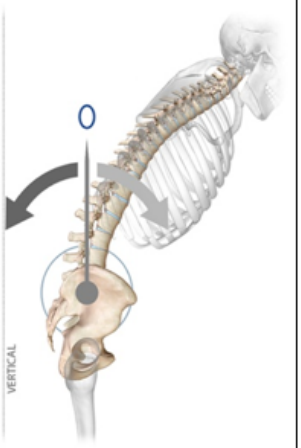
The importance of neck movements in volleyball, particularly in blocking, has been relatively understudied compared to other aspects of the sport. However, Ziv and Lidor (2010) highlighted the role of head and neck flexibility in visual tracking, which is crucial during blocking. Players must constantly adjust their head position to maintain visual contact with the ball, especially when dealing with high-speed attacks or deceptive shot trajectories. The ability to move the neck through flexion, lateral flexion, and rotation enables players to

Fig 1. Trunk volleyball players' "block" technical motion indicators

Tilt
Anterior[+]/Posterior[-]

In.	M±α	V%
Min °	0±0	0
Max °	42±5.21	12.4
Range °	42±3.85	9.1





Lateral Flexion
Right[+]/Left[-]

In.	M±α	V%
Min °	-10±1.24	14
Max °	8±0.74	9.25
Range °	18±1.30	7.2

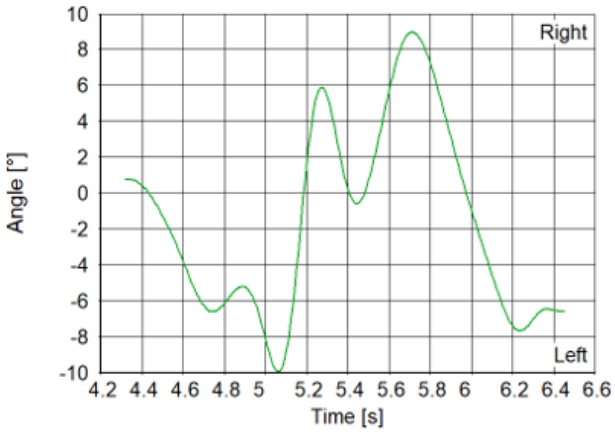
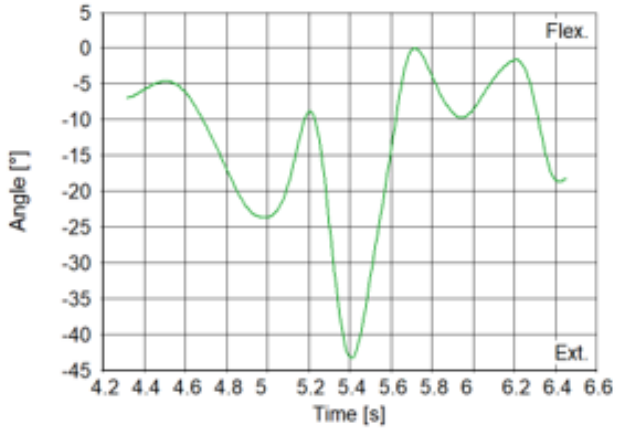




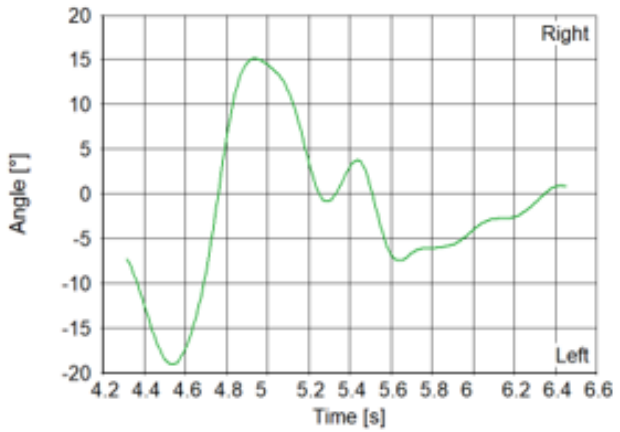
Fig 2. Kinematic indicators of the neck position of volleyball players performing the "block" technical movement

Flexion *Flexion[+]/Extension[-]*		
Min °	-44±2.14	
Max °	0±0	
Range °	43±3.15	



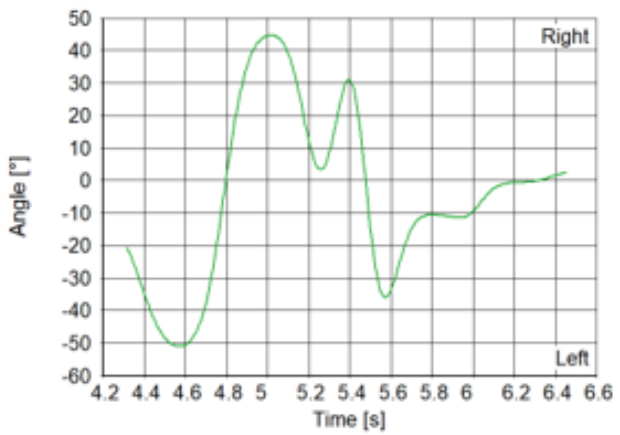


Lateral Flexion *Right[+]/Left[-]*		
Min °	-19±1.64	
Max °	15±2.1	
Range °	34±4.1	





Rotation *Right[+]/Left[-]*		
Min °	-51±5.3	
Max °	44±3.6	
Range °	95±8.2	





react quickly and effectively to the ball's movement.

In volleyball blocking, neck rotation is particularly important for tracking the ball laterally across the net, as discussed by Sheppard et al. (2009). The rapid nature of offensive plays requires blockers to turn their heads quickly to align themselves with the approaching ball. Neck flexibility also allows players to track balls that are attacked from various angles, ensuring that they are in the best position to intercept or deflect the ball.

Kinematic studies have been increasingly applied to understand the biomechanical requirements of volleyball, particularly in jumping and landing mechanics during blocking. Gabbett and Georgieff (2007) explored the kinematics of blocking in relation to player height, jump height, and timing. While these studies have largely focused on the extremities, partic-

ularly the arms and legs, the role of the trunk and neck has also been acknowledged as a significant factor in maintaining balance and executing a stable block.

The range of motion in the neck and trunk contributes to overall agility and flexibility during the block. Flexion, extension, and lateral movements in both areas allow players to fine-tune their positioning, which is essential for successfully defending against attacks. The analysis of these motions offers insight into how players can enhance their performance by improving their mobility and core strength.

One critical aspect of the literature is the relationship between kinematic movements and injury prevention. Häkkinen (1993) emphasized the importance of core strength not only for performance but also for reducing the risk of injury. Trunk and neck flexibility are key factors in preventing strain and injury, particularly in high-intensity movements like blocking. Ziv and Lidor (2010) similarly noted that improving neck flexibility can prevent injuries related to sudden head movements during play.

Training programs that target trunk stability and neck mobility have been shown to enhance blocking performance while reducing the risk of common injuries such as muscle strains and sprains. Sheppard et al. (2009) recommended specialized drills that incorporate dynamic flexibility exercises to improve the range of motion in both the trunk and neck, which can lead to more effective and safer blocking techniques.

The body of research on kinematic indicators in volleyball highlights the critical role of both trunk and neck movements during the blocking action. While arm and jump mechanics have been widely studied, the importance of trunk flexibility and neck mobility is increasingly being recognized as a key factor in successful blocking performance. By focusing on these areas, players can improve their reach, stability, and ability to react to the ball, while also minimizing the risk of injury through targeted strength and flexibility training.

The existing literature suggests that further research into the biomechanics of the trunk and neck during volleyball blocking would provide valuable insights into optimizing performance and injury prevention, areas that have significant implications for both elite athletes and coaches.

Tasks of the Research:

1. To examine the role of trunk movements (tilt and lateral flexion) during blocking.

2. To investigate the kinematic indicators of neck movements (flexion, lateral flexion, and rotation) during blocking.

3. To capture and analyze 3D motion data of the blocking technique.

4. To identify critical biomechanical factors that influence blocking performance.

5. To provide recommendations for performance enhancement and injury prevention.

Research Organization: The research was conducted at the Uzbek State University of Physical Education and Sports, specifically within the high-tech laboratory of Sport, which is equipped with advanced 3D motion analysis technology. This state-of-the-art facility allows for the precise measurement of biomechanical parameters. The subject of the study was a candidate athlete for Master of Sports in volleyball, with extensive experience in competitive play. The primary focus of the experiment was to analyze the blocking technique in volleyball, specifically looking at kinematic and kinetic data associated with trunk and neck movements. The controlled laboratory environment ensured accurate and reliable data collection, which provided deep insights into the biomechanics of elite volleyball blocking techniques.

Results and discussion

Blocking is a fundamental defensive maneuver in volleyball, primarily aimed at stopping or deflecting the opposing team's attack by intercepting the ball at the net. Successful blocking requires a combination of upper body strength, timing, coordination, and, most importantly, efficient use of the trunk muscles for stability and power. This article examines the technical motion indicators of the trunk during the blocking technique in volleyball players, specifically focusing on tilt and lateral flexion.

The term "tilt" refers to the forward (anterior) or backward (posterior) bending of the trunk. In volleyball, the anterior tilt is crucial during blocking, as it allows players to lean forward to meet the ball at the highest possible point, maximizing the blocking surface and effectiveness.

Players begin blocking from an upright, neutral trunk position (0º anterior tilt). This neutral posture allows for an explosive movement upward toward the block.

During the blocking motion, players can

tilt their trunk forward by up to 42º. This forward motion is critical for effectively reaching the ball and positioning the arms at an optimal angle for intercepting or deflecting the ball.

The total range of motion from the neutral (0º) to the maximum anterior tilt (42º) reflects the degree of trunk flexion required for optimal blocking. The ability to tilt the trunk forward is essential for closing the gap between the body and the net, creating a more imposing block (Drikos, et al., 2012).

The anterior tilt enables players to engage their core and hip flexors while maintaining balance, which is necessary to resist the impact of the ball or counter the opponent's attack. Effective blocking posture requires maintaining trunk stability while executing this forward motion, ensuring the player's hands reach the ideal height without losing balance (Ziv & Lidor, 2010).

Lateral flexion refers to the sideways bending of the trunk, either to the right or left. Lateral flexion is key when volleyball players adjust their positioning in mid-air to align with the trajectory of the ball or to compensate for the attacker's approach angle.

The minimum lateral flexion recorded is -10º to the left. This indicates that during the blocking motion, players may slightly bend their trunk to the left, helping adjust their body to align with the ball or the attacker's swing.

On the opposite side, the maximum lateral flexion to the right is 8º. This asymmetry in lateral movement reflects the variable demands on a player's body during blocking, where slight lateral adjustments may be necessary to execute an effective block.

The total range of lateral flexion during a block is 18º, indicating that while lateral flexion is not as pronounced as the anterior tilt, it still plays a vital role in enabling players to track the ball across the net and adjust their blocking position.

Lateral flexion contributes to the dynamic balance and flexibility required to reach balls that are not directly in front of the player. Volleyball attackers often aim to avoid the blocker by striking the ball at various angles, making lateral trunk adjustments necessary for successful interception (Häkkinen, 1993). By flexing the trunk laterally, players can shift their blocking reach from side to side while maintaining a stable core.

The trunk plays a pivotal role in the biomechanics of volleyball blocking. Both anterior/posterior tilt and lateral flexion are critical components that allow players to adjust their body positioning, extend their reach, and stabilize themselves during contact with the ball. In particular, the anterior tilt with a range of 42º highlights the need for core strength and flexibility, while the 18º range of lateral flexion demonstrates the importance of agility and quick, small adjustments. Proper training that focuses on these movement patterns can enhance blocking effectiveness and reduce the risk of injury (Sheppard et al., 2009).

Flexion and extension describe the forward and backward bending of the neck, respectively. In volleyball blocking, neck flexion occurs when players tilt their head forward to better track the ball's trajectory or adjust their gaze towards the net. Extension occurs when the head tilts backward, usually as the player prepares to jump and track the ball during the blocking motion (Table-2).

This represents the maximum neck extension observed during blocking, where players tilt their head backward by up to -44º±2.14 º. This extension helps them follow the ball's trajectory before making contact. The maximum flexion is recorded at 0±0 º, indicating a neutral neck position where the head is upright. This position allows players to maintain visual contact with both the ball and the opponent.

The total range of motion in the sagittal plane is around 43±3.15º, demonstrating significant flexibility in the neck as player's transition from neck extension during preparation to a neutral or slightly flexed position when executing the block.

Lateral flexion is particularly useful when players need to quickly reorient their body towards the ball. This movement helps players maintain visual contact with the ball even when their upper body or trunk is engaged in the blocking motion. The ability to tilt the head laterally is crucial in situations where quick side-to-side adjustments are needed (Sheppard et al., 2009).

Neck rotation involves turning the head to the right or left. In volleyball, this movement is vital during blocking because it allows players to follow the ball's lateral movement across the net and position themselves in alignment with the attacker's shot.

The minimum angle represents the leftward rotation of the neck, which can reach up to -51º ± 5.3. This leftward rotation is critical when the opponent attacks from the left side of the court.

The maximum rightward rotation is

44±3.6º, indicating that players can rotate their neck to the right to a similar extent, helping them align their block with right-sided attacks.

A total range of motion of 95±8.2º in the transverse plane reflects the significant rotational capability of the neck during blocking. This extensive range allows players to track the ball's horizontal movement across the net and respond accordingly.

Neck rotation is essential in volleyball blocking, as it enables players to scan the court, track the ball, and respond to quick, lateral attacks. A wide range of motion in rotation allows players to remain visually connected to the ball and the attacker, even as they prepare for the block. Adequate neck rotation helps in reading the trajectory of the ball and adjusting body positioning in real-time (Ziv & Lidor, 2010).

The kinematic indicators of neck movements during volleyball blocking provide crucial insights into the biomechanics of this defensive skill. Flexion and extension facilitate tracking of the ball as players prepare for and execute the block. Lateral flexion allows players to make quick, side-to-side adjustments in response to the attacker's positioning, while neck rotation plays a critical role in maintaining visual contact with the ball and opponent across the net. These kinematic indicators highlight the importance of neck flexibility, control, and strength for optimal blocking performance in volleyball.

Conclusion

The study of kinematic indicators in volleyball blocking reveals that effective blocking relies heavily on both **trunk** and **neck movements**. The trunk's anterior/posterior tilt, along with lateral flexion, enables players to adjust their body positioning dynamically to meet the ball at optimal angles. Meanwhile, the neck's flexion, lateral flexion, and rotation ensure that players maintain visual contact with the ball and adjust to its trajectory during the block. The total range of motion in both the trunk and neck highlights the importance of flexibility and core strength in the blocking process.

References

Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2012). *The identification of elite performance in volleyball.* _Journal of Human Kinetics_, 31, 121–129.

Gabbett, T., & Georgieff, B. **(2007).** *Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players*. _Journal of Strength and Conditioning Research_, 21 (3), 902–908.

Häkkinen, K. **(1993).** *Changes in physical fitness profile in female volleyball players during the competitive season.* _Journal of Sports Medicine and Physical Fitness_, 33 (3), 223–231.

Sheppard, J. M., Gabbett, T., & Stanganelli, L. C. **(2009).** *An analysis of playing positions in elite men's volleyball: Considerations for competition demands and physiological characteristics*. _Journal of Strength and Conditioning Research_, 23(6), 1858–1866.

Ziv, G., & Lidor, R. **(2010).** *Vertical jump in female and male volleyball players: A review of observational and experimental studies.* _Scandinavian Journal of Medicine & Science in Sports_, 20(4), 556–567.

Ziv, G., & Lidor, R. **(2010).** *Vertical jump in female and male volleyball players: A review of observational and experimental studies.* *Scandinavian Journal of Medicine & Science in Sports*, 20(4), 556–567.

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