BIOMECHANICAL ANALYSIS OF SPINE MOVEMENTS IN HIKING ON SAILING: A PRELIMINARY STUDY

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This study aimed to evaluate sailors' vertebral spine movements and positioning during hiking position. One Laser Class sailor composed the sample. Four 60Hz Peak Motus System® cameras were used. To evaluate some spine angles the following points were chosen: in saggital plane - the neck flexion angle, thoracic kiphosis angle and lumbar lordosis angle; in frontal plane – the lateral inclination angle; in transversal plane – the trunk rotation. Data were analysed through descriptive statistics. The analysis shows great angle variations performed in a 10s hiking execution. It can be observed that the sailor's trunk performs, in the three axes, a sum of movements during the technical gesture. It was demonstrated that hiking is not a static posture and to study this position researchers should not consider trunk as a fixed segment.

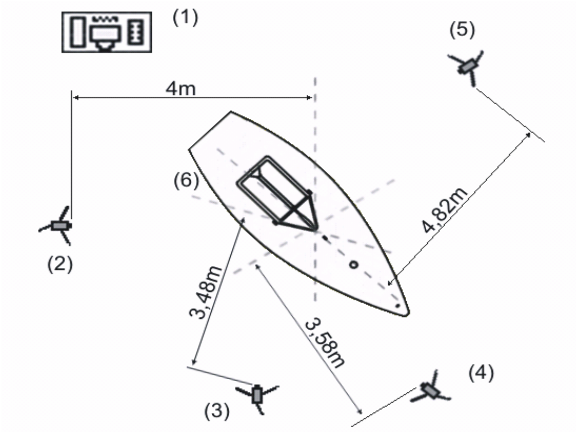
KEY WORDS: sailing, hiking, spine.

INTRODUCTION:

Sailing is a very competitive sport and requires high levels of training. The sailor controls the intrinsic regulations of the boat and still works with factors like speed and constant variation of wind direction, rapids, and different competition courses (Shephard, 1997). To deal with these situations, a constant movement of the sailor is required; this includes, according to Besier and Sanders (1999), pseudo-static positions, fast extensions and rotations of the trunk and eccentric/concentric contractions during the dynamic techniques of sailing control.
The "hiking" position is distinguished amongst the sailor's maneuvers. This position controls the tilt of the boat caused by wind against the sail and the keel against the water (Spurway, 1999). An efficient hiking produces minor attrition between boat and water and consequently more speed.
"Hiking" has different characteristics in the different classes and also varies according to the position of the boat in relation to the wind. It generally involves the pseudo-isometric maintenance of trunk position in light bending and rotation of the spine, associated with hip and knee bending for long periods (Spurway, 1999; Legg *et al*, 1997).
According to Maisseti *et al* (2002) the position of joints and segments varies according to the intensity of winds. The same author states that the variation of the trunk angle during hiking must be object of particular attention.
The aim of this study was to evaluate movement and positioning of the sailor's vertebral spine during hiking position.

METHODS:

Data Collection: This is a descriptive study and the sample was composed by the number 1 ranked sailor of Laser Class in Brazil. He is a 27-year-old athlete, is 1,74m high and weighs 82,5 kg. The analysis was carried out in the Biomechanics Laboratory of Santa Catarina State University. This research was approved by the Ethics Committee of this University. Four 60 Hz Peak Motus System® cameras were used. Figure 1 shows the cameras positioning.



1- **CPU**
2- **CAM 4 (0,89m from the floor)**
3- **CAM 1 (0,49m from the floor)**
4- **CAM 2 (2,57m from the floor)**
5- **CAM 3 (2,57m from the floor)**
6- **Laser Std. Boat**

Figure 1 – Cameras Positioning

To mark the anatomic points, 7mm reflexive balls were used. The chosen points are: Temporomandibular joints (TMJ), acromium of scapula, spinal processes of some vertebrae (C7-T7-L1-L3-L5) and trochanter of femur. To evaluate the spinal positions and movements, some angles of spine were chosen: in saggital plane - the neck flexion angle (1) (T7-C7-TMJ), thoracic kiphosis angle (2) (C7, T7, L1) and lumbar lordosis angle (3) (L1-L3-L5); in frontal plane – the trunk inclination angle (4) (using lines between the trochanters and acromia reflexive points); in transversal plane – the trunk rotation (5) (using the same protocol as in inclination).

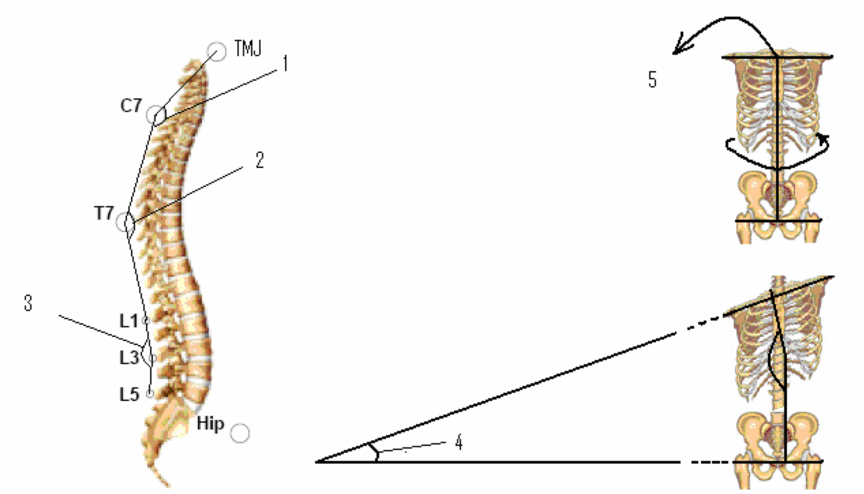


Figure 2 – Demonstration of evaluated angles

For this evaluation a Laser Standard boat was used. It was placed on supports that raised it 1,20m high (Figure 3) in order to facilitate the view of the reflexive points placed on the spine. One execution (10s) was performed and recorded. The athlete was instructed to perform the hiking posture and movements as real as possible.

Data Analysis: The execution was digitalized in APAS XP® Software in frame-to-frame digitizing mode. All data were analysed through descriptive statistics, in MS Excel® 2003 Software by calculation of mean, maximum angle, minimum angle and standard deviation.

Figure 3 – Sailor Hiking in Laboratory

RESULTS:

Table 1 shows values of mean, maximum angle, minimum angle and standard deviation for the variables neck flexion angle, thoracic kiphosis angle, lumbar lordosis angle, trunk rotation angle and trunk inclination angle.

Table 1 – Values of mean, maximum angle, minimum angle and standard deviation for the variables of the study.

Angles (degrees)	Mean	Max. Ang.	Min. Ang.	SD
Neck Flexion Angle	107,5	124,9	97,6	7,2
Thoracic Kiphosis Angle	147,4	155,3	139,4	3,4
Lumbar Lordosis Angle	171,4	149,8	212,5	3,9
Trunk Rotation Angle	4,7	36,4	-27,2	19,9
Trunk Inclination Angle	-7,4	12,7	-29,2	13,3

Figure 4 shows all angle variations during the execution:

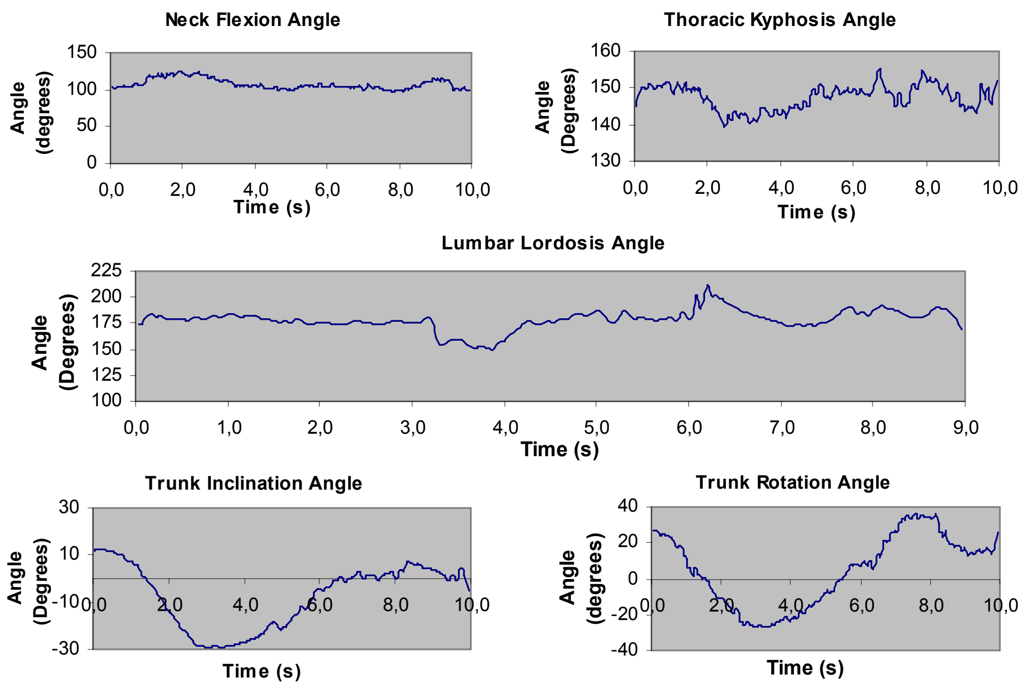


Figure 4 - Angle variations of trunk analyzed in this study by the time

The trunk inclination and rotation graphics demonstrate negative numbers. In this study, for these angles, the trunk anatomic position means 0º. The negative values of trunk inclination movements mean movements in rear direction, while positive values mean movements in front direction. The rotation angle also presented negative and positive values, which were due to movements performed by the sailor in order to watch the back and the front of the boat, respectively.

DISCUSSION:

Previous studies (Harrison and Coleman, 1987; De Vito *et al.,* 1993; LeDeroff and Ianchkine, 2001) analyzed biomechanical variables during hiking position. They considered the trunk as a fixed and immobile segment. In this study, graphics showed a great number of angle variations in a 10s hiking execution. One observed that the sailor's trunk performs, in the three axes, a sum of movements during the technical gesture.
Studies before the 90´s believed hiking posture was a static position, and all simulations performed in those years were based in isometric contractions. However the graphics showed in this study did not present that characteristic. Spurway (1999), corroborating with the findings of this study suggests a new term named "quasi-isometric" to describe the hiking posture. According to him, the muscles are continually making small adjustments to their length and their metabolic situation. This fact must be assumed in order to distinguish this kind of movement from exactly isometric postures.
In order to verify the angles and their possible consequences in posture and pathological conditions more subjects should be evaluated in future studies.

CONCLUSION:

This study identified the movements and adjustments performed by the sailor's trunk in hiking position. It was demonstrated that hiking is not a static posture. The body micro-movements executed to control and adjust the boat in the water during this posture must be considered. Therefore, when studying the sailors' hiking position researchers should not consider the trunk as a fixed segment.
Patterns of spine angles and movements and their consequences should be studied in future evaluations.

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