Considerations on the Role of Biomechanics in Performance Fighting Sports

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Abstract

Sports technique is very different from discipline to discipline and its acquisition is based on a series of physical, mechanical and biomechanical laws that ultimately condition the achievement of sporting performances. Biomechanics is an important science that allows in the fighting sports to establish a specific technique by analyzing the forces involved, the lever system used, in the positions of attack, defence and counterattack techniques. In addition, the forces acting on the body are conditioned by the condition of the bone, joint and muscular system, the position of the center of body weight, the weight of the athletes, the acceleration, and the level of their motor skills, strength, strength, speed, skill and mobility.

Practically, the correct use of biomechanics can become an important point of support in understanding technical training, which can lead to performance. The biomechanical characteristics of the movement must always be linked to the tactical intention of the fighter. The coach should offer the fighters the opportunity to experience how the technique will be applied in the most effective way in the combat situation.

Conclusion. There is a close link between the two areas, mechanical and biomechanical, and also an interdependence between them in the field of physical education and sport. Thus, knowledge of biomechanical problems allows coaches and specialists in the field to act on: the correct understanding of sporting techniques and the realization of programs that have the purpose of acquiring an efficient and varied technique; improving the primary selection criteria for performance sports; avoiding and preventing accidents in sport performance.

Keywords: combat sports , biomechanics , balance, stability, performance

9. Introduction

Sports technique is very different from discipline to discipline, and its use is based on a series of physical, mechanical and biomechanical laws that ultimately condition the achievement of sporting performances.

Biomechanics is an important science that allows in the fighting sports to establish a specific technique by analyzing the forces involved, the system of levers used in the positions and frequent changes of positions, specific to the techniques of attack, defense and counterattack. Thus, in combat sports, the movements preceding the action itself, such as displacements, sockets, unbalances, are very important. In addition, the forces acting on the body are conditioned by the condition of the bone-articular and muscular system, the body's center of gravity, the weight of the athletes, the acceleration, the inertia, as well as the level of motor skills, strength, resistance, speed, skill and flexibility.

For example, in combat sports, one of the main objectives of athletes is to remove the opponent from balance and change his/her position towards the support point, so that any finishing action can be accomplished by forcing the opponent to rotate around one or if the several axes (Manolachi, 2003). In order to achieve this rotation, I.Alihanov (1986) believes that two forces are needed: muscle strength, body mass, vertical reaction of the support point, kinetic energy of the body mass, reaction force of the point contact with your opponent, your own or opponent's forces, as well as the friction force of the mattress etc. In addition, there are other factors that influence and differentiate the reciprocity of fighters in engaging (Figure 1), such as: the support surface, the center of gravity of each fighter, the angle of resistance, the balance maintaining area (Manolachi, 2003).

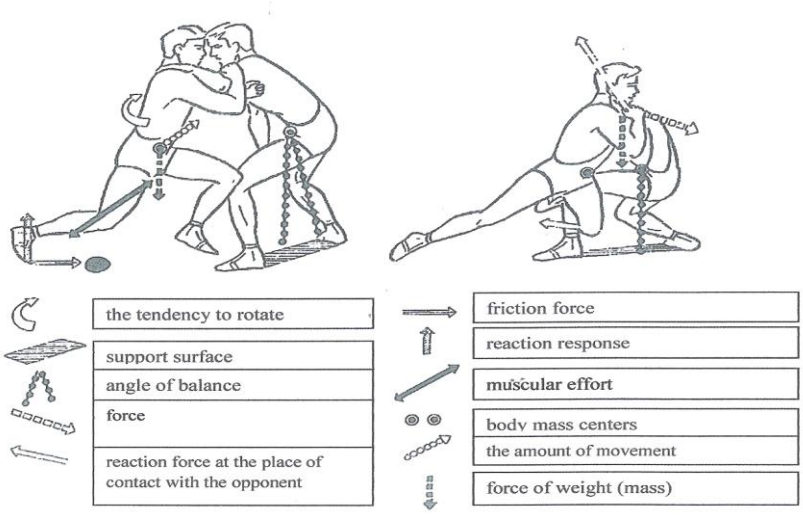

Figure 1. Reciprocity of fighter forces in the execution of a process (after Alihanov, 1986)

At the same time, the realization of an attack technique determines, through the threat it involves, a reaction necessary to the counterattack technique. Most often, this reaction consists in increasing the angle of stability and the direction of motion, knowing that the opposition of the rotation angle decreases the stability, so this technique allows the attack to be directed in this direction. When the attacks are numerous, the opponent's attention decreases due to various changes in the rhythm of the fight, and the opponent's tactical tactic fails.

Thus, let's not forget that training in combat sports must include real fighting situations to properly shape and develop gestures of open motor skills (unpredictable situations are frequent), which will then become automatisms. In order to quickly understand the real fight situation and to react effectively, it is necessary to execute the movements that have become automatisms in the training so that it can unbalance and design the opponent by winning the fight.

Starting from the above observations, it is clear that effective training in combat sports must include complex information in areas such as anatomy, physiology, physical anthropology, psychology, biomechanics, etc.

Next, we will try to analyze the role of biomechanics in the training of combat performance athletes, starting from the idea that a number of variables are important in the battle, such as reaction time, time and moment movement, speed, force and strengths, balance, stability, energy balance, etc.

According to the DEX[1], biomechanics (*bios* = life, gr. M*echane* = machine) is the science that studies, on the basis of general mechanics, the structure, evolution and functions of the animal and human motor apparatus (fr. *biomécanique*).

The main role of biomechanics is to understand the mechanical relationship of cause - effect caused by the movement of living organisms. In biomechanics, each movement includes three moments: intention, balance and execution. The biomechanics are not allowed to just happen or left to chance, everything is accurately calculated based on the knowledge of the position where the cop is found, the science itself allowing for mathematical calculations applied in the patterns it creates.

The biomechanics of the walking device is a science that studies statics, the movement of beings in the gravitational field. Thus, man seeks to define laws, conditions of movement, and their adaptation to the influence of the gravitational field.

Gravity determines the characteristics of the movement of beings, because it is the most important force acting on the human body. All other forces intervening in statics and the dynamics of the body result directly or indirectly from the interaction with gravitational force.

Gravity forces always act vertically, from top to bottom. Against them, cumulated internal forces act in the opposite direction, from bottom to top.

The point of reference on which the force of gravity attraction acts is called the **Weight Center.**

The location of the center of gravity depends both on the position of the body and on the relative position of the segments that make up it. Each segment having its own center of gravity by summing the gravitational forces that act upon it produces a resultant that will act on the body as a whole.

The notion of **equilibrium** is defined by the ability to achieve harmonious movement or to maintain a static (stable) position. The balance is directly dependent on the position of the center of gravity of the body.

J. Catala (1979) and P.J. Rasch (1991) divide balance into three categories: ***static balance*** (the body is resting), ***kinetic balance*** (the body is motionless and uniform) and ***dynamic balance*** (the body maintains its balance through inertia rather than the forces applied to it). In the case of static equilibrium, there are three possible stages: unstable, neutral or indifferent. Stable equilibrium is defined as the ability of the body upon which a disturbing force is exerted to return to the original position. It increases if the sum of the forces exerted on the body, as well as the sum of moments of force, is equal to zero (Hibbeler 1989).

In the practice of combat sports, a sportsman's body exerts a force (action) on the opponent's body, which in turn opposes a force (reaction) equal in magnitude, but to the contrary. This is the way in which the two athletes maintain their stability, preserving and recovering their respective static or dynamic equilibrium positions (Figure 2).

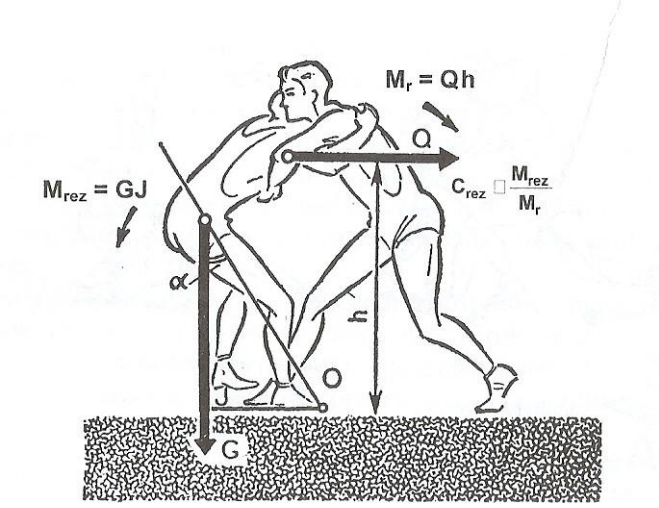

Figure 2. Correlation of forces and moments under relative equilibrium conditions (after Kuptov, 1978)

If the opponent's body cannot resist a force equal to the action of the body of the athlete, his stability is lost, so that the first one reaches an unstable equilibrium position, difficult to control (risking imbalance or projection), with one of the specific techniques.

As for the gravitational attraction due to it, the gravitational field determines the characteristics and properties of the bone system (size, consistency, position, strength). The very notion of equilibrium is the consequence of the gravitational attraction. Both the will and human ability to move are subject to the limits of the action of gravity, i.e. the ability of the body to react to the gravitational pull.

The fall of a fighter after being designed by a discipline-specific technique is a clear example of this effect - gravitational. If the direction of a force passes through the center of gravity of the body, this force only modifies the body's translational movement without changing its possible rotation. On the contrary, if the direction of that force does not go through the center of gravity of the body, it changes the translational movement and the body's rotation movement.

Moreover, in the absence of air, its friction force, the bodies fall at the same speed, regardless of their mass and volume. Accelerating the athlete's body reductions due to the gravity effect would be constant if the kinetic energy produced by the opponent did not intervene. It develops a force (kinetic energy) that imparts an acceleration to the opponent's body during contact, changing its speed, magnitude, and direction. Both bodies, the athlete and his opponent stay together after the contact, moving at the same speed.

As most of the movements of athletes are complex movements, several muscular groups with synergistic or antagonistic action in kinematic couples are mobilized in their realization. Cinematic differs from biomechanics by studying the movement itself without being concerned about its causes, while biomechanics explains the foundation and cause of the movement.

The kinetic structure of the unbalance process in combat sports, for example, represents the morphological and spatial configuration of specific techniques and their spatial dynamics, articulated in the determinant phases of clearly differentiated executions.

In the complex movements there is a merging of the dynamic activity of the muscles with elements of static activity. In this context, the specialists recall three phases of the execution of the movement: the preparatory phase, the initial phase and the final phase.

The kinetic structure of the movement is a totally flexible and not rigid, mobile and invariable, where the various elements influence each other so that we can also speak of interdependence phases.

Returning to the kinetic structure of the imbalance process, for example, we find that it has three phase phases, which have a special temporal and dynamic character, being independent and autonomous, but dependent on two factors:

- the purpose/goal;
- the dynamic stereotype formed in the process of practical training through exercise and training.

I. Pavlov speaks of the necessity of *"ordering the forces in the connection space of the dynamics with the cerebral structure"*, which leads us to the idea of that cortical mosaic without which the movement would not be so varied in its manifestation.

From this perspective, we can consider the fighting techniques as acyclic movements, with a three-dimensional structure: spatial-temporal; dynamical-temporal movement and pace of movement, their learning being motrically intelligent.

The kinetic structure in phases of the imbalance process is determined by the static/dynamic balance of the two athletes. Improving the training process thus involves selective routing of the functions of the vestibular apparatus, starting from the fact that the walking device is the one that has the task of producing the movement, which fully justifies the biomechanical approach to the training process, both while its components are also biomechanical elements.

Starting from the function that the anatomical elements fulfill and their morphology can be deduced the biomechanical aspect, because between form and functions there is a close connection.

Ideal with regard to the technique of combat balancing is the use of a minimal force to design the opponent who is thus brought out of the stable static equilibrium position and brought into an unstable equilibrium to execute a process.

Combat sports are sporting disciplines where the basic technique of executing basic movements is a very important part, essential being the stability of the bodies, the force and moments of the application of force.

Stability is a relative concept - in the same situation stability may have more or less equilibrium, defining the basis of support and the height of the center of gravity (Gutiérrez, 1998). The condition that a body is in balance is the result of external forces to or equal to the moment of force applied to the body.

The formula for calculating the stability coefficient is:

$$CS = \frac{G \cdot d}{F \cdot h}$$

Where:
C.S. is the coefficient of stability; G - gravitational force; d -distance to the limit of the support base; F - applied force; h - the height at which the force is applied.

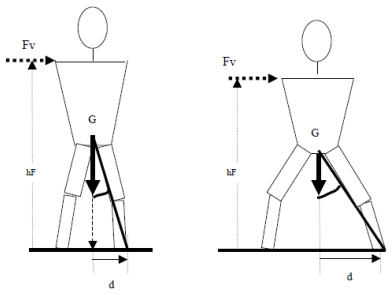

Figure 3. Parameters for determining the stability coefficient and the angle of stability
(after Donskoiand Zatiorski, 1988)

The support base is a **supporting polygon** (Figure 4a) - formed by joining points that delimit the outer edges, fingertips and calcaneus. The higher the area of the polygon perimeter - in the defense position, for example, the greater the stability and maintaining the contact of both legs of the athletes with the combat surface gives it more stability than if only one foot is on mattress. The stability degree in this situation is given by the angle of stability (Figure 4b), which is the design of the center of gravity on the surface of the support polygon and the oblique line joining the center of gravity to the side of the polygon in the direction in which stability is determined. The higher the stability angle, the greater the stability of the athlete.

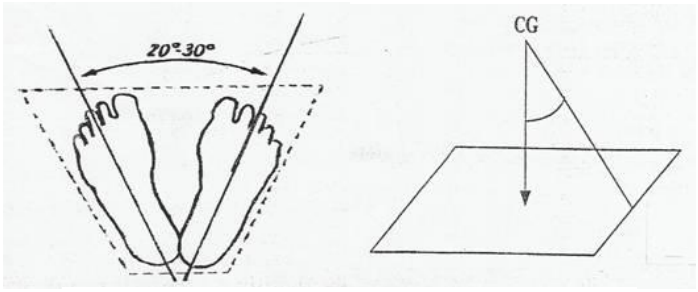

Figure 4. a. Supporting polygon and b. Stability angle

However, beyond the supporting polygons, the position of the body and limbs of the athlete, as well as the weight center projection, can determine their stability. Thus, in Figure 5, for example, the position of the athlete in red is advantageous, its stability being achieved by placing the body outside the support polygon and supporting the opponent's shoulder blades.


Figure 5. Athlete's position in favor (in red)

Generally, the exit of the center of gravity outside the support pole adversely affects the stability of the fighter, and this happens when the fighter performs torso flexions during the fight, so the body segments change their position and hence the center of gravity. Fortunately, this relative instability is offset by the ability to support the opponent. In fact, during the fight, we are talking about the presence on the battlefield of two athletes, and the problem of individual equilibrium is at one point turning into the issue of the balance of the couple formed by both athletes, which is not given by the sum of the individual support surfaces, the area bounded by the lines passing successively through the support points. As a result, the center of gravity of the couple's athletes passes through them as long as they are in contact. Abrupt breakage of the contact destroys this type of torque equilibrium and can even endanger the individual balance. The solution, in the latter case, would be for the athlete to step elastically towards the direction in which it would be unbalanced, trying to attenuate the opponent's movement by adequate muscle strength at the level of the segments with which they are in direct contact with the opponent. If he wants to balance his opponent then he must reduce all his possibilities to rebalance.

Also, according to Gheorghe Cismaş (1988), the particulars of the neuro-muscular system (kinetic analyzer) are important. From this perspective, the ground positions are those that are characterized by the highest degree of stability due to the support points and the center of G.

Changing the center of gravity by moving from static to motion will also cause biomechanics of the body to change, with muscles, joints, tendons, ligaments, etc. The human body's center of gravity under normal conditions - the body in orthostatic position - is located on the axis of vertical symmetry of the body in a plane parallel to the ground that intersects the body at the lower abdomen (about 3 cm below the navel) or at the level of the second sacral vertebra, equivalent to 58% of the height of a man and 56% of the height of a woman (Luttgens and Wella, 1982).

When the center of gravity projects to one side of the support polygon, the balance decreases in that direction.

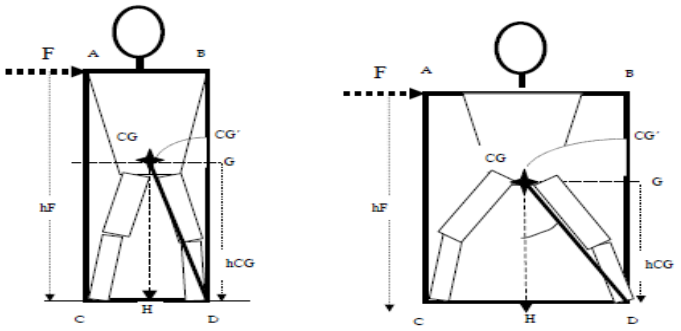

Figure 6. Changing the center of gravity and stability of the human body
(Watanabe and Aviakan 1990)

The position of the center of gravity depends on the state of equilibrium, and in order for it to be optimal, the following requirements should be met:

- the distribution of human body weight at the sole should be symmetrical - requirement met when C.G. is in the optimal center-center position;
- the center of gravity must be as close to the ground as possible, the projection being within the soles formed by the soles;
- the ground support surface at ground level is perfectly flat.

Among the objectives of biomechanics in sport, we have to mention the instruments for the evaluation of technical executions (García-Fojeda, Biosca and Vàlios, 1997) and criteria for determining the effectiveness of applying the laws of classical mechanics in the execution of movements (Walker, 1980).

Practically, the correct use of biomechanics can become an important point of support in understanding the basic components of technical training, which can determine performance. Thus, sports practitioners, physiotherapists, coaches and sports scientists have to work together to structure training programs that improve performance and prevent casualties specific to each sporting sector.

The morpho-functional components, which are nothing but the organs of the walking system (bones, joints, muscles) and the organs of the nervous system (receptors, sensory nerves, spinal cord, encephalus, motor nerves, motor plates, gamma systems), are the basis of human body motions. The moving organism should be regarded as a whole, as a whole, the movement being the result of the action of all the morpho-functional components mentioned. The entry into action of these factors and their mechanisms are stereotyped and can be considered as principles. The biomechanical features of the movement must always be linked to the tactical intention of the fighter. The coach should offer the fighters the opportunity to experience how the technique will be applied in the most effective way in the combat situation.

Conclusion. There is a close connection between the two areas, mechanical and biomechanical, but also an interdependence between them in the field of physical education and sport. Thus, knowledge of biomechanical problems allows coaches and specialists in the field to act:

- on a deeper understanding of the sporting technique and the realization of programs that have the purpose of acquiring a correct and varied technique;
- on improving the primary selection criteria for performance sports;
- in order to avoid and prevent accidents in sports performance.

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Correction of Faulty Attitude and of Physical "Kyphosis" in Children Using Specific Means of Gymnastics and Swimming

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Abstract

This work aims to submit a complex programme of specific means of gymnastics and swimming for the purpose of correcting posture and rectify spine Kyphosis in children (12-14 years old) as the number of people suffering from obesity is getting higher and their sedentary lifestyle has become one of the characteristics of the daily life. Doctors warn that more and more children weigh more than normal since they show no desire to practice a sport and prefer the TV or the computer as ways of spending spare time. The lack of any physical activity shall be reflected in the deficiencies in the physical development, particular in the spine. The main purpose of this research is the improvement of the detailed rules for the application of some specific exercises in gymnastics or swimming in order to correct the kyphotic attitude and to rectify kyphosis.

Keywords: deficiencies physical, specific means, swimming, gym

Introduction

The correction of the attitudes and physical shortcomings in the aquatic environment and on land is a problem of topical interest, taking into account the small number of specialized publications in this field. A series of physical deficiencies are well-known and there is a longing for positions of the body to be influenced by beneficial swimming and gymnastics specific exercises. Explaining the purpose of these exercises, using the means and methodical indications of the actuator in water and on land, I watched the standing committee compliance with the principle of hippocratic "primum non nocere".

The exercises are arranged in an easy and accessible form, knowing their influence over the musculo-skeletal system, cardiovascular disease, respiratory, the nervous system and metabolism. The implementation of these programs in water and on land means for those interested useful models and sources of inspiration (Mergheş and Țeghiu, 2006).

Objectives of the research:

- general body tonification;
- a better toned spinal in the dorsal area;