The study of Taekwondo kick techniques from the biomechanics point of view.

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Taekwondo has a rich technical arsenal in terms of quantity and quality. It is no worse than the techniques of Chinese Wushu or Japanese Karate, and is in many ways superior to them.
Thanks to the fact that Taekwondo has such a legacy as the "Encyclopedia of Taekwondo", written by our founder, General Choj Hong Hi and also the proper structure of the International Taekwondo Federation (ITF) work which constantly watches over the development and improvement of Taekwondo as a martial art which is constantly being perfected.

In the world of martial arts, Taekwondo is widely recognized for its range and the advantages of its foot techniques.
Taekwondo's arsenal of foot techniques is so great that in order to cover it completely, a separate book in which each technique is described from the point of view of biomechanics (the physics of the human anatomy) would be needed.
Hence, the single technique that I will attempt to describe in this article is nothing more than a drop in the ocean when compared to a full study of the range of such techniques available in Taekwondo.
The process of comprehending the art of kick techniques can be compared to the construction of a pyramid consisting of an acquired knowledge of skills and habits. Each new brick laid at the bottom of the pyramid contains information about the rules and requirements the observance of which is necessary in the study of a specific technique. Following the existing rules and requirements will bring about the formation of the necessary skills and abilities. If a person is not diligent in their study of any technique and does not understand the rules and requirements relating to that technique, then a poor-quality brick is laid at the base of the pyramid. This means that the pyramid is vulnerable in this place. The more such low-quality bricks there are, the more imperfect the construction. It follows that, the study of foot techniques should be approached with particular thoroughness in the preparation of both body and mind.
In building your own pyramid, first of all you should not be

frightened of difficulties remembering that, as you master the foot techniques what once seemed impossible will become merely difficult, complicated becomes habitual and in time habitual becomes easy.

The general concept of the kick techniques.

The technique of kicking is diverse and requires deep, serious, theoretical and practical study. When it comes to Taekwondo's techniques in general, and in this case, the foot techniques are an effective form of rationally constructed kicks, which take into account the patterns of motion. The technique of kicking does not remain unchanged becoming more and more effective primarily as the motor skills and habits develop. Despite the individualization of the kicking techniques and continuous improvement, there are specific technical concepts (rules and characteristics), the observance of which is necessary to attain improvement and a complete understanding of the full details of the technique from the viewpoint of biomechanics.

The basic kick technique consists of a series of linked movements which can be viewed as separate parts.

The basis of the kicking technique is the totality of those links and features of the structure of the movement that are necessary to carry out the manoeuvre in the prescribed manner (the order of implementation of muscular forces, the main moments of coordinating movements in space, time, etc.)

Missing or breaking even one element or the ratio of the given totality makes impossible the execution of the move itself.

The main stage or stages of kick techniques are the most important parts of the manoeuvre in this method. The movement performance of the main stage usually takes a relatively short period of time and requires considerable

muscular effort. The details of the kick techniques are usually referred to by their individual components in which variations of the technique of an unprincipled nature manifest themselves. They often differ because of the diverse morphological and functional characteristics of individual practitioners.

It is undesirable to deviate far from its general basis even if individual differences in the details of techniques exist.

It is a mistake to take as a standard the kick techniques used by any particular athlete because their techniques are always individual to them. Mechanical copying often leads to negative results. The kick chosen to be described in this article is intended to be a model. This kick was chosen because it is the one most frequently used during bouts. Compliance with the basic techniques of the described kick, even allowing for a certain degree of individualization, will allow the student to master and apply it in practice with little difficulty.

A kick is the process of transferring kinetic energy from one body to another. As the kinetic energy is proportional to the mass(m) of the moving body and the square of its velocity(v^2) it can be enhanced by increasing the speed of the striking foot. However, it is important to take into consideration that the increase in the kick's energy is also achieved by converting the energy of a significant mass of the body moving with a small speed, significantly accelerate the strike. This is focused by the study of biomechanics, the "phased" composition of the kick, the preparation of the muscular apparatus of the fighter, the technical kick performance and the training process as a whole. The technique of impact, the legs distinguish between direct and side impacts, which imposes some differences on the biomechanics of increasing the speed of the striking limb. In side kicks this is mainly achieved by increasing the angular

speed of the lower leg. In direct kicks, the wave principle of the formation of the kick's kinetic energy is very effectively used. This is the so-called "whip" principle. The wave movement of the whip demonstrates it very well.
The massive handle of the whip through a wavy movement with a low speed transfers energy to the elastic body of the whip. At the same time, the speed of the wave increases toward the end of the whip, as the weight of the whip's body decreases linearly to its end. The same type of process of transforming the energy of a fighter's body moving with a relatively low speed towards the enemy creates a wave along the body that transforms the energy of the body's motion into the increased speed of the striking foot is due to the elasticity of the muscles. In general, the phase of the end of the kick is not the kick itself but the fighter's position in the so-called "gathering" phase. From the biomechanical point of view the technical performance of this phase has variations depending on the results of the interaction of the fighter's body and that of their opponent. When the kick is completed, that is, when the impulse of the movement is completely transferred to the enemy, the process of "gathering" is greatly simplified by the reverse impulse. In the case of a miss or insufficient kicking power, "gathering" requires not only significant muscular efforts on the part of the fighter but increases the time available to his opponent for retaliatory actions.

In concluding a brief review of the biomechanics of kicks, one should note the general rule of carrying out preparatory phases of the kick consists of rotational movements and swiveling the body. These elements of technical actions should be carried out whenever possible with the minimum possible moments of inertia of the bodies of rotation, during which the legs and arms must be tightly pressed against the body of the fighter.

Side - direct kick (Yuop chagi)

The kick can be divided into 3 parts that are interrelated and form the basis of the technique. These parts are called the preparatory, basic, and final stages.

The importance of the **preparatory** stage is to create the most favorable conditions for the completion of the final movement in the **main** phase.

When analyzing the description of the kick:

a.) the preparatory part of a kick is called the “charge phase”,
b.) the main part of a kick is called the “final phase “,
c.) the final part of a kick is called the “gathering phase”.

In addition to these basic 3-phases, there are many intermediate phases, the number of which is determined by the trainer for a more comprehensive understanding of the kick’s structure or for correcting mistakes.

The order of the performance of the kick.

Contacting foot zones are foot: footsword, heel.

The technical performance of the kick includes the following phases:

1. Preparation for the initial phase of the kick.
2. The initial kick “phase”.
3. The kick “phase”.
4. The return phase.
5. Return the foot into the fighting position.

1.1 From the fighting position (Fig.1) the start of the kick "phase" (Fig. 2) begins with the lifting of the thigh initiating the kick and changing the position of the pelvis.
Pelvis reversal occurs when the striking foot is level with the knee. The heel of the striking foot follows the thigh, changes the initial trajectory and is redirected to the side of the kick simultaneously with a horizontal turn of the pelvis, the foot of the supporting leg turns 90 degrees and the heel is directed towards the kick.

Fig.1 (fighting posture)

Fig. 2 (initial “phase” output)

2.1 The initial "phase" of the kick (Fig. 3 and 3.1), the thigh and the lower leg performing the kick , are parallel to the horizontal plane, its heel and the heel of the supporting leg are aligned in the direction of the target, the trunk is sideways on to the direction of kick , the shoulder of the (left) arm is laid back and down, using the muscles of the back, which do not allow the body to deviate significantly in

the opposite direction to the kick. The right arm protects the trunk, the sight is directed to the trunk and is significantly deflected in the opposite direction to that of the kick, the right (front) arm protects the trunk, the sight is directed towards the kick. The output to the initial "phase" of the kick can be divided into components, so as to visually represent the kick model. This is the raising of the hip and the turning of the pelvis onto a horizontal plane, but it must be remembered that the kick is one continuous movement and the separation of these phases only happens in training.

Fig.3
(initial kick phase)

Fig.3.1
(initial kick phase)

3.1 The "kick phase" (Fig. 4 and 4.1) is performed by active extension of the thigh, which kicks, the kick is strengthened by the active translational movement of the pelvis in the direction of kick, in which the knee and heel are in line, moving along with the thigh in the horizontal plane, at the moment of contact, the supporting leg and the second leg which carries out the actual kick, are absolutely straight, their heels are directed towards the side of the kick, the

trunk is in the side position, the left (far) arm is drawn back and down, the right arm protects the trunk, the sight is directed to the kick side.

(Fig. 4 . The kick phase)

(Fig. 4.1 The kick phase)

4.1 The foot return "phase" (Fig 5) is as important as the kick phase, because a quick return of the foot will not allow the opponent to grab the foot and will quickly return to the fighting posture and, if necessary, continue the attacking actions or make an output to a safe distance. The leg returns to the initial "phase" of the kick along the same trajectory as the kick and no less quickly than the "phase" of the kick itself. It is a mistake to consider that the kick ends at the moment of contact with the target, and that the leg is then put down, without any particular control.

(Fig 5. Return phase)

(Fig 6. The foot placement in the fighting posture).

5.1 The placement of the foot in the fighting posture is carried out actively and consciously, the fighter must know where to put the foot and what actions will follow. After the return of the foot, with an active change in the position of the pelvis with simultaneous transfer of the center of gravity, the leg assumes the fighting posture (Fig. 6).

Let us consider some of the specific phases presented by the techniques of side-kick in terms of biomechanics.

The preparatory phase (or the charge phase).

After actively raising the striking foot and turning the pelvis to a horizontal plane, the body of the fighter (Fig. 3) is in a state of unstable equilibrium with the natural output from it with the movement of the pelvis towards the kick. The moment of inertia of this motion is largely due to the body's weight and the length of the supporting leg, but the speed of movement is low. Further, this pulse is greatly increased by the moments of inertia of the bending hips and lower leg. As a result, the energy of all three rotational movements is summed up in the energy of the translational motion of the striking foot, which significantly increases its speed.

Considering the “gathering” phase. Figure 4 shows the kick phase, which is the initial point of the “gathering “phase. The transition from kick phase to the gathering phase differs only in that the kick force from the heel at the moment of impact generates an equal and opposite reaction the energy of which is converted into reverse rotational movements of the thigh, lower leg and pelvis.

The training is completed by the analysis of this technical action performed in the dynamics of hitting heavy punching bags and the application of a kick in sparring. (Fig. 7)

(Fig .7 Kick application).

General Choi Hong HI wrote - "be afraid of the imitators of Taekwondo."

To ensure that the next generations of Taekwondo fighters do not learn the techniques of kicks and blocks only visually, as in some other martial arts. The training of young athletes at entry level, of conscious age, must be conducted with an explanation of the technique of kicks and blocks in terms of biomechanics. They should not only be able to physically perform the movement, but also understand every moment of the action performed from this point of view and be able to explain the process.

In teaching athletes scientifically based techniques, any trainer will be able not only to maintain techniques but also to avoid injuries, the sport's specific injuries.

Our International Taekwondo Federation takes care of preserving the classic technique of tulle and traditional sparring, developing Taekwondo KIDS programs and the Harmony course, conducting workshops and master classes on sports sparring. Unfortunately, we do not yet have seminars that explain Taekwondo-Do as a science-based form of single combat. In conducting such seminars, we would also raise to the next level such sections of the tournament as impact force, power tests special techniques and sports sparring.

I think this would give a new impulse to the development of all sports disciplines within Taekwondo.

Taekwondo is a scientifically grounded, complex-coordinated and accurate type of sport, in which the concept of "School" is very important. This is our heritage that we must not only preserve but also improve.

Literature.

1. Choi H. H. - Encyclopedia Taekwondo, 15 volumes. Edition (in Russian) - 2000
2. Choi H. H. - Encyclopedia Taekwondo-Do. Edition (in Russian) - 1993
3. Simakov A .M (Candidate of Science, associate professor, head of the department) - Scientific notes of the University of Physical Culture named after P.F. Lesgafta - 2015 .
4. Safonkin S.N. - Taekwondo. Edition St. Petersburg State Academy of Physical Culture named after P.F. Lesgafta - 2001
5. S.N. Safonkin. Secrets of Taekwondo. Ministry of Education and Science of the Russian Federation, Cherepovets State University, Faculty of Biology and Physical Culture. - 2014