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SOME SPECIAL BIOMECHANICAL QUESTIONS OF OLYMPIC WEIGHTLIFTING

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Abstract

The paper deals with some special questions of biomechanics, successfully applied in the analysis of technique of weightlifters. Special attention is paid to the following topics: efficient technique, ideal trajectory, analysis of the barbell+lifter system, change of category from point of view of biomechanics.

Key-words: *biomechanics, performance, technique, trajectory, weightlifting*

Introduction

There are different lifting branches (e.g. stone lifting, power lifting), one of these sports is weightlifting. Modern weightlifting (Olympic lifting) is not only an individual sport branch, evaluating the performance in snatch and clean and jerk, but this is a basic sport, the background for many other sport branches, fitness for almost all other sports(1). Trying to give an appropriate definition of modern Olympic lifting I agree perfectly with opinion of a former excellent lifter, today a well-known specialist in weightlifting, Dragomir Cioroslan (1997): "*Olympic weightlifting is a sport of outstanding neuromuscular coordination, fine kinestetic perception, agility and ability to perform accelerated and explosive movements in a specific line of technique with maximum accuracy*."

There are many factors influencing the performance level of the lifters, e.g. the physical, biological and mental parameters of the competitors, the volume and intensity of the training, the conventional nourishment and the application of food supplements, the level of coaching etc. Naturally, if we speak about the performance of top lifters we should not forget to mention the application of scientific knowledge, which is becoming increasingly important in order to maximise the performances in order to increase the chances to win medals at the major international competitions, the World Championships and even at the Olympic Games.

One of the possibilities of application of modern scientific knowledge in weightlifting sport is to use the achievements of biomechanics. This can be carried out for example in the following directions:

- to study the dynamics of movement
- to analyze the lifting technique
- to determine the efficiency of the lifts
- to analyze the movement of the barbell+body common system

In order to carry out such types of measurements, sophisticated monitoring and measuring system, the equipment to analyze the lifting and the technique of he lifters in training and in competition are all needed. Therefore, the biomechanical experts should employ computers, video equipment and specialized sensors. In developed countries paying special attention to application of the newest results of scientific research, there are some special possibilities of biomechanical character in use, e.g. the measurement of 3D external and internal kinematic parameters (barbell trajectories, barbell velocity and acceleration, horizontal and vertical displacement, angular velocities in the hip, knee and ankle joints etc.) and application of force plates, mounted into the platform, containing sensors to record the ground reaction forces and some other high performance techniques, like ultrasound, magnetic resonance (MR), computer tomography(CT) and others(3-9).

In this paper, it is not indended to carry out a general biomechanical analysis of Olympic lifting, instead, only the following special topics are to be in focus:

- good technique, efficient technique, development of technique and strength
- mechanics – biomechanics – economy
- optimum trajectory, ideal technique
- change of category from point of view of biomechanics

Good technique - efficient technique - development of technique and strength

To my mind it is not correct if the coaches sharply differentiate between strength development and technique development (improvement) using classical competition lifts. The reason is quite simple: with low intensity weights it is not possible to develop technique, because e.g. in case of exercise with 50 % intensity weight the trajectory of the lift is completely different from the ones that the lifters use in case of sub-maximum or maximum weights. On the other hand, if the weight exceeds the minimum requirement (70-75 %) for improvement of the technique, this interval is typical for the dynamic strength development, and even in case of higher reps it is convenient for maximum strength development, as well. Thus, if you improve the technique in the same time it is good also for strength development.

Based on the principles of biomechanics, it is evident, that each weight (different intensity!) needs a different technique; if we would like to perform an optimum lift from a biomechanical point of view. The good technique means at the same time an effective and economical technique, and the evaluation of the trajectory with the given weight can be carried out only as a function of this fact.

Mechanics – biomechanics – economy

The task of the lifter, naturally according to the valid technical rules, is to lift the barbell (bar with the discs) to the necessary height. This height depends on the anthropometrical parameters, the weight category of the lifter, the skill of technique as a function of flexibility, the level of development of muscles etc. From a mechanical point of view the vertical trajectory of the lift seems to be the optimum, because the lift should be performed in a gravitation space, and the vertical trajectory is the shortest way. It is known that the labour (energy) required to perform the lift is proportional to the product of multiplication of force (weight) and way (trajectory). Of course from the point of view of mechanics we have to take into account the question of turning moments, as well; turning moment is the measure of force multiplied with lever, which is necessary to be minimised. It is easy to understand the difference if we compare the work, carried out by the lifter with e.g. 50 kg load on the bar, having 2 different positions. The first: the bar is on the chest, so the centre of gravity of the body and the centre of gravity of the barbell is approximately on the same vertical line. The second: the bar is held by the lifter with straight arms, in a horizontal position, and there is no coincidence regarding the centre of gravity of the lifter and the centre of gravity of the barbell.

Clearly, weightlifting is not pure mechanics, but biomechanics, so it is a science applied for movements in biological systems. The lifter never lifts the weight perfectly vertically, and the lifter does not only lift the barbell but also his/her bodyweight. Therefore, when analysing the technique, we should take into account not only the movement of the barbell (trajectory) and the movement of the centre of gravity of the bar, but analyze the common (body+barbell) system and the movement of the common centre of gravity.

Optimum trajectory – ideal technique

The exercise carried out by the lifter is in that case close to the optimum, if during the lift the movement of the common centre of gravity is vertical and the energy requirement based on the turning moments is on the minimum. Based on these principles the different loads (different intensities) need different trajectories, if we speak about ideal ones. The ideal technique is never absolute, it is always individual, because of the anthropometrical differences among individuals. At the competitions, expecting the maximum results from the lifters, athletes have to perform lifts with maximum or almost maximum weights, and the successful lift is possible only by using optimum or close to the optimum techniques. The maximum or close to the maximum weights need a similar (rather stabile) trajectory, therefore the ideal weight for technique improvement is approximately 80-85%. This intensity is high enough for the optimization of the trajectory (biomechanical point of view) and it is still not an exceedingly high psychical load because of the high intensity.

Change of category

Based on the statement referring to the common centre of gravity, it is not difficult to understand that the ideal technique does not only depend on the intensity, but the body mass of the lifter (the category) has an impact on it as well. Therefore, changing the category also changes the common centre of gravity, even in case of the same intensity. Accordingly, we need a slightly modified technique in comparison with the previously used one, because of the fact that during the lifting not the barbell, but the common centre of the gravity should be lifted vertically, and owing to the change of the body mass of the lifter, it also changes the centre of the body+barbell system.

It is necessary to mention that the question of technique-modification as a function of category-changes is more difficult; there are other and not only biomechanical parameters we have to take into consideration. In the current paper, these factors are not discussed in detail, but the most important ones are: change of body-composition, change of level of development of different muscle groups, change in the flexibility and in the joint mobility, change of the ratio of agonistic and antagonistic muscles.

Conclusion

As a conclusion, the opinion of an Indian thinker, Swami Vivikananda may be cited: "*Your way is the most appropriate one for yourself, but it is not applicable for other people. Always use your own way, and do not copy the others*." This view also seems to be relevant in case of the technique of Olympic lifters. Every individual human being has to have his/her own technique, which can be rather different from the technique applied by other people with other body parameters. Of course if somebody would like to carry out an optimum technique, this should be based on appropriate biomechanical principles. It means, not the barbell, but the centre of the gravity of the common (barbell+lifter) system should be lifted vertically.

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