QUANTIFICATION OF TECHNICAL SKILLS IN WEIGHTLIFTING

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INTRODUCTION: Weightlifting is a sport in which a weight shaped as a barbell must be brought from a position on the ground in front of the weightlifter into a position above the athlete's head with the legs and arms stretched. There are two different Olympic Techniques, the 'clean & jerk' and the 'snatch'. In this study we have investigated the snatch technique. The path of the barbell (Kazuo *et al.*, 1996) was identified as one of the most important indicators of the quality of the movement. There is no priority path that can be identified as the most desirable for being successful as a weightlifter. However, by comparing many trials a certain path seems to coincide with a good and successful snatch. Garhammer (1984) suggested taking the kinetic energy of the different body segments as an indicator for quality. We hypothesize that a well-performed snatch needs to be an (muscle) energy effective movement that results in a certain path of the barbell, as seen by the research mentioned above. To prove our hypothesis we compared the path of the barbell and the muscle energy for successful snatch movements.

METHOD: Subjects with 19 markers were videotaped by five digital cameras of 50 Hz (PAL standard). Using the APAS system, we digitized all views. The tracks of the markers together with the anthropometry of the athletes are the input for a simulation system (SDS 6.2 of Solid Dynamics). We calculated the path of the barbell as the coordinate between the two hands. The muscle energy was approximated as $E_{mus} = \sum_{j,k=joining\_segments} \int_0^t \left| \left(\vec{\omega}_j - \vec{\omega}_k \right) \cdot \vec{T}_j \right| dt'$ (Vieten, 1995). So far, for this project in progress we have analysed the movement of two weightlifters.

RESULTS AND DISCUSSION: The smootherst shape of the path of the barbell coincides with the movement of highest quality as rated by a coach. The less skilled weightlifter needs much more muscle energy in comparison to the technically advanced athlete (see Table 1).

Table 1. Performed trials.

Subject 1, mass=105kg, height=1.87m			Subject 2, mass=105kg, height=1.80		
Trial	m [kg]	E [J]	Trial	m [kg]	E [J]
1	80	5421	1	90	58044
2	85	7872	2	110	59777
3	90	8088	3	115	88152
4	100	9385			
5	110	10738			

The enormous differences in muscle energy are seen in all trials. The results are very little dependent on the athlete's anthropometry since we simulated the movement by using different model anthropometries without much difference in the outcome.

CONCLUSION: Should additional data support our previous findings, then muscle energy can be established as an extremely sensitive tool for monitoring the technical skills of the weightlifters. It is not clear yet if a correlation between the characteristic patterns of the path of the barbell and the muscle energy can be established with the appropiate accuracy. But at least the final stage of this study should answer this question.

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