ANGLES AND MOMENTS DURING UNRESTRICTED AND RESTRICTED SQUATS

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INTRODUCTION

Squat is one of the most used exercise in sport and rehabilitation. Squatting belongs to the highest risk in training due to overload or wrong execution [1]. 50 % of all injuries during training concern the lower extemities or the back. Hence, a correct execution of the squat is important not to compromise the effect of the training [2,3,4,5]. Wide distributed guidelines to barbell squat cite the need to keep the knees from moving forward past the toes. To our knowledge, the instruction for squats regarding the position of the knee are based on studies of [6,7,8] and are established in the NSCA [9] and in Europe.

From a biomechanical point of view it as been discussed that during the movement of the knee beyond the toes, shear forces accrue that might harm the knee [8]. This shear force is below the ultimate load of healthy cruciate ligaments [10,11]. As a second argument, the pressure between the patella and the femur rises with the flexion of the knee [12,13,14]. This pressure in general seems to be within the limit of the tolerated load [11].

This study was designed to compare the angles of the knee and the hip and the corresponding moment during unrestricted and restricted squats.

METHODS

Kinematics and kinetics of squat exercise was evaluated using a 12 camera 3D Vicon motion (Oxford, UK) system. They performed restricted and unrestricted squats with zero, 25%BW and 50%BW loading. Each foot was on a Kistler force plate (Winterthur, SUI). The marker set [15] consisted of 53 skin markers including 20 for the spine. Joint centers were functionally defined and the estimation of the joint rotations was based on a least-square fit of two point clouds and orthogonal anatomically defined joint coordinate systems [16]. For the calculation of the moments an inverse dynamics based on the position of the body and the ground reaction force was performed.

RESULTS AND DISCUSSION

Here, we present preliminary results of one subject. As expected, the maximal moments during restricted squats are lower in the knee and higher in the hip. At a knee flexion of 60°, the moment in the knee is the same with no load and 10% respectively 14 % higher with 25% and 50%BW for the unrestricted squat (Figure 1). In the hip, the moment is 34 to 40% lower for the unrestricted squats (Figure 2). This leads based on theoretical consideration to a smaller load of the lower spine. Whereas the angle of the knee is higher for unrestricted squatting; in the hip, the flexion angle is similar in both conditions. Therefore, compensation mechanisms like flexion of the spine are expected to counter act these differences.

CONCLUSIONS

The higher moments in the hip and the load of the lower back are strong arguments to reevaluate the role of “no knee in front of the toes”. The instruction of the exercise should be adapted to the aim and condition of the subject.

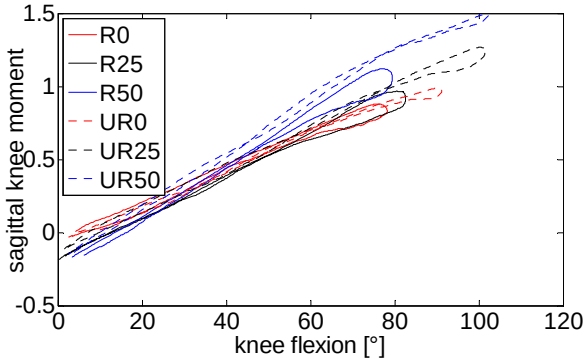

Figure 1: Knee flexions vs. moments for restricted (R) and unrestricted (UR) squats.

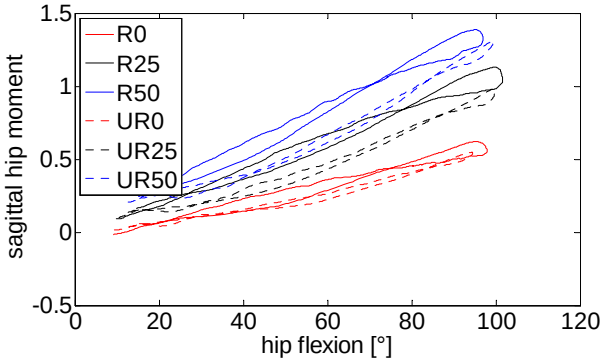

Figure 2: Hip flexions vs. moments for restricted (R) and unrestricted (UR) squats.

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